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Appendix F
IESC Report

Groundwater Modelling Technical Addendum

NEW ACLAND COAL

New Acland revised Stage 3 Project AEIS

13 August 2014

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New Acland revised Stage 3 Project AEIS

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Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to provide summary documentation of the groundwater modelling assumptions, setup and results in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

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1. Introduction

The groundwater model reported in the draft EIS is classified as a “Class 2” model (SKM 2012); commensurate with the level of input data available at the time of EIS production. This was deemed suitable for the purpose of the State level assessment of the EIS by SKM, and agreed with DNRM in his preliminary assessment regarding the groundwater model. The original model was reported in the revised Project’s draft EIS (SKM, 2013).

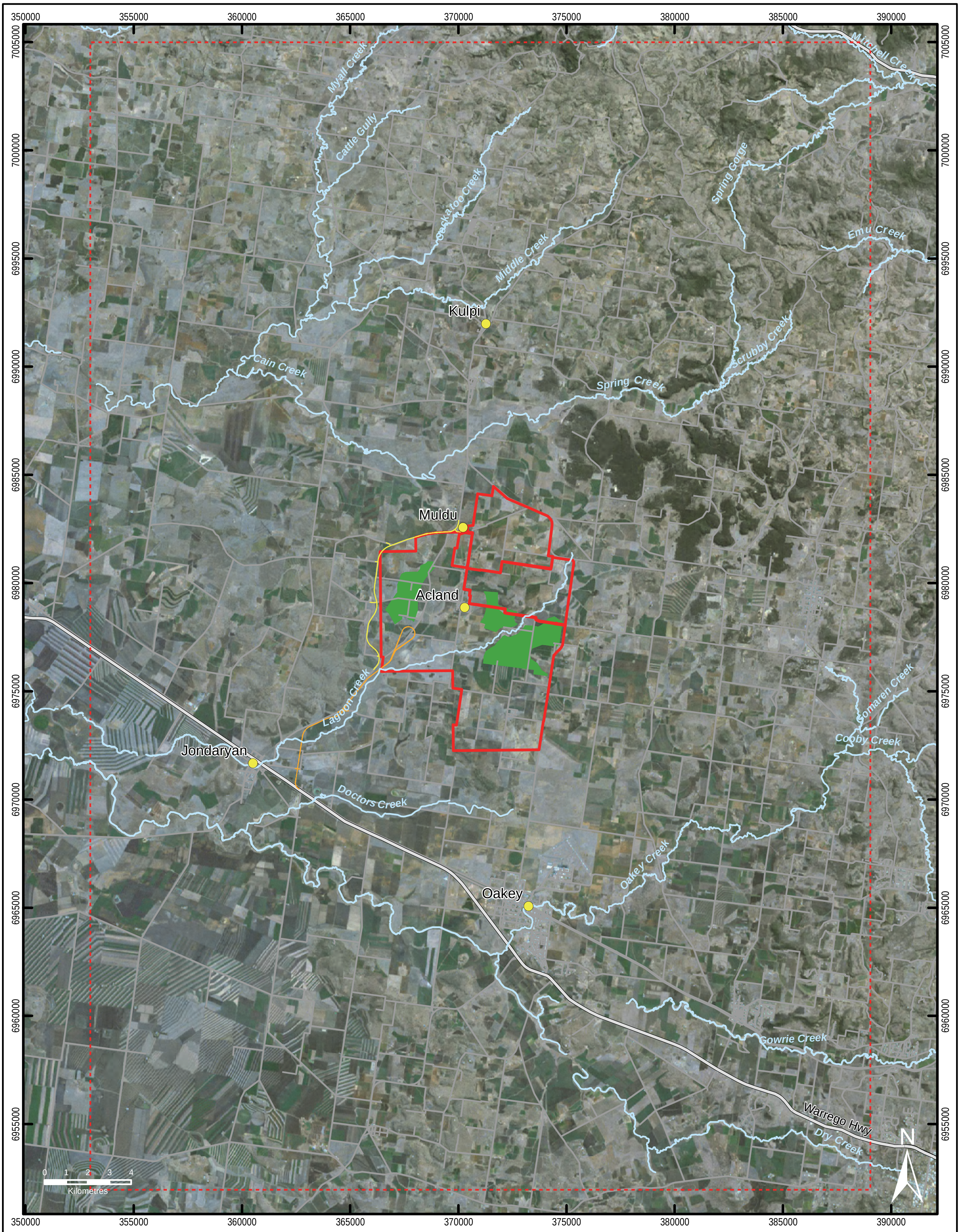
Since the original commencement of work for the EIS, additional information and data became available that if incorporated could provide additional confidence in the model and model results. Given the increased level of scrutiny and reporting requirements as a result of the introduction of the Commonwealth Water Trigger review (including a submission to the IESC), the NHG commissioned Jacobs to undertake a refinement of the numerical groundwater model used for the groundwater impact assessment for the proposed New Acland Stage 3 Project operations (the revised Project) (**Figure 1-1**).

The objective of the additional modelling was to update the model with the latest data available as well as to conduct a sensitivity and uncertainty analysis, as required for the Water Trigger review. The sensitivity and uncertainty analysis are to further assist in the quantification of the potential impacts of the proposed mining operation on the groundwater regime, and to further clarify mitigation and contingency measures, where applicable.

The confidence level of the model predictions is directly related to the availability of input data and was increased by incorporating the additional input data. The following courses of action were undertaken in order to increase model confidence:

- Reinterpretations and data analyses:
  - Update and refine the model layers based upon a review and collation of the most recent LiDAR, geologic model, and borehole logs (publically available, from landowners from recent survey, and from NAC).
  - Update model boundary conditions using the latest LiDAR, where available, for improved accuracy in water table and surface and groundwater interactions.
- Recalibration: After the refinements of model setup, the model was recalibrated. The calibration process included a stochastic based sensitivity and uncertainty analyses. Sensitivity and uncertainty assessments for calibration are key criteria for model confidence classification, as per the groundwater modelling guidelines (SKM, 2013), and are also considered a key component of the Commonwealth assessment.
- Predictive Simulations: The predictive simulations included a stochastic based sensitivity and uncertainty analyses. Sensitivity and uncertainty assessments for predictive simulations are key criteria for model confidence classification, as per the groundwater modelling guidelines (SKM, 2013), and are also considered a key component of the Commonwealth assessment.
- Updated Model report.

Models often require continuous revisions and updates as more information becomes available or when different questions are asked of it. This latest 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. As such the results presented herein should be considered as superseding the previously reported results as they are a better reflection of our current understanding of the system and how it behaves.



LEGEND

- Towns and Localities
- Creeks

Revised Rail & Road Infrastructure

- Revised Jondaryan-Muldu Road Diversion
- Revised Rail Spur and Balloon Loop Alignment
- Model Extent
- Mining Tenements
- Stage 3 Pit Areas

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 1-1 - Project Area

Scale 1:232,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 25/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140416_NewHope_Groundwater_Figure1-1_ProjectArea.mxd

2. Background Information

All information on which the model is based has either been provided by NAC, or is publicly available via the internet or literature references. A description of data sources is provided in the following sections.

2.1 Supplied Information

NAC provided the following datasets and background information:

- Surface Topography (LiDAR) grid files
- Mine Plan (Years 2017-2030 (2-yr increments) and Closure)
- Well construction and geologic logs
- Updated groundwater monitoring database
- Landowner survey database

2.2 Other Data

Additional information gathered by Jacobs were:

- Climate data
  - Annual and Monthly rainfall data at Oakey Bureau of Meteorology rainfall station (www.bom.gov.au)
  - Streamflow data at Station 422359A Oakey Creek at Jondaryan (DNRM, 2014)
  - Actual and Potential evapotranspiration rates (BOM, 2014)
- DNRM bore logs and water level data
- SRK Geology Maps (SRK, 2006)

3. Hydrogeological Setting and Conceptual Model

A conceptual model is a simplified representation of the real system. It aims to identify the most important hydrogeologic processes and geological units, and to quantify them in a manner that can then be translated into a numerical model. Thus the conceptual model forms the basis for the numerical groundwater flow model. The EIS chapter for groundwater provides a comprehensive description on the background information available and the overall conceptualisation of the hydrogeological regime. A summary of the conceptual model that forms the basis for the groundwater model are described below.

The conceptual hydrogeological model describes the aquifers present within the revised Project site, how they interact with each other and surface waters, and their attributes such as groundwater depth, thickness, transmissivity, storativity and hydraulic conductivity. The aquifers present within the revised Project site include the following:

- Quaternary Alluvial aquifer;
- Tertiary Basalt aquifer;
- Walloon Coal Measures aquifer;
- Marburg Sandstone aquifer; and
- Helidon Sandstone aquifer.

These aquifers are described further in the following Sections. **Figure 3-1** presents a schematic of the conceptual hydrogeological model for the revised Project.

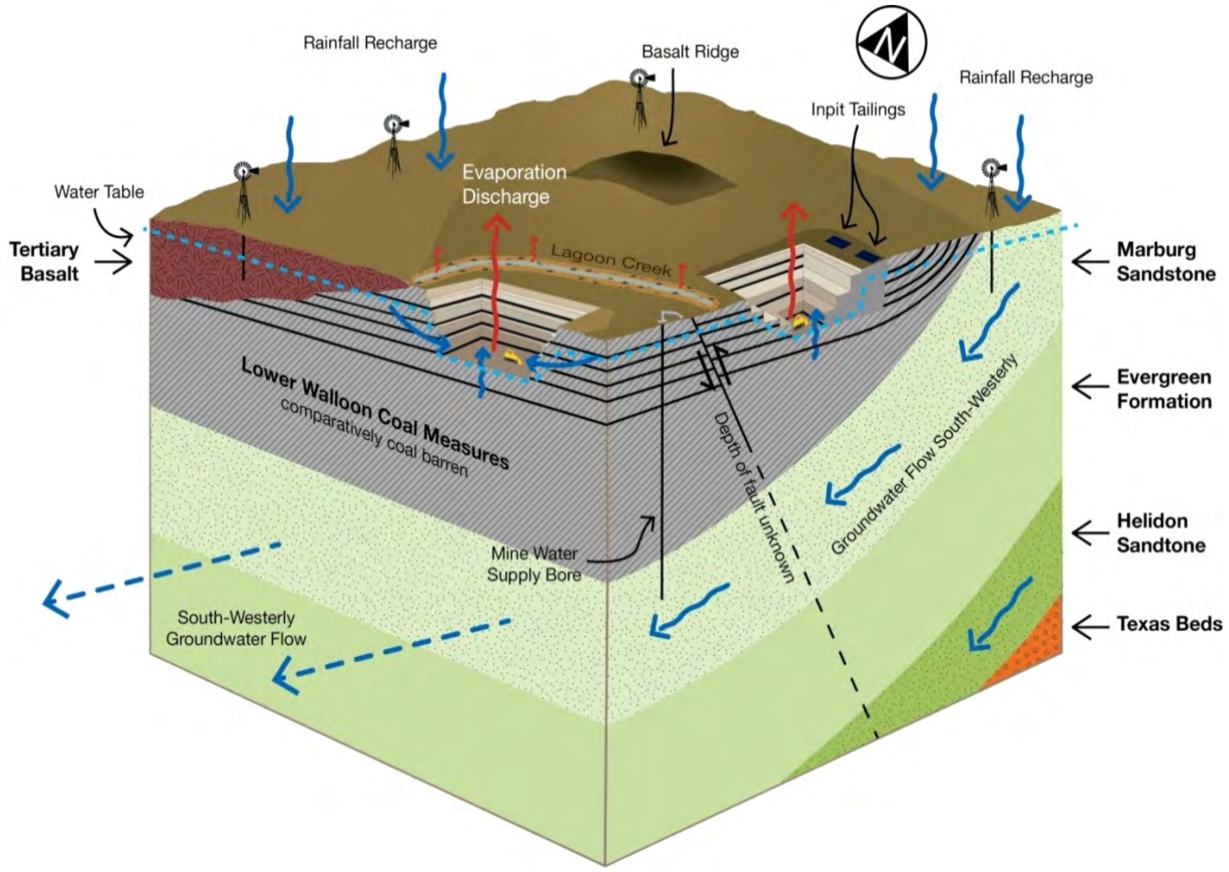


Figure 3-1 : Conceptual Hydrogeological Model

The conceptual hydrogeological model has been developed using the best available data and assumptions. The conceptual hydrogeological model will continue to be updated and refined based on the results of a targeted groundwater monitoring program and further investigations into local bore information (e.g. landholder bore surveys).

3.1 Quaternary Alluvial Aquifer

The shallow Quaternary Alluvial aquifer is limited in aerial extent and unlikely to form a major aquifer at the revised Project site. The alluvial aquifer is known to occur south of the revised Project site in association with Oakey Creek and its tributaries, where it reaches a thickness of up to 60 m and contains significant groundwater supplies. Similarly, groundwater supplies may also be developed in association with this aquifer to the northwest of the current Mine site in association with Myall Creek and its tributaries.

The predominant mechanism for recharge of the alluvial aquifer is direct infiltration. Discharge is likely to occur via evapotranspiration and infiltration to underlying aquifers.

Due to the minor nature of this aquifer within the revised Project site, data on groundwater yield and quality within the revised Project site was not obtained. Due to the lack of alluvial aquifer presence close to current mining activities, the current mine is not expected to be causing an impact to this aquifer.

3.2 Tertiary Basalt Aquifer

There is a minor occurrence of the Tertiary Basalt aquifer in the northwestern section of the revised Project site. The location of this aquifer in relation to the revised Project's mine pits means that this aquifer is unlikely to be affected by the revised Project, except where the western Manning Vale West Pit may intersect basalt to only a very minor degree. Where present in the revised Project site, the Tertiary Basalt aquifer varies in thickness from 1 m to 90 m.

Permeability within this aquifer is considered to consist of both primary and secondary porosity; however the latter is expected to dominate. The Tertiary Basalt aquifer has relatively shallow depth to groundwater at the revised Project site. Groundwater yield in the Tertiary Basalt aquifer can be up to 10 L/sec. An average bore yield of approximately 3 to 5 L/sec was reported in the Stage 2 EIS.

Pumping test data obtained from the Stage 2 EIS indicate a relatively high transmissivity of 150 m^2/day and storativity ranging from 0.001 to 0.05. The storativity values suggest that the aquifer is unconfined to semi-confined in the test locations.

The DNRM uses a uniform value of 80 mm of groundwater recharge per annum for basalt aquifers in the local area as part of water allocation assessments. This factor has been calculated to be approximately 12.7% of annual mean rainfall based on 635 mm mean annual rainfall observed at the Oakey Aero station. This suggests that recharge rates are relatively high for this aquifer.

The Mine currently draws groundwater from the Tertiary Basalt aquifer, covered under a license for 160 ML/year. However, the mine uses only approximately 11 ML/year of this allocation. Groundwater extraction from the Tertiary Basalt aquifer is also undertaken by nearby private groundwater users, mainly to the west and northwest of the revised Project site. Groundwater salinity in the Tertiary Basalt aquifer is generally lower than in the Walloon Coal Measures aquifer. This fact is reflected by a greater number of livestock and domestic users in the Tertiary Basalt aquifer.

Given that there is little occurrence of the basalt aquifer within the revised Project site, it is unlikely that mining activities will have a direct impact on the basalt aquifer. However, it is known that the basalt aquifer was deposited in palaeochannels incised into the Walloon Coal Measures palaeosurface and so the potential exists for direct hydraulic connection between the basalt aquifer and the Walloon Coal Measures, especially if a coal seam (the main water bearing units of the Walloon aquifer) were exposed in the palaeochannels.

3.3 Walloon Coal Measures Aquifer

The Walloon Coal Measures will be the main aquifer which will be affected by the revised Project. The Walloon Coal Measures outcrop across much of the revised Project site with coal seams being the principal conduit for groundwater flow.

Pumping tests undertaken in this aquifer, suggest that it is semi-confined, and of low to moderate transmissivity. Groundwater within the Walloon Coal Measures regionally flows from the north-east to south-west in accordance with the regional dip of the coal seams. Groundwater flow within this aquifer at the revised Project site is to the south, from potentiometric elevations of around 420 mAHD to potentiometric elevations of around 380 mAHD. A groundwater depression reaching around 410 mAHD exists in the vicinity of the current Mine workings, whilst a groundwater mound of around 440 mAHD exists in the vicinity of previously mined and backfilled northern Mine areas, where in-pit tailing dams now exist. The current Mine workings are likely to intercept much of this groundwater mounding given the close proximity and hydraulic gradient between the two features.

Recharge into the upper portions of the Acland-Sabine Sequence, is likely to be predominantly via coal subcrop areas on the upthrown side of faults and through deep drainage from the overlying basalt and alluvium where they occur. The comparatively higher salinity of groundwater in the lower seams of the Acland-Sabine interval and underlying Balgowan interval suggests that recharge zones for these measures are progressively more remote with depth and groundwater has longer residence times and longer migration paths. Leakage from underlying and overlying seams within the Walloon Coal Measures to these lower-lying coal seams is likely to be insignificant. Discharge from the Walloon Coal Measures aquifer occurs via mine pit dewatering and private bore extraction within the Clarence-Moreton Basin.

Significant surface water and groundwater interaction is unlikely for the Walloon Coal Measures aquifer. Groundwater has not been identified as contributing to surface water flows within nearby creeks and streams. Groundwater levels within the Walloon Coal Measures underlying the revised Project site range from around 6 to 55 mBGL.

The Walloon Coal Measures aquifers varies from being confined to semi-confined by low permeability mudstones and siltstones which occur in between the coal seams. Short term pumping tests indicate that the coal seams behave as separate aquifers. However, it is considered likely that over the long term the seams would behave as one aquifer system when stressed by dewatering in association with mining operations. Results from these tests suggest that a leaky aquifer system is likely to exist with vertical movement of groundwater occurring between seams, especially where the confining layers are thin, and via fractures within the coal measures aquifer system.

Transmissivity values within the Walloon Coal Measures were estimated to range between 7 and 47 m^2/day. Transmissivity values obtained from pumping tests undertaken for the Stage 2 EIS are consistent with those estimated from field tests undertaken for the revised Project. This result demonstrates that the transmissivity of the Walloon Coal Measures aquifer is similar from the Mine to the revised Project site.

Storage coefficients were estimated to range between 0.006 and 0.00006 for the shallow and deep coal seam aquifers respectively, suggesting the deeper seams act as confined aquifers whereas the shallow seams act as semi-confined aquifers. Bore yields for this aquifer are around 1 L/sec or less. Groundwater quality in the Walloon Coal Measures at the revised Project site is slightly acidic to slightly alkaline and is generally brackish with sodium and chloride ions dominating.

3.4 Marburg Sandstone Aquifer

The Marburg Sandstone aquifer underlies the Walloon Coal Measures and is up to 500 m thick. This aquifer exists as a confined aquifer at a depth of about 150 m within the revised Project site and is a major aquifer of the GAB.

Aquifer parameters based on pumping tests conducted for the Stage 2 EIS indicate a transmissivity of 14 m^2/day and a storativity of 0.003.

Aquitard layers separating the coal seam aquifer within the Walloon Coal Measures and the intervening lower permeability sediments of the Eurombah Formation act as effective confining layers to the Marburg Sandstone aquifer, hydraulically isolating it from the coal seams of the Walloon Coal Measures. Groundwater levels obtained from on and off site bores ranged from 410 m AHD to 425 m AHD. Typical production rates range from 5 L/sec to 25 L/sec within this aquifer. The higher yields indicate that the transmissivity of the aquifer may be larger than 14 m^2/day as indicated in the Stage 2 EIS pumping tests.

Recharge to this aquifer is likely to occur from surface water infiltration where the geological formation outcrops to the northeast of the revised Project site, with discharge via groundwater bores and throughflow to the southwest.

The mine periodically extracts groundwater from the Marburg Sandstone aquifer at a rate of approximately 10 ML/year for industrial use.

The Marburg Sandstone aquifer is a confined aquifer located more than 75m below the base of the revised Project mine pits. Therefore, the revised Project's mine pits and depressed landforms (rehabilitated final voids) are unlikely to have an effect on this aquifer.

3.5 Helidon Sandstone Aquifer

The Helidon Sandstone is the deepest aquifer at the revised Project site and is a major aquifer of the GAB. This aquifer is separated from overlying aquifers by the relatively impermeable Evergreen Formation and is up to 170 m thick.

Pumping test data indicates the transmissivity of this formation is likely to vary between 45 m^2/day to 200 m^2/day. Recharge to the Helidon Sandstone aquifer occurs where the aquifer outcrops in the northeast. This area represents the primary source of recharge to the aquifer via infiltration of rainfall and overland surface water flow, with discharge occurring mainly via groundwater bores and throughflow to the southwest.

The Mine periodically extracts groundwater from the Helidon Sandstone aquifer at a rate of 17 ML/year for industrial use and has an allocation of 710 ML/year from this aquifer. Groundwater extraction from the Helidon Sandstone aquifer for industrial use reduced greatly once the WWRF Pipeline came into operation in 2010. The Mine and other nearby private groundwater users are the main sources of groundwater extraction from the Helidon Sandstone aquifer.

The Helidon Sandstone aquifer is a confined aquifer and is located below the relatively impermeable Evergreen Formation, which in turn is located below the Marburg Sandstone aquifer. Accordingly, it is unlikely the revised Project's mine pits and depressed landforms (rehabilitated final voids) will effect on this aquifer.

4. Model setup

4.1 Modelling software

A three-dimensional finite difference model was created using the Groundwater Vistas pre-processor. MODFLOW (McDonald and Harbaugh, 1983) in conjunction with MODFLOW SURFACT (Version 4) were used to allow for saturated and unsaturated flow conditions.

A MODFLOW-based model was chosen because it is a well-documented and widely used program, and is often used for open-cut mining projects. MODFLOW-SURFACT or a finite element model such as FEFLOW is appropriate for this type of mining assessment (Mackie, 2009).

The pseudo-soil unsaturated flow option was used for the calculation of unsaturated flow conditions within MODFLOW-SURFACT. Using the MODFLOW-SURFACT package was not intended to accurately depict the unsaturated flow processes but instead to add the known stability MODFLOW-SURFACT provides. The pseudo-soil option also provides a better mass balance for post-mining void simulation. In addition, the MODFLOW-SURFACT package has an automatic time stepping program that allows for the time increments to accelerate or slow down depending upon how many iterations the solver requires to find a solution. This package was used during the calibration and predictive simulations and provided good stability.

A further feature of MODFLOW-SURFACT 4 that makes it particularly suitable for modelling mine dewatering is the Transient Material Properties (TMP) module that allows for conductivity and storage to vary with time throughout the simulation.

4.2 Model complexity

The groundwater model is classified as a “Class 2” model; commiserate with the level of input data available at the time of EIS production. This was deemed suitable for the purpose of the State level assessment of the EIS by SKM and agreed with Adrian McKay of EHP. Although the additional refinements, recalibration and sensitivity\uncertainty analyses do not bring the class of the model up to a Class 3, as per the modelling guidelines, the additional work does increase the overall confidence in the model predictions and robustness of the model.

The model is suitable for predicting the impacts of the proposed operations and post-mining recovery.

4.3 Model exclusions

The model or modelling process did not include:

- Flood or high river stage recharge.
- Quantitative calibration to baseflow.

These processes have not been explicitly included because of lack of data or they were assumed to be relatively minor influences within the groundwater regime given the existing modelling objectives and scope.

4.4 Model domain and boundary conditions

The model boundary conditions have been assigned to represent the regional groundwater flow system as described in the EIS Chapter.

The model domain (**Figure 4.1**) covers an approximate area of 36 x 53 km (1,908 km^2). The revised Project area is located within the centre of the model domain. The model area was divided into a uniform grid with spacing of 400 m by 400 m, with refined grid spacing near the revised project area of 200 x 200m, resulting in 168 rows and 132 columns. The model domain therefore consisted of 22,176 cells a layer, or 110,880 cells for the full five-layer model, of which only 96,121 were active.

The model contains five layers, all of which are active except for in layer 1 outside the alluvial extents where cells are set as inactive. Where deeper geologic units are not present cell thicknesses are set at a minimum thickness of 0.1m and the underlying hydrogeological properties are carried up.

The hydrogeological units of relevance to the revised Project area have been simplified for incorporation into the groundwater model as discrete model layers, as described in **Table 4.1**. Layers within the model do not solely represent one individual simplified geologic unit. Geologic units are represented in the model by parameterisation of hydraulic conductivity and storage. For example, Layer 2 is intended to simulate the Basalt. Where its estimated to exist, the cells have been assigned parameters associated with the Basalt. Where it does not exist, the next sequential geologic unit interpreted to exist is represented by a change in hydraulic conductivity and storage, and cell thicknesses are set at a minimum thickness of 0.1m. An example cross-section of the model is presented in **Figure 4.2**.

The alluvium is represented by its own layer (Layer 1) with inactive cells where it does not exist. This method is a simplification made during the model setup process which can decrease model size and run time, while at the same time increase numerical stability. The vertical conductivities for the alluvium are sufficiently high to allow for movement between layers, thus not unnecessarily limiting interaction between simulated geologic units.

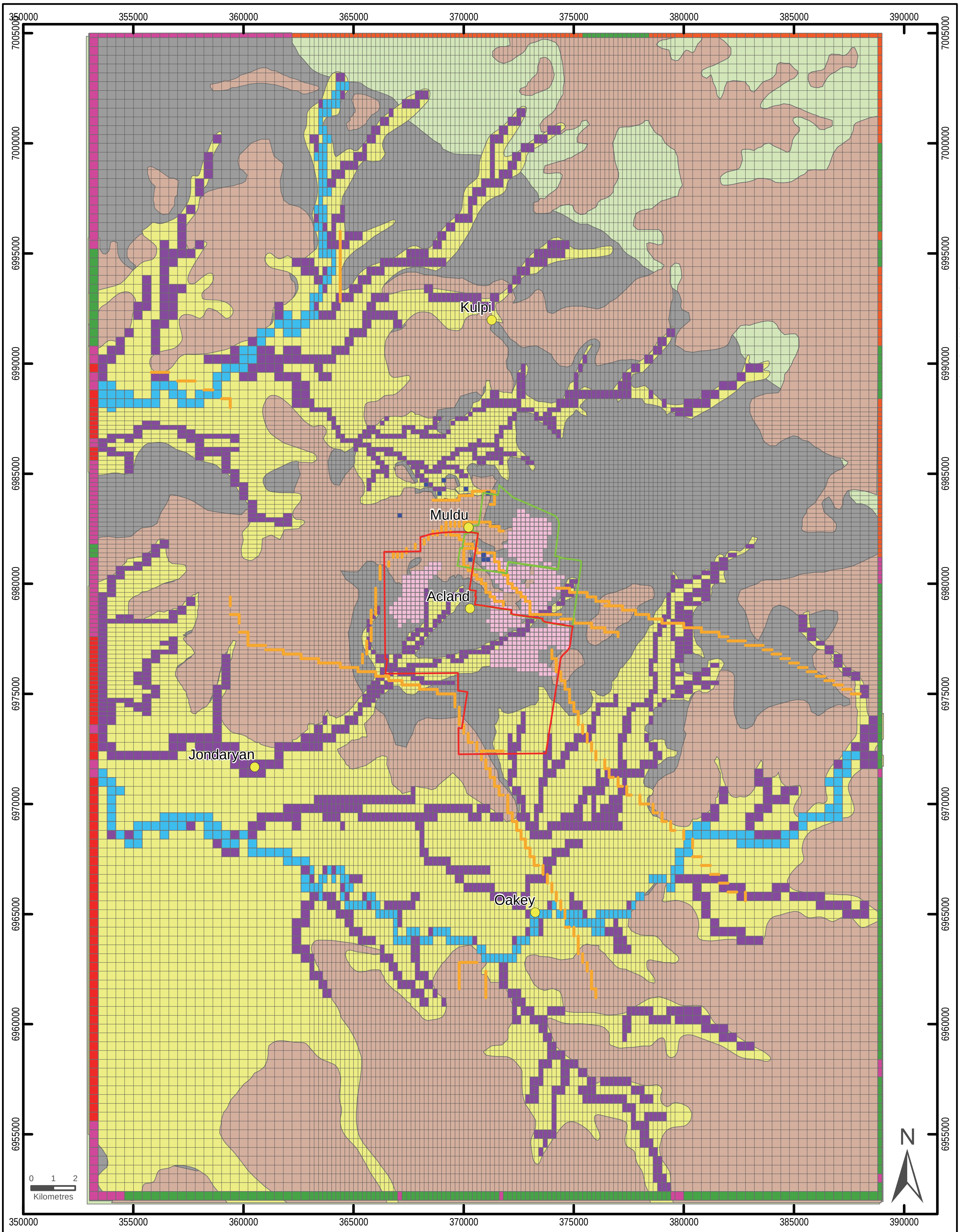
Table 4.1 : Model layering

Layer(s)	Hydrogeologic unit	Layer thicknesses (m)
1	Alluvium	0.1 - 52
2	Tertiary Basalts	0.1 - 143
2 - 3	Upper WCM	0.1 - 145
4	Lower WCM	0.1 - 153
2 - 5	Marburg Sandstone	250

The extent and, top and bottom elevations for each geologic unit were calculated based upon the following data sets:

- LiDAR digital elevation files provided by NAC
- digital elevation model (DEM) surface topography
- surface and bedrock mapping (SRK, 2006)
- DNRM database
- NAC monitoring bore geologic logs

Geologic extents for all geologic units have been modified during the latest revision. These revisions are based upon the use of more recent geologic mapping that is more consistent with bore database as well as the use additional information such as LiDAR.



LEGEND

- Towns and Localities
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Model Grid

Note: Refer to report for description of head distributions in Constant Head cells

Boundary Conditions

- Constant Heads (L1-L5)
- Constant Heads (L2-L5)
- Constant Heads (L3-L5)
- Constant Heads (L5)
- Oakey and Myall Creek (L1)
- Tributaries (L1)
- Mine Drains (L1/2/3)

Boundary Conditions

- Wells
- Modelled Faults (L3/L4)

Modelled Surface Geology

- Alluvium
- Basalt
- Walloon Subgroup
- Marburg Sandstone

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 4-1 - Model Domain and Boundary Conditions

Scale 1:228,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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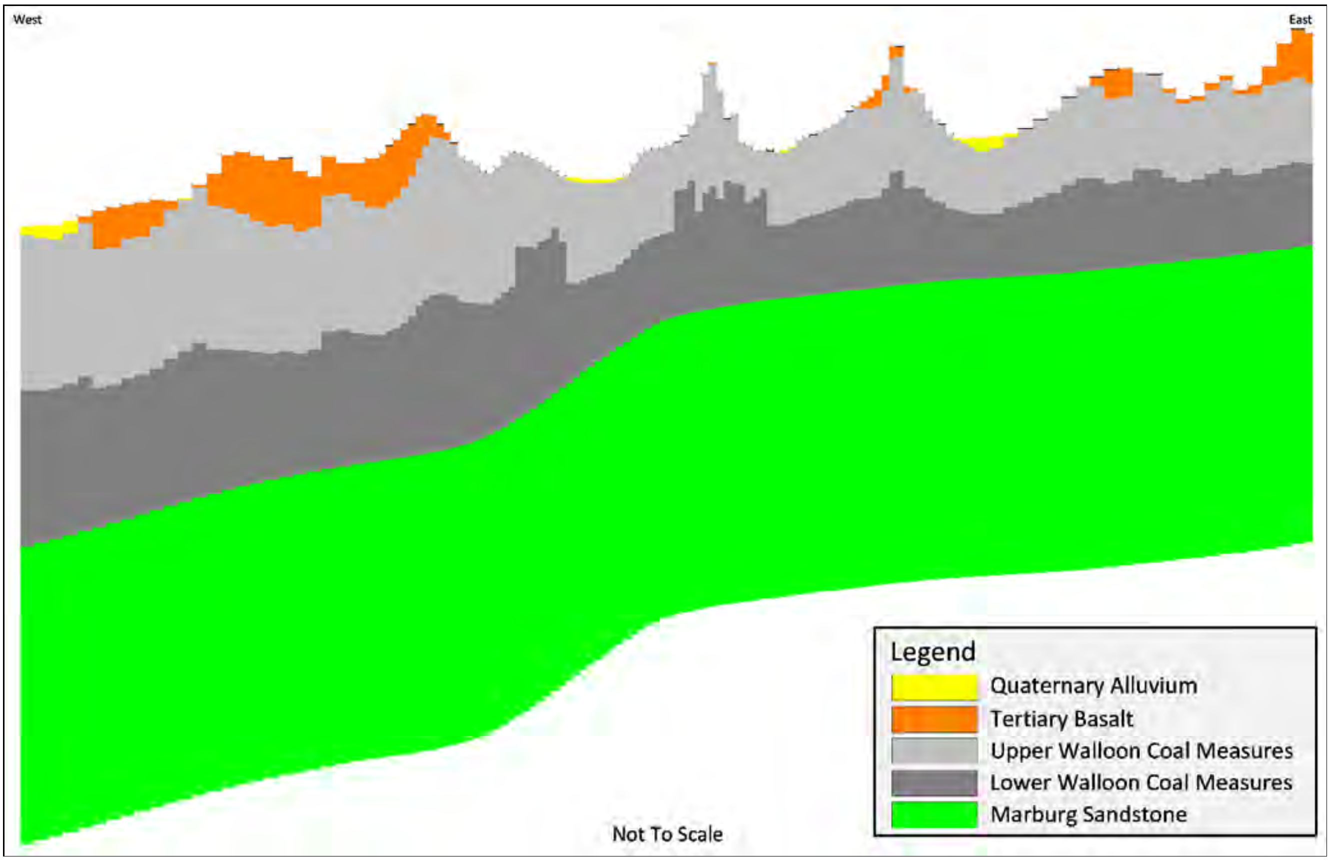


Figure 4-2 : Example Cross Section through the model domain

Isopach maps for each geologic unit are provided in **Figure 4-3** through **Figure 4-6**.The extents of each geologic unit were based upon referenced geologic maps (SRK, 2006) for all consolidated units. Jacobs SKM used topography data (LiDAR and DEM) to refine the extents of the alluvium using a slope break analysis. Thicknesses were interpreted based upon available geologic logs, DRNM database and publically available interpretations of isopach and floor elevations (SRK, 2006).

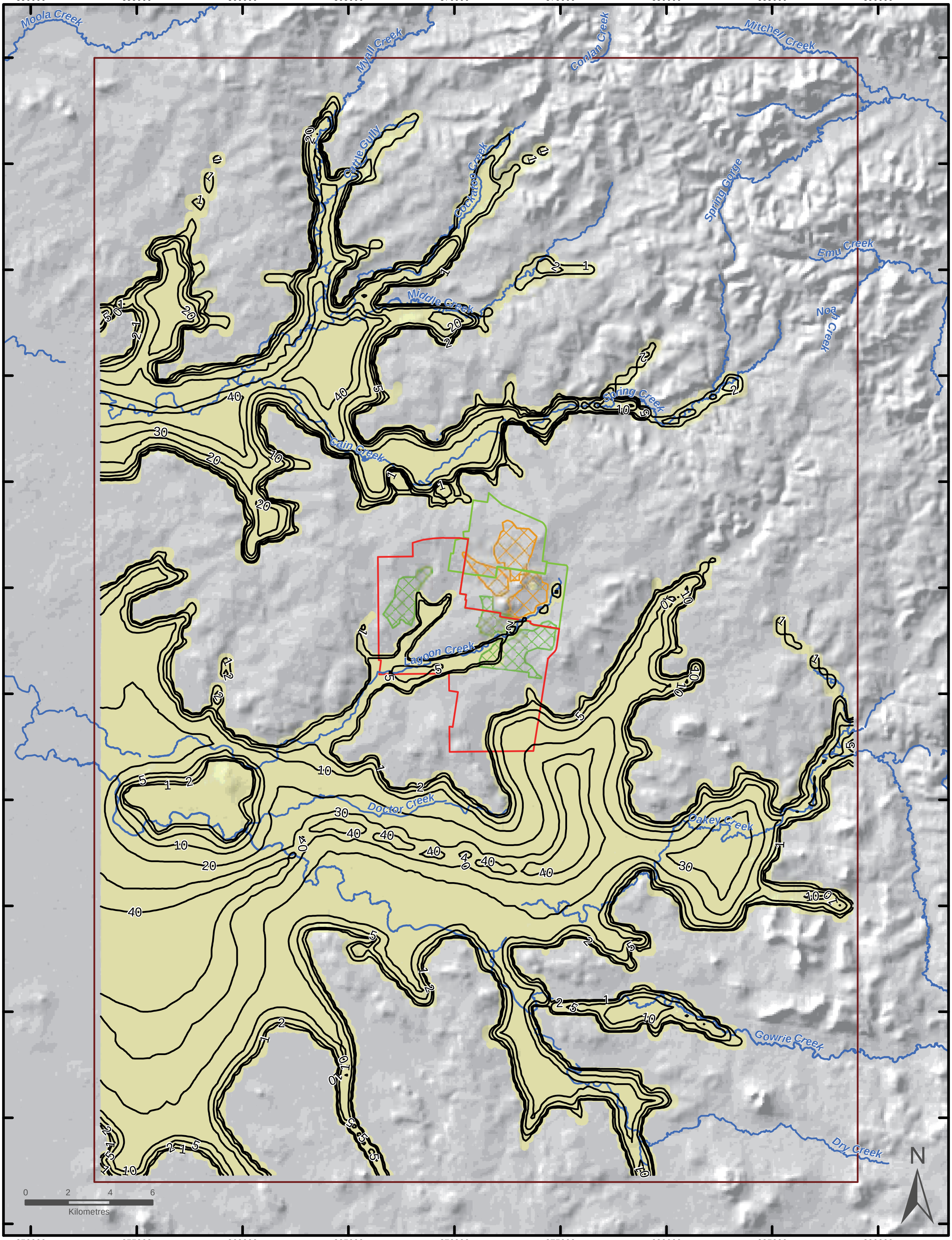
Constant head boundaries were assigned at active cells adjacent to model boundaries where the aquifer is known to extend further than the model boundary. Head values in the alluvium were based upon a typical depth to water of approximately 13.5 mbgl. For all other geologic units as relationship between topography and water levels was used to assign spatially variable heads. These relationships are presented in **Figure 4-7**through **Figure 4-9**.

The model boundary distances were chosen with the intent that drawdown in the predictive simulations would not reach the boundaries, and thus their influence would be minimised. Previous model simulations demonstrated that the extents were adequate.

Structural features, such as the faults have been explicitly simulated using the Horizontal Flow Barrier (Wall) boundary condition feature of MODFLOW within the Upper and Lower Walloon layers as well as the Basalt. The overall conductance for the faults was set at $1x10^{-10}$ m^2/d using a thickness of 1m and a hydraulic conductivity of $1x10^{-10}$ m/d. These features are shown in **Figure 4-1**.

Investigations undertaken as part of the existing Mine operations, including field investigations (e.g. WSA, 2013), have sought to identify the role that faulting within the Walloon Coal Measures plays in control on groundwater flow and aquifer compartmentalisation. These investigations have shown that these faults may play a significant role in providing barriers to groundwater flow in the Walloon Coal Measures. During the original model development as part of the draft EIS, the calibration procedure involved simulating the existing Mine operation with and without the inclusion of barrier faults in the model. The results of this procedure indicated that in order to best represent the compartmentalisation of the Walloon Coal Measures and the resulting monitoring bore responses, the faults which have been previously mapped by NHC's geologists based on drilling results and observations of the existing Mine's open cut pits are best simulated as barrier 'Walls' in the model. For the updated modelling, this approach has again been adopted without specifically undertaking calibration trials without the inclusion of these Walls in the Walloon Coal Measures.

Model calibration runs were undertaken with and without barrier Wall faults applied to the Marburg Sandstone. The results of this sensitivity analysis showed that the model is relatively insensitive to the inclusion of these faults. Given that the Marburg Sandstone is conceptualised as a relatively thick, permeable and homogenous unit compared to the upper Walloon Coal Measures, it was considered that compartmentalisation of the unit is much less likely to occur than in the Walloon Coal Measures, and therefore it was decided to not apply faults to the Marburg Sandstone for the model predictions. This approach is considered conservative as it will result in further lateral propagation of drawdown away from the revised Project site in the Marburg Sandstone than would be the case with barrier faults applied.



LEGEND

- Modelled Formation Isopach (m)
- Watercourse
- Groundwater Model Extent
- Modelled Alluvium Extent
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Stage 3 Pit Areas
- Existing Permission

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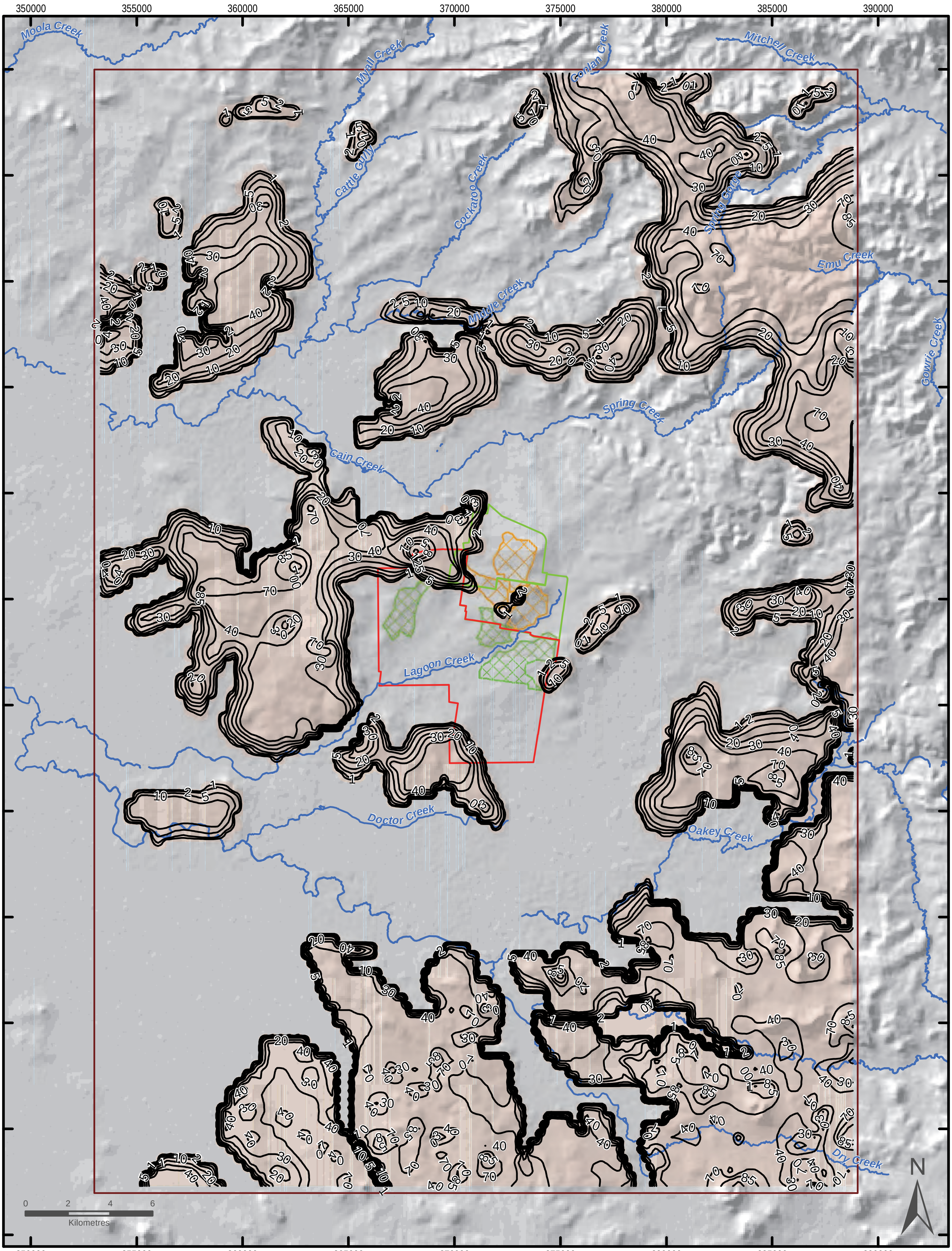
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 4-3 - Modelled Formation Isopach Quaternary Alluvium

Scale 1:245,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)



LEGEND

- Modelled Formation Isopach (m)
- Watercourse
- Groundwater Model Extent
- Modelled Basalt Extent
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Stage 3 Pit Areas
- Existing Permission

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Figure 4-4 - Modelled Formation Isopach Tertiary Basalt

Scale 1:245,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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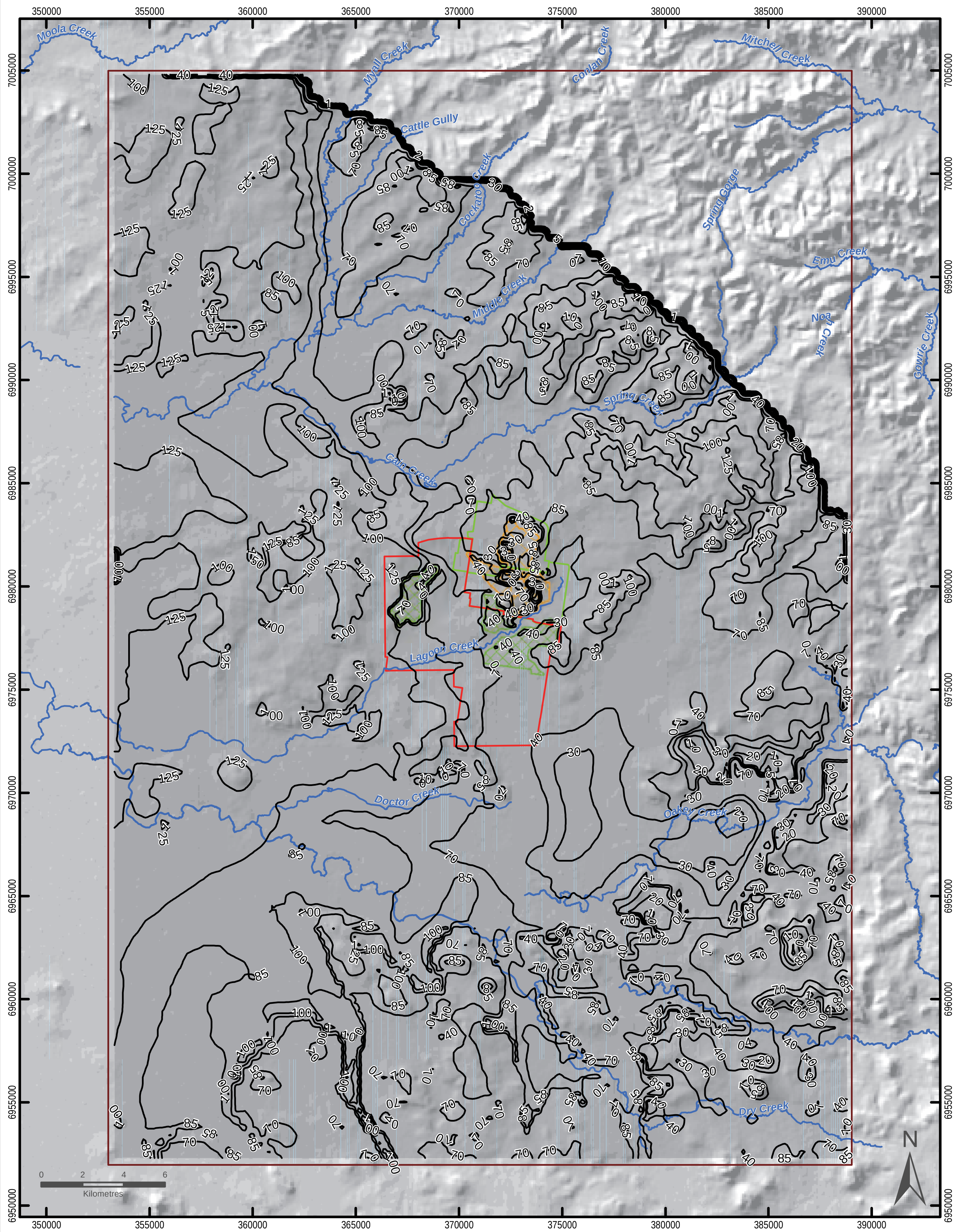

LEGEND

- Modelled Formation Isopach (m)
- Watercourse
- Groundwater Model Extent
- Modelled Upper Walloon Extent
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Stage 3 Pit Areas
- Existing Permission

NEW HOPE GROUP

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 4-5 - Modelled Formation Isopach Upper Walloon Coal Measures

Scale 1:245,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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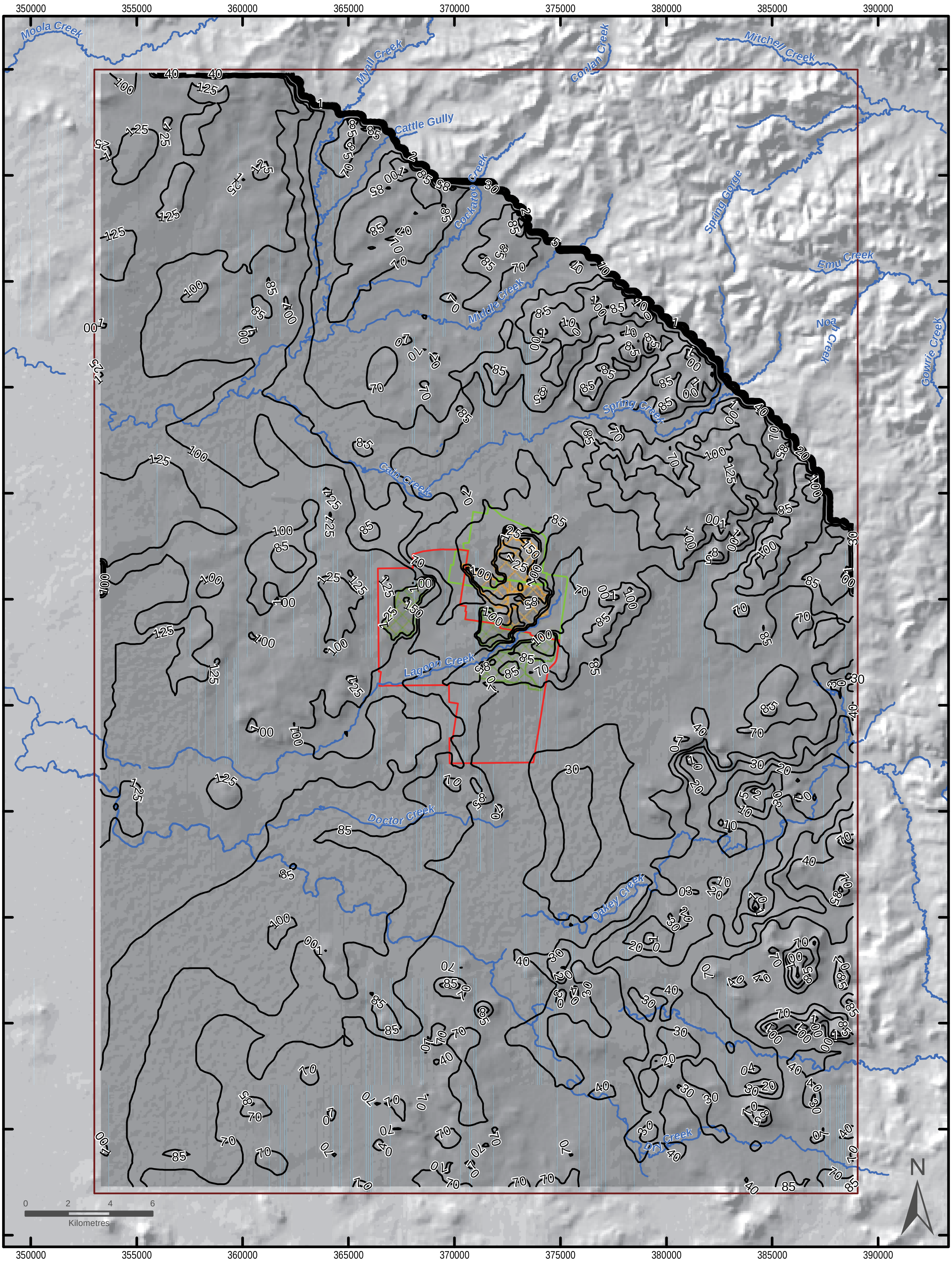

LEGEND

- Modelled Formation Isopach (m)
- Watercourse
- Groundwater Model Extent
- Modelled Lower Walloon Extent
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Stage 3 Pit Areas
- Existing Permission

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 4-6 - Modelled Formation Isopach Lower Walloon Coal Measures

Scale 1:245,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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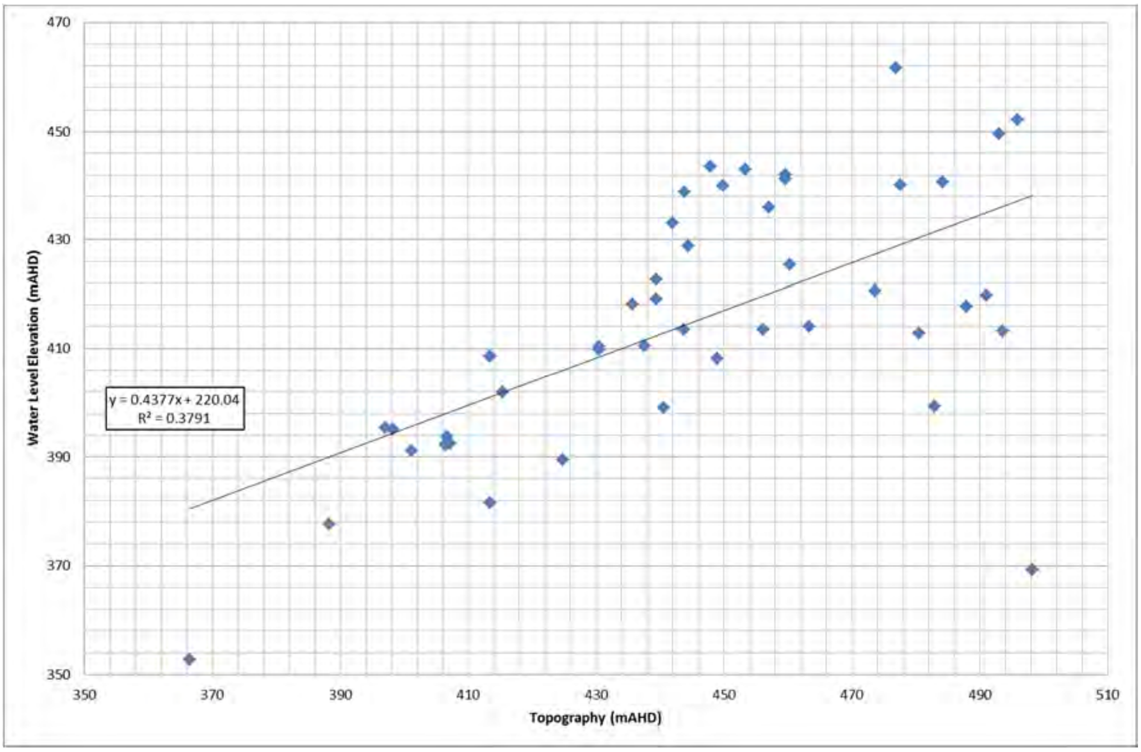


Figure 4-7 : Basalt – Relationship between topography and water levels

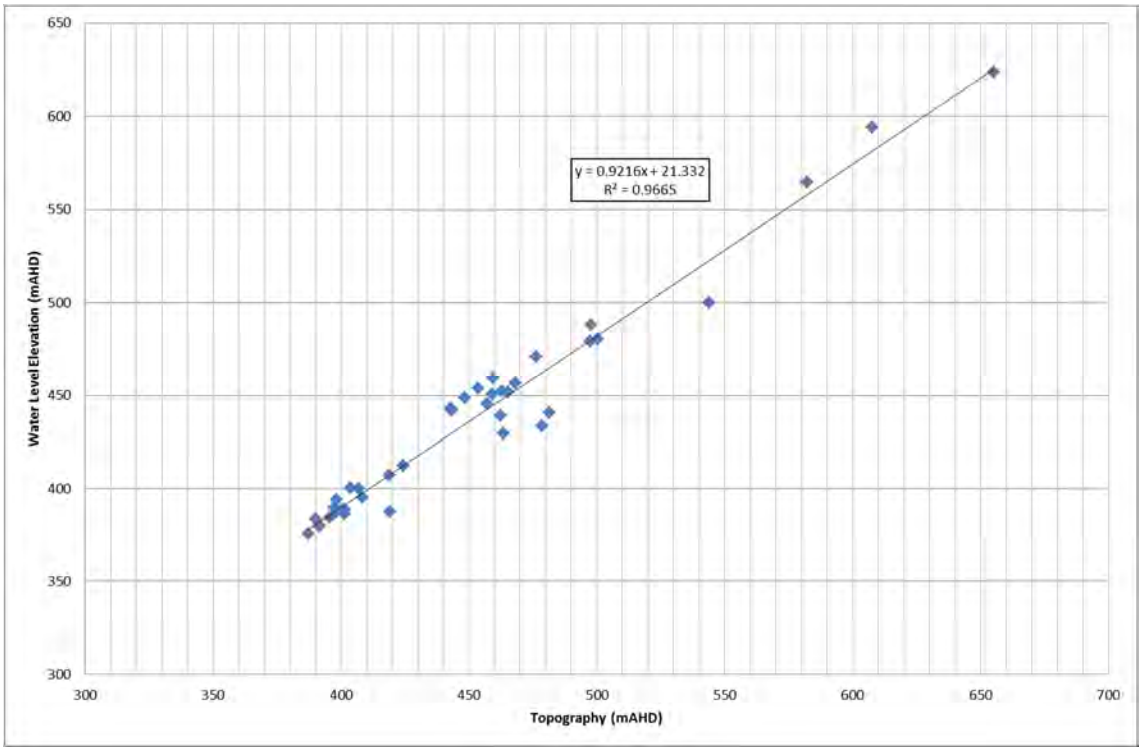


Figure 4-8 : Walloon Coal Measures – Relationship between topography and water levels

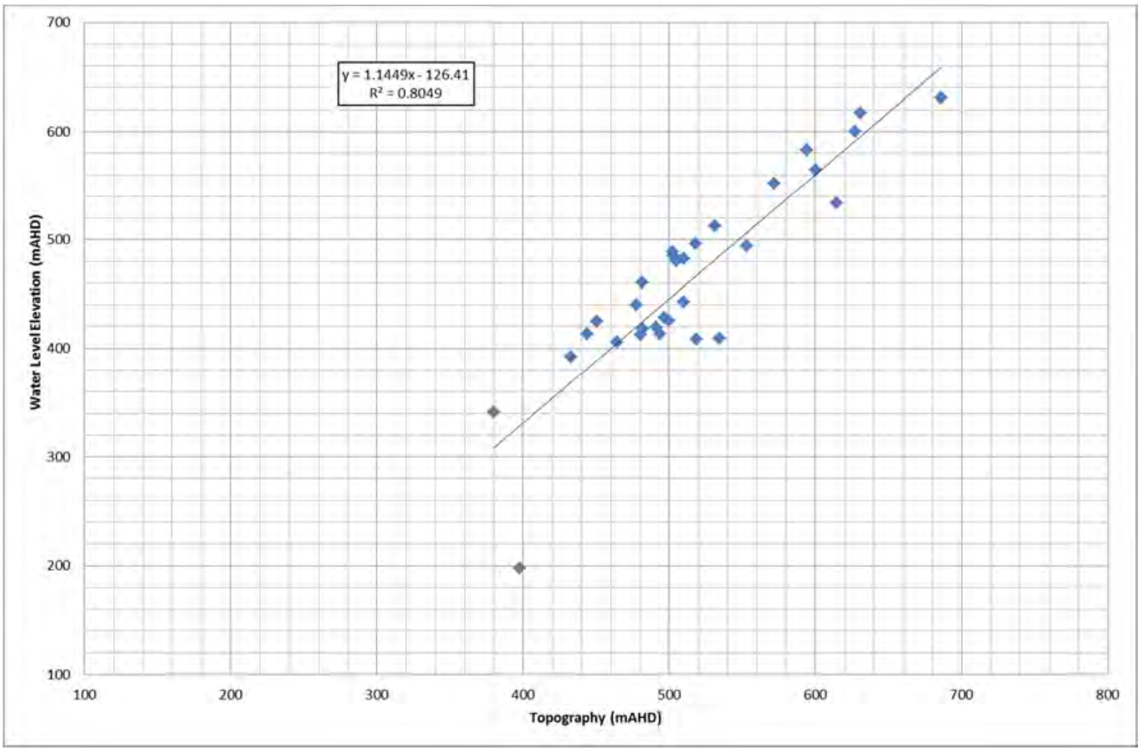


Figure 4-9 : Marburg Sandstone – Relationship between topography and water levels

4.5 Recharge

It is believed that recharge in the study area is influenced by the geological unit present at the surface. Therefore recharge zones were created for each of the different geology outcrops. From a modelling perspective this involves applying recharge to the uppermost active layer.

During calibration recharge is allowed to vary according to the historic rainfall for the corresponding period. Multipliers, calculated by dividing the actual rainfall for the period by the average annual rainfall, are assigned for each period with records. These multipliers then correct for increased or decreased rainfall recharge by being multiplied by the calibrated percent of average annual recharge. For all other time periods, and for steady state calibration, the calibrated percent of average annual recharge is applied.

4.6 Discharge/evapotranspiration

Evapotranspiration (ET) is expected to be an active form of groundwater discharge in the model domain and has been simulated using the EVT package of MODFLOW.

Maximum ET Potential was initially estimated to be between 1400-1500 mm/yr from local meteorological data (BoM, 2011). However the latest update for the AEIS uses the Australian Bureau of Meteorology estimate for Aerial Actual Evapotranspiration (AAE), estimated to be between 600 to 700 mm/yr (BoM, 2011), which is assumed to be better reflection of actual ET for areas where water is not ponded at surface. For modelling purposes, maximum ET was set to 650 mm/yr for all non-void areas consistent with the BoM AAE estimate. The maximum ET potential rate of 1450 mm/yr was assigned for all areas of voids where water has the potential to be ponded at surface, consistent with the BoM Maximum ET Potential, because it is based upon measured potential ET rates of water exposed at surface..

The EVT package of MODFLOW requires that an extinction depth be provided, which indicates at what depth ET no longer occurs (i.e. ET rate =0). The ET rate is then linearly decreased from the maximum rate when the water level is estimated to be at the ground surface to 0 mm/year when the water level is estimated to be at the extinction depth. The extinction depth is allowed to vary during the calibration process.

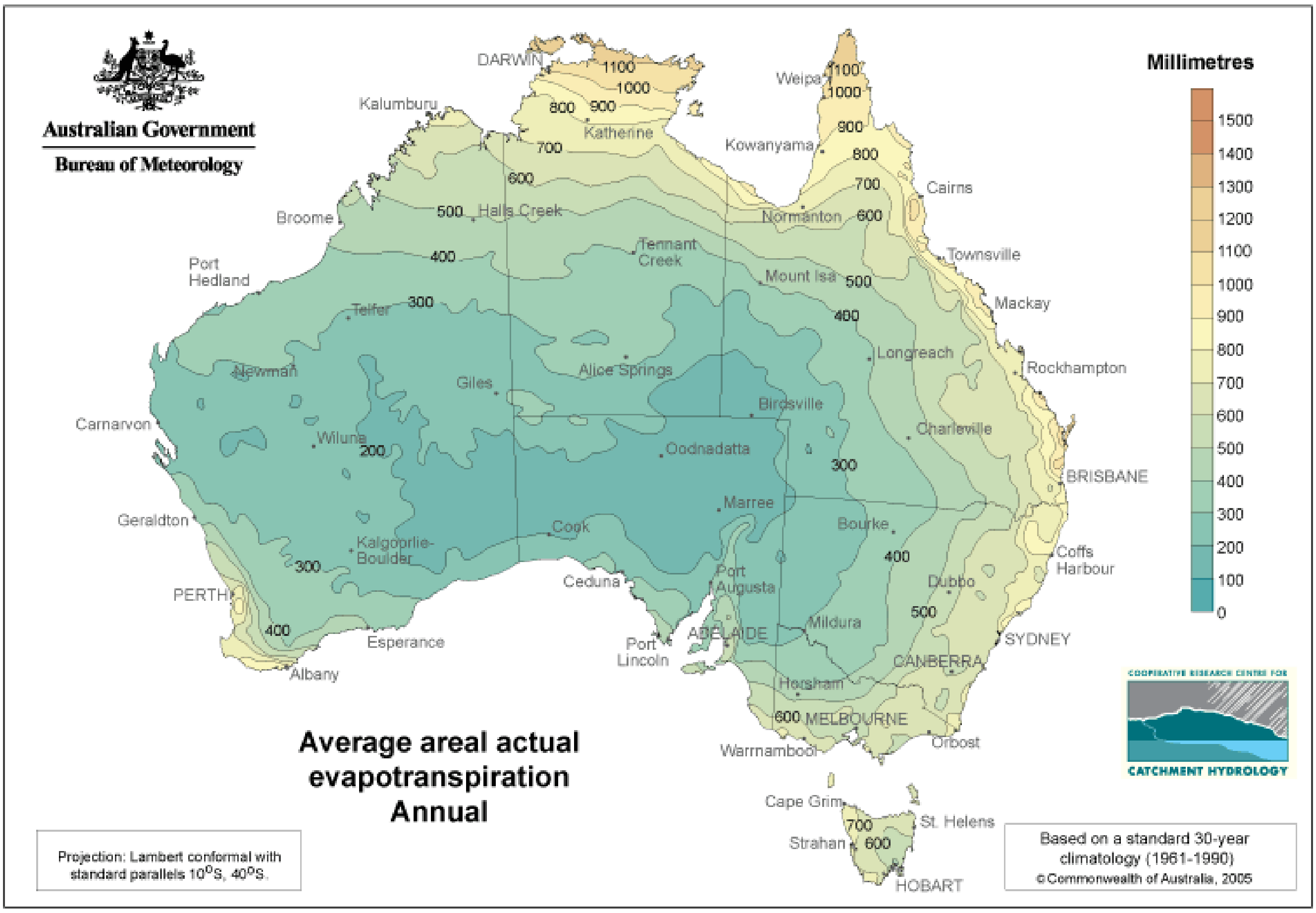


Figure 4-10 : Estimated Aerial Actual Evapotranspiration

4.7 Model simulation design

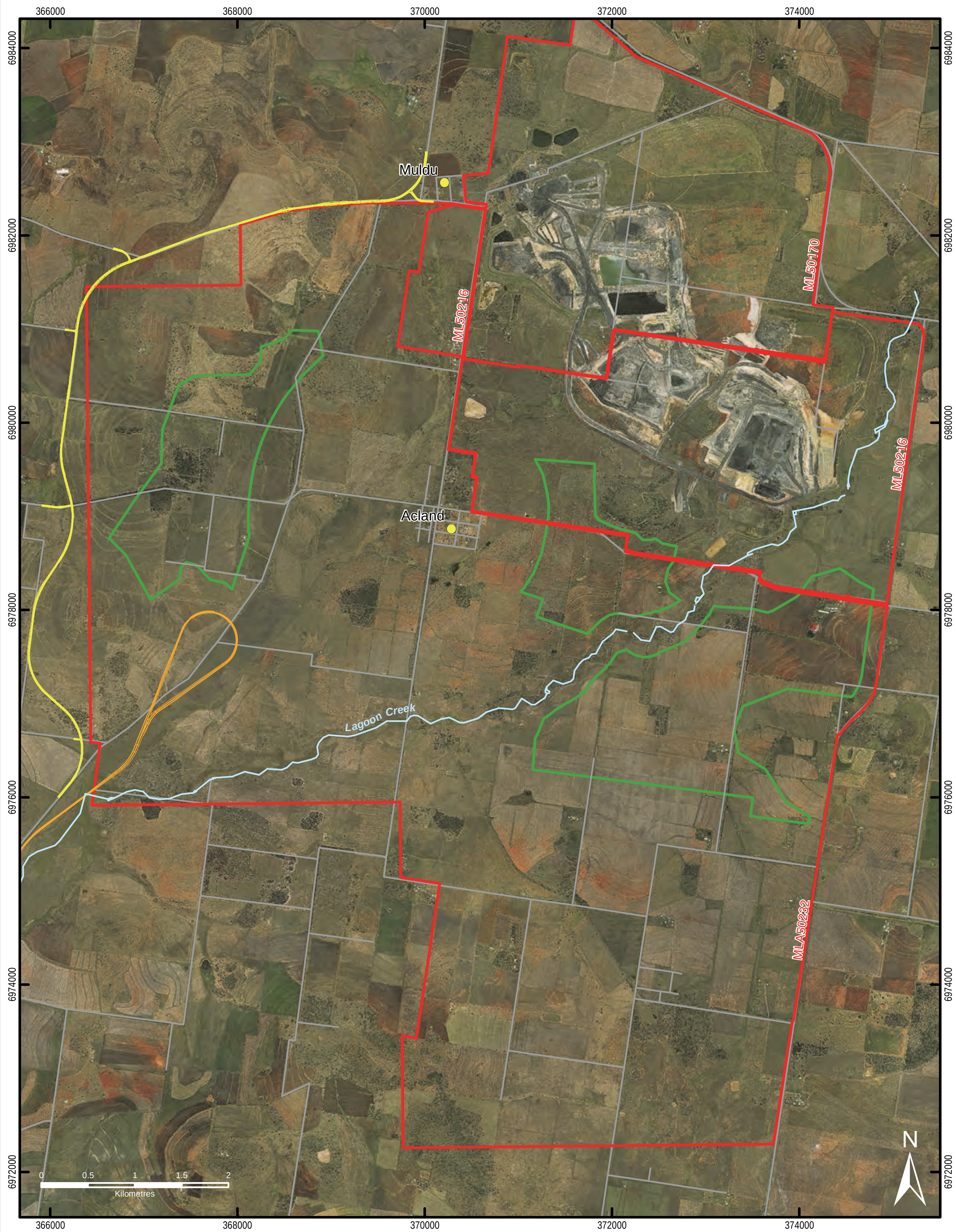
The objective of the predictive modelling was to assess the revised Project's potential impacts on the groundwater environment. The specific outputs required from the model were:

- estimated mine inflow rates/volumes
- regional changes to groundwater levels during mining and post-mining

4.7.1 Drains

Drain boundary conditions were used to replicate the sequential reduction in land surface as mining progressed throughout all layers in which mining would occur (i.e. Layers 1-3 where active). Jacobs SKM was provided with total pit depth and final landform (**Figure 4-10**, **Figure 4-11** and **Figure 4-12**) as well as a yearly mine progression map. This data was used to simulate an excavation to total depth for each year of mining. Drains remain active for 2 years.

The conductance of the drains is a product of the cell widths and a hydraulic conductivity and thickness for the "draining layer". The thickness was assumed to be 1 m and the hydraulic conductivity was assigned 200 m/day which provided numerical stability whilst still fully dewatering all actively mined areas.



LEGEND

- Towns and Localities
- Creeks
- Roads
- Mining Tenements
- Stage 3 Pit Areas

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NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 4-11 - Pit Floor Elevation

Scale 1:54,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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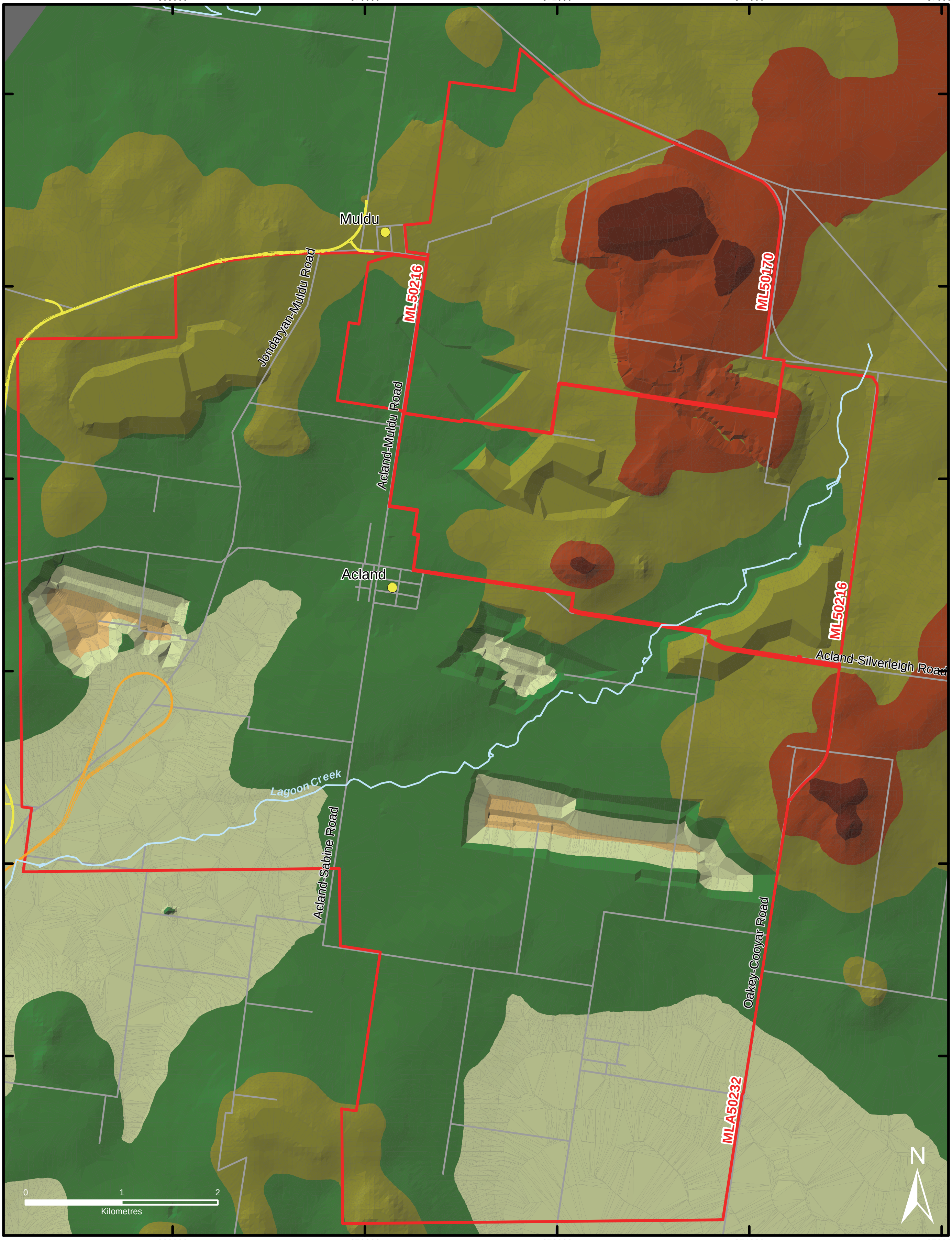

LEGEND

Towns and Localities

Roads

Creeks

Mining Tenements

Elevation	
604 - 636	480 - 511
573 - 604	449 - 480
542 - 573	417 - 449
511 - 542	386 - 417
	355

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Figure 4-12 - Final Landform

Scale 1:54,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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Produced: 25/08/2014

4.7.2 Time-Varying Hydrogeological Parameters

An important feature of the model was the inclusion of changing hydrogeological parameters as a result of mining and backfill sequencing. The TMP1 package implemented in MODFLOW-SURFACT allows time-varying hydrogeological parameters to be incorporated into transient simulations. When changing the hydrogeological parameters using the TMP1 package there are two key inputs:

- The timing of the changes; and
- The multiplier to be applied to the parameter starting value.

The timing and magnitude of the changes are then tied spatially to the progression of the simulated mine operation. The areas used for the drain cells depicting mine operations were used to delineate Hydrostratigraphic Units (HSUs) within the model. HSUs are used in Groundwater Vistas to group cells so that their parameters can be changed together. The TMP1 package allows for hydrogeological parameters to be varied according to HSU zones.

Since HSUs are defined by both the timing of the change and the multiplier to be applied, many different zones are required to fully represent the aerial and vertical migration of pit growth and subsequent backfilling sequences. The changes to parameters used to replicate groundwater recovery post-mining are set to take effect in the stress period after each drain cell becomes inactive. The multiplier for each HSU was calculated by dividing the new parameter(s) by the starting (i.e. calibrated) parameter(s).

In development of the post-mining prediction simulation the following assumptions were made for the backfill:

- hydraulic conductivity (x, y, and z) = 15 m/day
- specific yield = 0.15
- Maximum ET rate = 650 mm/yr.
- ET extinction depth = 2 m.

Areas within the mine pit where a void is left at the completion of mining are represent with parameters that are appropriate for a void. The property values used within the model to represent voids are as follows in **Table 4.2**.

Table 4.2 : Air Property Values

Property	Value
K_h	1,000 m/d
K_z	1,000 m/d
S_s	0.000005 m^{-1}
S_y	1

4.7.3 Transient ET Surface

Groundwater Vistas 6, allows for the simulation of transient ET surface changes. This allows ET to change in a manner that accurately reflects the changes that occur during and after mining operation. Pre-mining the ET surface is set at surface topography. In the period of mining, the ET surface elevation drops to the pit floor and post mining it is increased to the elevation of the final landform. The ET surface remains at final landform throughout the recovery period.

For areas of active mining, the extinction depth is reduced to 0.5 m.

4.7.4 Recovery recharge

Throughout the mining operations the recharge rate to the pit is assumed to be zero. Once mining operations are finished, recharge to the pit areas is assigned for the new material properties. For areas within the voids recharge is assumed to be 100% of average annual rainfall, plus estimated average annual runoff to the voids calculated as part of the surface water impact assessment. For areas of backfill, recharge is assumed to be 10% of average annual rainfall.

4.7.5 Wells

The Well Package of MODFOW is used to simulate the historic and estimated future groundwater extraction by mining operations for water supply. For more information on the rates of extraction are provided the EIS Chapter.

5. Model calibration

5.1 Methodology

Calibration of the model was undertaken using a stochastic calibration methodology designed to meet the following objectives:

- Establish datasets of model parameters that match measured groundwater levels within acceptable error limits. These parameter sets are reported collectively as the 'stochastic datasets'.
- Evaluate the sensitivity and uncertainty of model calibration
- Run the predictive simulations with the stochastic datasets to obtain an envelope of possible outcomes that also collectively represent the uncertainties associated with predictive modelling.

The stochastic approach was adopted in preference to a deterministic calibration methodology as it is capable of meeting the agreed upon objectives while offering the additional benefits of providing appropriate uncertainty analysis for predictive model results. This concept is highlighted specifically in the Australian Groundwater Modelling Guidelines (Barnett et al., 2012):

> *"The approach taken to model calibration must be linked to the questions that all groups of stakeholders (project proponents, regulators and modellers) are trying to answer. It is important at the start of model calibration to understand the purpose of the model, that is, what the model is intended to predict. It is the desire for accuracy in future predictions that must drive the choices that are made during model calibration."*

Model calibration using the stochastic approach employed here accounts for the inherent uncertainty associated with complex models based on many inter-related parameters. Each of the 'calibrated' datasets, or realisations that generate model results within the adopted calibration acceptance criteria, is considered equally plausible. The range of model results generated using these stochastic datasets provides a good indication of the uncertainties associated with predictive modelling. Such uncertainty analysis is important in any predictive modelling exercise and is recommended in the Australian Groundwater Modelling Guidelines (Barnett et al., 2012).

The stochastic calibration methodology comprised the following tasks:

- Generation of initial datasets within parameter bounds and constraints determined from the conceptual hydrogeological model and relevant data sources;
- Model simulations using each dataset;
- Comparison of model results to calibration targets, including historical groundwater levels and estimated pit inflows, when available;
- Establish the set of calibrated datasets; and
- Run predictive simulations using the calibrated datasets.

5.2 Monte Carlo Calibration Simulations

The initial datasets were generated automatically using a Monte Carlo simulation program developed by SKM. The program allows for the range of values for each parameter to be:

- Distributed as normal, log normal, random, or log random; and
- Constrained or tied to other parameters. For example, one parameter can be constrained so that it cannot exceed another parameter, or one parameter may be defined as a multiplier of another parameter (as commonly used to define a consistent level of anisotropy in hydraulic conductivity).

The generation of datasets in this method allows for flexibility in how parameters are defined and constrained, and also allows for multiple linking of parameters and constraints. These checks and constraints are important in generating datasets to ensure that datasets are not created that violate our conceptual understanding of the system (e.g. vertical conductivities exceeding horizontal conductivities, or the hydraulic conductivity of the interburden exceeding that of the coal seams).

The model parameters used as inputs for the Monte Carlo analysis included hydrogeological parameters properties (horizontal and vertical hydraulic conductivity, specific yield); conductance terms for river cells, and recharge rates.

Table 5.1 summarises of the range of values within which the model parameters were permitted to vary. The level of constraint for the parameter bounds was directly related to field-based and information available from the OGIA modelling report (GHD 2012). The ranges in parameters allowed does not necessarily reflect the expected or final values that will be selected for analysing potential inflows but are simply intended to:

- Allow for a wide range of potential values and thus possibilities to be assessed through the calibration process; and
- Evaluate the sensitivity and uncertainty in the parameterisation and calibration of the model.

Specific storage was not allowed to vary as part of the Monte Carlo process and were left at values equal to compressibility of water. The primary reasons behind this simplification are:

- For hard rock aquifers the compressibility of water is typically orders of magnitude greater than that of the material and thus any error in leaving it out is minor
- Measured values of specific storage, typically from pumping tests, do not typically account for leakage. Therefore measured values greater than the compressibility of water are often a reflection of leaky aquifers rather than the actual release of water from a drop in pressurised head. The model explicitly simulates the leakage across aquifers\aquitards. If a higher specific storage were used that included a leakage component, the resulting model simulations would either over estimate flow, under estimate drawdown or potentially underestimate the vertical connectivity between aquifers and aquitards.

5.3 Calibration Targets

Two distinct datasets were identified as appropriate calibration targets to determine which sets of model parameters represented calibrated datasets:

- The first calibration target was the matching of historical water levels recorded (steady state and transient).
- The second calibration target was set by estimated observed pit inflows between 300 and 400 m^3/d for years 2011 and 2012.

Jacobs SKM performed a qualitative assessment of data reliability based upon the information available for the bore and the sources of the data. A summary of the information and source of information are provided **Table 5.2**, along with the final weighting applied to each head target used in calculating calibration statistics.

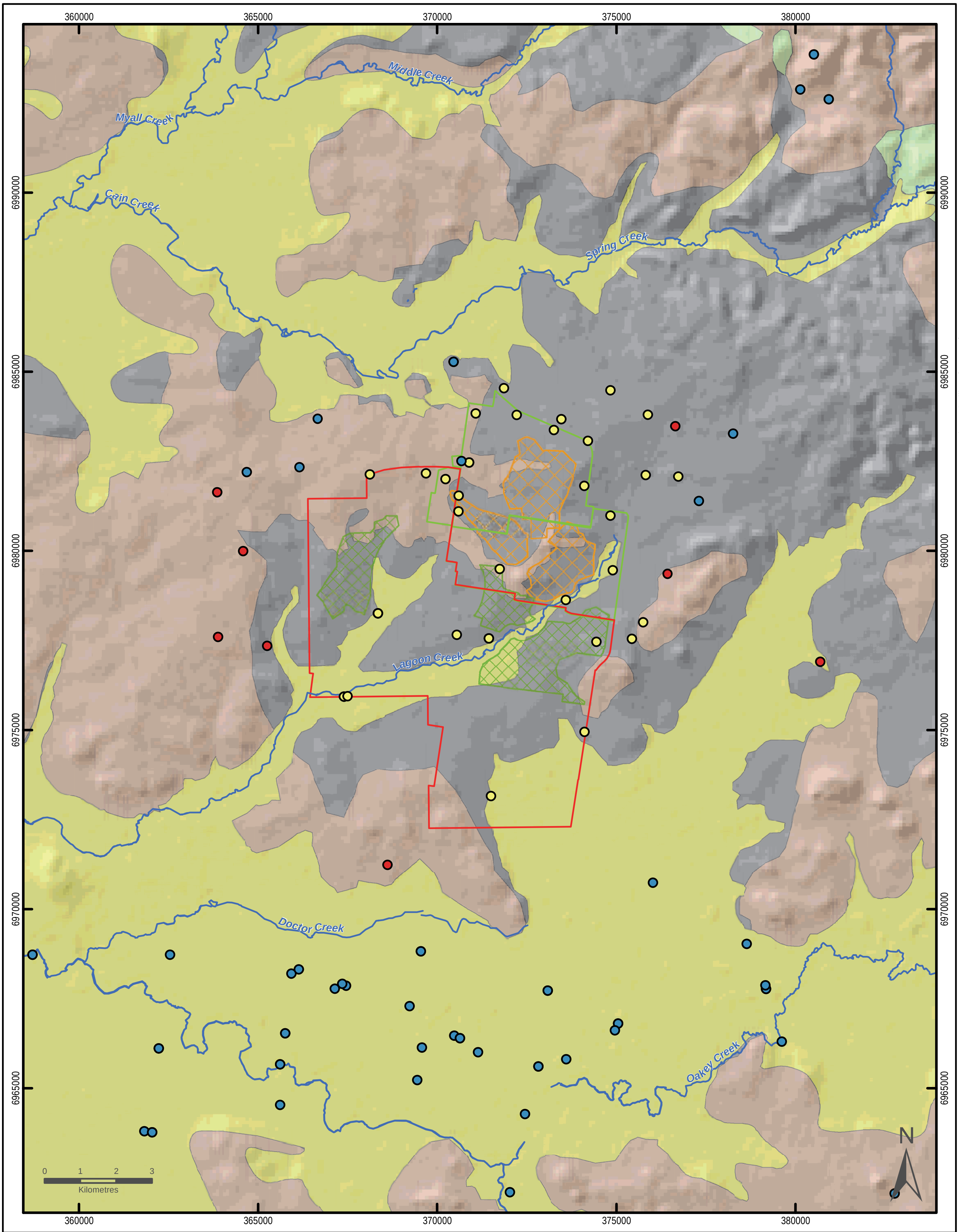
Table 5.1 : Parameter Bounds Assigned for Monte Carlo Analysis

Parameter	Geologic unit	Mean	Mean (log(x))	Standard Dev. (log(x))	Constraints
K_h (m/d)	Alluvium	8.51	0.93	0.5	None
	Basalt	0.54	-0.27	0.5	None
	Upper WCM	0.08	-1.11	0.75	None
	Lower WCM	0.01	-2.00	1	K_h Lower WCM < K_h Upper WCM
	Marburg Sandstone	0.05	-1.30	0.75	None
Parameter	**Geologic unit**		**Min. Multiplier of K_h**	**Max. Multiplier of K_h**	**Constraints**
K_z (m/d)	Alluvium		0.001	0.1	Tied to K_h Alluvium
	Basalt		0.001	0.1	Tied to K_h Basalt
	Upper WCM		0.0002	0.01	Tied to K_h Upper WCM
	Lower WCM		0.001	0.1	Tied to K_h Lower WCM
	Marburg Sandstone		0.001	1	Tied to K_h Marburg Sandstone
Parameter	**Geologic unit**	**Mean**	**Mean (log(x))**	**Standard Dev. (log(x))**	**Constraints**
S_y	Alluvium	0.01	-2.00	0.5	None
	Basalt	0.01	-2.00	0.5	None
	Upper WCM	0.005	-2.30	0.5	None
	Lower WCM	0.005	-2.30	0.5	None
	Marburg Sandstone	0.005	-2.30	0.5	None
Parameter	**Watercourse**	**Mean**	**Mean**	**Standard Dev. (log(x))**	**Constraints**
River Conductance (m^2/d)	Myall Creek	1	0	1	None
	Oakey Creek	1	0	1	None
Parameter	**Region**		**Parameter Min.**	**Parameter Max.**	**Constraints**
ET Extinction Depth (m)	Model Domain		0.5	4	None
Parameter	**Geologic unit**		**Parameter Min.**	**Parameter Max.**	**Constraints**
Recharge[1]	Alluvium and Basalt		0.2%	6.5%	None
	Upper WCM		0.4%	6.5%	None
	Marburg Sandstone		0.4%	6.5%	None
[1] Percent of annual rainfall (635 mm/yr) (www.bom.gov.au)					

Notes:

k_h - horizontal hydraulic conductivity

k_z - vertical hydraulic conductivity



LEGEND

Bores Used
- DNRM Bores
- Landholders Bores
- Project Bores
- Watercourse

- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Stage 3 Pit Areas
- Existing Permission

Modelled Surface Geology
- Alluvium (Qa)
- Basalt (Tm)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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Figure 5-1 - Bores Used In Calibration

Scale 1:140,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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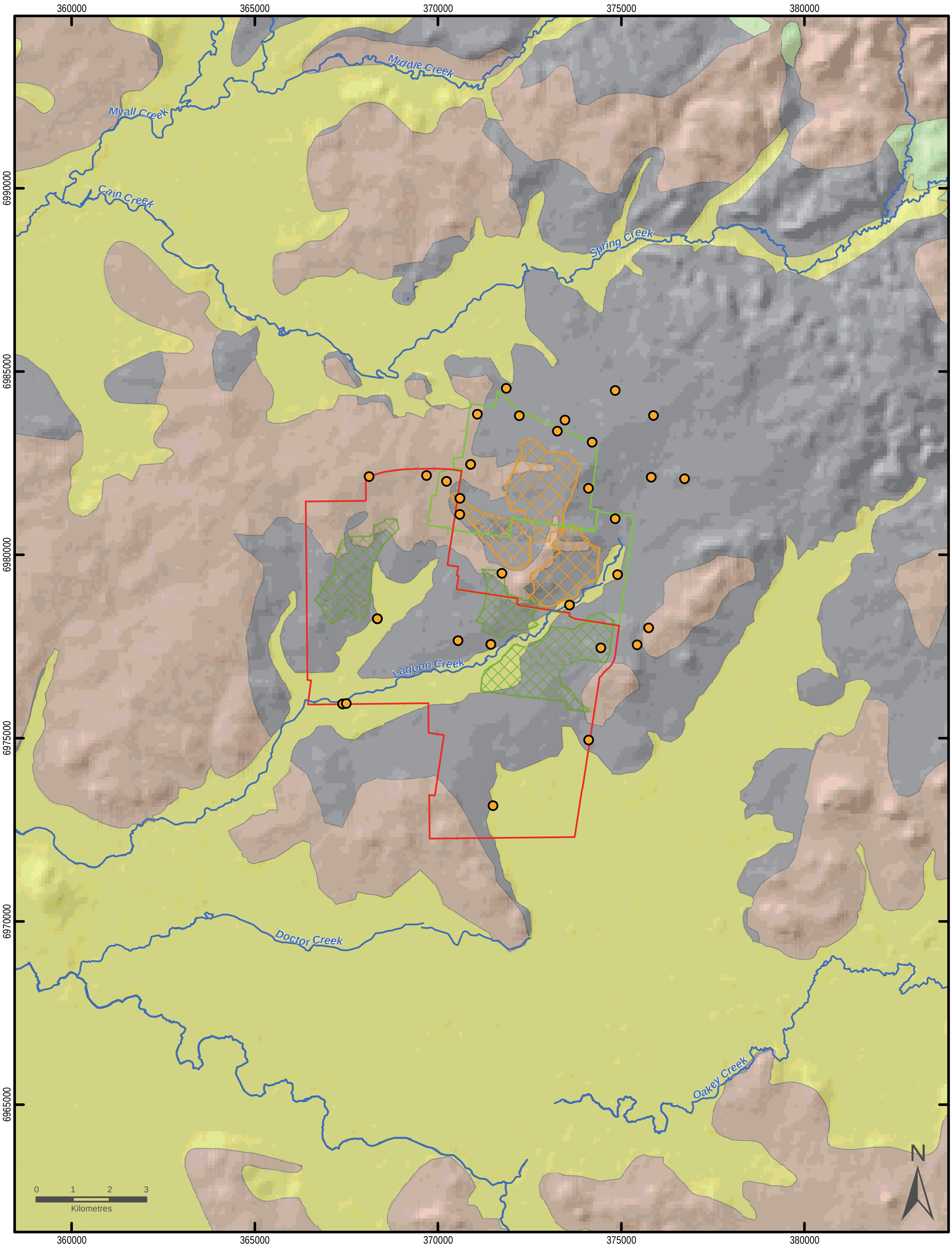

LEGEND

- Monitoring Bore Locations
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Stage 3 Pit Areas
- Existing Permission

Modelled Surface Geology

- Alluvium (Qa)
- Basalt (Tm)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 5-2 - Monitoring Bore Locations

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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Table 5.2 : Summary of Head Target Weighting

ID	Source	Geological log	Well construction details	Formation reliability	Sampled by	Steady State Water Level (m AHD)	Weight	Geologic Formation
2289	NAC	N	N	Confirmed	NAC		1	Upper WCM
2291	NAC	N	N	Confirmed	NAC		1	Upper WCM
109P	NAC	Y	Y	Confirmed	NAC		1	Tertiary Basalt
110PGC	NAC	Y	Y	Confirmed	NAC		1	Upper WCM
111PGC_Low	NAC	Y	Y	Confirmed	NAC		1	Upper WCM
111PGC_Up	NAC	Y	Y	Confirmed	NAC		1	Lower WCM
112PGC	NAC	Y	Y	Confirmed	NAC		1	Upper WCM
113PGCA	NAC	Y	Y	Confirmed	NAC		1	Upper WCM
113PGCB	NAC	Y	Y	Confirmed	NAC		1	Lower WCM
114P	NAC	Y	Y	Confirmed	NAC		1	Upper WCM
116P	NAC	Y	Y	Confirmed	NAC		1	Upper WCM
117PCG	NAC	Y	N	Confirmed	NAC		1	Upper WCM
118P	NAC	Y	Y	Confirmed	NAC		1	Upper WCM
119PCG	NAC	Y	Y	Confirmed	NAC		1	Upper WCM
120WB	NAC	Y	Y	Confirmed	NAC		1	Upper WCM
18Pb	NAC	N	N	Confirmed	NAC	439.554	1	Tertiary Basalt
18Pc	NAC	N	N	Confirmed	NAC		1	Upper WCM
20Phs	NAC	N	N	Confirmed	NAC	419.8	1	Marburg Sandstone
21Phs	NAC	N	N	Confirmed	NAC	415.3	1	Marburg Sandstone
25Pc	NAC	N	Y	Confirmed	NAC		1	Upper WCM
26Pc	NAC	N	Y	Confirmed	NAC	452	1	Upper WCM
27Pc	NAC	N	Y	Confirmed	NAC	439.148	1	Upper WCM
28Pc	NAC	N	Y	Confirmed	NAC	432.56	1	Upper WCM
29Phs	NAC	N	N	Confirmed	NAC	441.63	1	Marburg Sandstone
40Pc	NAC	N	N	Confirmed	NAC	402.758	1	Upper WCM
41Phs	NAC	N	N	Confirmed	NAC	414.09	1	Marburg Sandstone
42Pc	NAC	N	N	Confirmed	NAC	415.037	1	Upper WCM
48Phs	NAC	N	N	Confirmed	NAC	415.51	1	Marburg Sandstone
81Pc	NAC	N	N	Confirmed	NAC		1	Upper WCM
82Pc	NAC	N	N	Confirmed	NAC		1	Upper WCM
83Pc	NAC	N	N	Confirmed	NAC		1	Upper WCM
843b	NAC	N	N	Confirmed	NAC	424.54	1	Tertiary Basalt
848c	NAC	N	N	Confirmed	NAC	436.89	1	Upper WCM
84Pb	NAC	N	N	Confirmed	NAC		1	Tertiary Basalt
BMH1	NAC	N	N	Confirmed	NAC		1	Tertiary Basalt
CSMH1	NAC	N	N	Confirmed	NAC		1	Upper WCM

ID	Source	Geological log	Well construction details	Formation reliability	Sampled by	Steady State Water Level (m AHD)	Weight	Geologic Formation
52921	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
83425	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
87205	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
87282	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
129159	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
129694	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
129701	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
129708	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
129711	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
143028	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
143029	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
143030	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
143040	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
143432	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
143557	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
143927	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
147191	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
147193	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
147197	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
147198	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
147200	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt

ID	Source	Geological log	Well construction details	Formation reliability	Sampled by	Steady State Water Level (m AHD)	Weight	Geologic Formation
147202	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
147205	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
147295	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
147296	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
147304	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
147309	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
147312	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
147317	DNRM	N	Y	DNRM Description	Unknown		0.2	Alluvium
147342	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
147345	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
147368	DNRM	N	Y	DNRM Description	Unknown		0.2	Lower WCM
147392	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
147704	DNRM	N	Y	DNRM Description	Unknown		0.2	Lower WCM
147710	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
154313	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
42230136	DNRM	N	Y	DNRM Description	Unknown	346.14	0.2	Alluvium
42230875	DNRM	N	Y	DNRM Description	Unknown	425.16	0.2	Alluvium
42230876	DNRM	N	Y	DNRM Description	Unknown	422.49	0.2	Alluvium
42230876	DNRM	N	Y	DNRM Description	Unknown	422.49	0.2	Alluvium
42230880	DNRM	N	Y	DNRM Description	Unknown	402.48	0.2	Alluvium
42230882	DNRM	N	Y	DNRM Description	Unknown	378.69	0.2	Alluvium

ID	Source	Geological log	Well construction details	Formation reliability	Sampled by	Steady State Water Level (m AHD)	Weight	Geologic Formation
42230883	DNRM	N	Y	DNRM Description	Unknown	378.29	0.2	Alluvium
42230883	DNRM	N	Y	DNRM Description	Unknown	378.29	0.2	Alluvium
42230884	DNRM	N	Y	DNRM Description	Unknown	375.37	0.2	Alluvium
42230886	DNRM	N	Y	DNRM Description	Unknown	377.8	0.2	Alluvium
42230934	DNRM	N	Y	DNRM Description	Unknown	371.335	0.2	Alluvium
42230934	DNRM	N	Y	DNRM Description	Unknown	371.335	0.2	Alluvium
42230935	DNRM	N	Y	DNRM Description	Unknown	386.6	0.2	Tertiary Basalt
42230936	DNRM	N	Y	DNRM Description	Unknown	382.76	0.2	Tertiary Basalt
42230937	DNRM	N	Y	DNRM Description	Unknown	379.7	0.2	Tertiary Basalt
42230937	DNRM	N	Y	DNRM Description	Unknown	379.7	0.2	Tertiary Basalt
42230938	DNRM	N	Y	DNRM Description	Unknown	393.98	0.2	Tertiary Basalt
42230953	DNRM	N	Y	DNRM Description	Unknown	390.13	0.2	Tertiary Basalt
42230954	DNRM	N	Y	DNRM Description	Unknown	440.87	0.2	Tertiary Basalt
42230954	DNRM	N	Y	DNRM Description	Unknown	440.87	0.2	Tertiary Basalt
42230959	DNRM	N	Y	DNRM Description	Unknown	483.28	0.2	Tertiary Basalt
42230960	DNRM	N	Y	DNRM Description	Unknown	507.135	0.2	Tertiary Basalt
42230981	DNRM	N	Y	DNRM Description	Unknown	386.63	0.2	Tertiary Basalt
42230981	DNRM	N	Y	DNRM Description	Unknown	386.63	0.2	Tertiary Basalt
42230982	DNRM	N	Y	DNRM Description	Unknown	379.81	0.2	Tertiary Basalt
42231183	DNRM	N	Y	DNRM Description	Unknown	400.47	0.2	Tertiary Basalt
42231229	DNRM	N	Y	DNRM Description	Unknown	378.23	0.2	Alluvium

ID	Source	Geological log	Well construction details	Formation reliability	Sampled by	Steady State Water Level (m AHD)	Weight	Geologic Formation
42231229	DNRM	N	Y	DNRM Description	Unknown	378.23	0.2	Alluvium
42231230	DNRM	N	Y	DNRM Description	Unknown	377.89	0.2	Alluvium
42231293	DNRM	N	Y	DNRM Description	Unknown	364.37	0.2	Alluvium
42231294	DNRM	N	Y	DNRM Description	Unknown	364.42	0.2	Alluvium
42231294	DNRM	N	Y	DNRM Description	Unknown	364.42	0.2	Alluvium
42231295	DNRM	N	Y	DNRM Description	Unknown	352.12	0.2	Upper WCM
42231296	DNRM	N	Y	DNRM Description	Unknown		0.2	Alluvium
42231299	DNRM	N	Y	DNRM Description	Unknown	395.745	0.2	Alluvium
42231299	DNRM	N	Y	DNRM Description	Unknown	395.745	0.2	Alluvium
42231300	DNRM	N	Y	DNRM Description	Unknown	421.36	0.2	Alluvium
42231301	DNRM	N	Y	DNRM Description	Unknown	401.18	0.2	Alluvium
42231302	DNRM	N	Y	DNRM Description	Unknown	399.975	0.2	Alluvium
42231302	DNRM	N	Y	DNRM Description	Unknown	399.975	0.2	Alluvium
42231303	DNRM	N	Y	DNRM Description	Unknown	396.005	0.2	Alluvium
42231304	DNRM	N	Y	DNRM Description	Unknown	397.67	0.2	Alluvium
42231305	DNRM	N	Y	DNRM Description	Unknown	395.765	0.2	Alluvium
42231305	DNRM	N	Y	DNRM Description	Unknown	395.765	0.2	Alluvium
42231306	DNRM	N	Y	DNRM Description	Unknown	397.48	0.2	Tertiary Basalt
42231307	DNRM	N	Y	DNRM Description	Unknown	389.675	0.2	Alluvium
42231308	DNRM	N	Y	DNRM Description	Unknown	383.33	0.2	Alluvium
42231308	DNRM	N	Y	DNRM Description	Unknown	383.33	0.2	Alluvium

ID	Source	Geological log	Well construction details	Formation reliability	Sampled by	Steady State Water Level (m AHD)	Weight	Geologic Formation
42231309	DNRM	N	Y	DNRM Description	Unknown	378.115	0.2	Alluvium
42231310	DNRM	N	Y	DNRM Description	Unknown	380.38	0.2	Alluvium
42231340	DNRM	N	Y	DNRM Description	Unknown	373.54	0.2	Upper WCM
42231340	DNRM	N	Y	DNRM Description	Unknown	373.54	0.2	Upper WCM
42231341	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
42231342	DNRM	N	Y	DNRM Description	Unknown	395.22	0.2	Upper WCM
42231357	DNRM	N	Y	DNRM Description	Unknown	395	0.2	Upper WCM
42231357	DNRM	N	Y	DNRM Description	Unknown	395	0.2	Upper WCM
42231358	DNRM	N	Y	DNRM Description	Unknown	394.16	0.2	Upper WCM
42231382	DNRM	N	Y	DNRM Description	Unknown	393.25	0.2	Alluvium
42231383	DNRM	N	Y	DNRM Description	Unknown	393.54	0.2	Alluvium
42231383	DNRM	N	Y	DNRM Description	Unknown	393.54	0.2	Alluvium
42231384	DNRM	N	Y	DNRM Description	Unknown	383.8	0.2	Alluvium
42231385	DNRM	N	Y	DNRM Description	Unknown	385.39	0.2	Alluvium
42231395	DNRM	N	Y	DNRM Description	Unknown	373	0.2	Alluvium
42231395	DNRM	N	Y	DNRM Description	Unknown	373	0.2	Alluvium
42231396	DNRM	N	Y	DNRM Description	Unknown	380.58	0.2	Alluvium
42231397	DNRM	N	Y	DNRM Description	Unknown	379.26	0.2	Alluvium
42231398	DNRM	N	Y	DNRM Description	Unknown	376.72	0.2	Alluvium
42231398	DNRM	N	Y	DNRM Description	Unknown	376.72	0.2	Alluvium
42231399	DNRM	N	Y	DNRM Description	Unknown	381.71	0.2	Alluvium

ID	Source	Geological log	Well construction details	Formation reliability	Sampled by	Steady State Water Level (m AHD)	Weight	Geologic Formation
42231400	DNRM	N	Y	DNRM Description	Unknown	382.53	0.2	Alluvium
42231401	DNRM	N	Y	DNRM Description	Unknown	385.19	0.2	Tertiary Basalt
42231401	DNRM	N	Y	DNRM Description	Unknown	385.19	0.2	Tertiary Basalt
42231402	DNRM	N	Y	DNRM Description	Unknown	391.78	0.2	Tertiary Basalt
42231403	DNRM	N	Y	DNRM Description	Unknown	388.49	0.2	Tertiary Basalt
42231404	DNRM	N	Y	DNRM Description	Unknown	389.31	0.2	Tertiary Basalt
42231404	DNRM	N	Y	DNRM Description	Unknown	389.31	0.2	Tertiary Basalt
42231405	DNRM	N	Y	DNRM Description	Unknown	404.93	0.2	Alluvium
42231447	DNRM	N	Y	DNRM Description	Unknown	387.79	0.2	Tertiary Basalt
42231447	DNRM	N	Y	DNRM Description	Unknown	387.79	0.2	Tertiary Basalt
42231492	DNRM	N	Y	DNRM Description	Unknown	363.5	0.2	Alluvium
42231493	DNRM	N	Y	DNRM Description	Unknown	363.395	0.2	Alluvium
42231498	DNRM	N	Y	DNRM Description	Unknown	378.32	0.2	Alluvium
42231498	DNRM	N	Y	DNRM Description	Unknown	378.32	0.2	Alluvium
42231523	DNRM	N	Y	DNRM Description	Unknown	443.9	0.2	Tertiary Basalt
42231524	DNRM	N	Y	DNRM Description	Unknown	418.455	0.2	Upper WCM
42231529	DNRM	N	Y	DNRM Description	Unknown	590.89	0.2	Tertiary Basalt
42231529	DNRM	N	Y	DNRM Description	Unknown	590.89	0.2	Tertiary Basalt
42231590	DNRM	N	Y	DNRM Description	Unknown		0.2	Marburg Sandstone
42231593	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
42231594	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt

ID	Source	Geological log	Well construction details	Formation reliability	Sampled by	Steady State Water Level (m AHD)	Weight	Geologic Formation
42231594	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
42231603	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
42231668	DNRM	N	Y	DNRM Description	Unknown		0.2	Tertiary Basalt
Private_Bore1	Landholder Bore	y	Y	Confirmed	SKM		1	Tertiary Basalt
Private_Bore2	Landholder Bore	y	Y	Confirmed	SKM		1	Upper WCM
Private_Bore3	Landholder Bore	y	N	Confirmed	SKM		1	Marburg Sandstone
Private_Bore4	Landholder Bore	N	N	Anecdotal	SKM		0.4	Upper WCM
Private_Bore5	Landholder Bore	N	N	Anecdotal	SKM		0.4	Upper WCM
Private_Bore6	Landholder Bore	N	N	Anecdotal	SKM		0.4	Upper WCM
Private_Bore7	Landholder Bore	N	N	Anecdotal	SKM		0.4	Tertiary Basalt
Private_Bore8	Landholder Bore	N	N	Anecdotal	SKM		0.4	Tertiary Basalt

5.4 Calibration Results

The calibration simulations resulted in 1836 realisations (out of 2980), or sets of model parameters, that simulated groundwater levels within the target calibration criteria of 5% weighted SRMS (the first calibration target). Of these, 45 also simulated pit inflows within the range of inflow estimates used for calibration (between 300-400 m^3/day for 2011 and 2012) (the second calibration target). Therefore, these 45 realisations are considered the calibrated datasets available for an assessment of calibration sensitivity\uncertainty, as well as forming the input parameters for the predictive simulations and associated sensitivity\uncertainty assessments.

5.4.1 Water balance

The overall water balance for the steady state model is provided in **Table 5.3**, as represented by the realisation with the best calibration statistics. Constant Heads provide a majority of the calculated throughflow with the model, although it should be noted that constant head flows have not been filtered for flows between constant head cells. Recharge comprises the majority of total net inflows. Baseflow (Drains) to tributaries and ET are the primary outflows mechanisms.

The water balance discrepancy between calculated inflows and outflows is negligible.

Table 5.3 : Steady state water balance

	Inflows	Outflows
Well	0	-170.3
Constant Heads	213661.5	-201993
River	106.1	-93.8
Drain	0	-33082.5
Recharge	35364.0	0
ET	0	-13792.5
Total	**249131.6**	**-249132.1**
Percent Discrepancy	**-0.012**	

5.4.2 Statistics

Table 5.4 provides a summary of statistical measures used to compare results from model simulations using the calibrated datasets with observed data used as calibration targets. Plots of observed and all equivalent realisation-simulated groundwater levels for the steady state and transient calibration are presented in **Figure 5-3** and **Figure 5-4** respectively, as represented by the realisation with the best calibration statistics.

Table 5.4 : Summary of Calibration Statistics

	Minimum	Median	Maximum
Mean Residual	0.0	4.7	8.7
Absolute Residual Mean	6.6	7.9	9.3
Standard Deviation	10.6	12.5	14.1
Sum of squares	556775.8	778458.4	1218447.3
RMS Error	11.2	13.2	16.6
Min Residual	-54.2	-36.9	-22.9
Max Residual	42.2	48.9	55.9
Number of observations	4440	4440	4440
Range in observations	449.7	449.7	449.7
Scaled Standard Deviation	0.02	0.03	0.03
Scaled Abs. Mean	0.01	0.02	0.02
Scaled RMS	2.5%	2.9%	3.7%

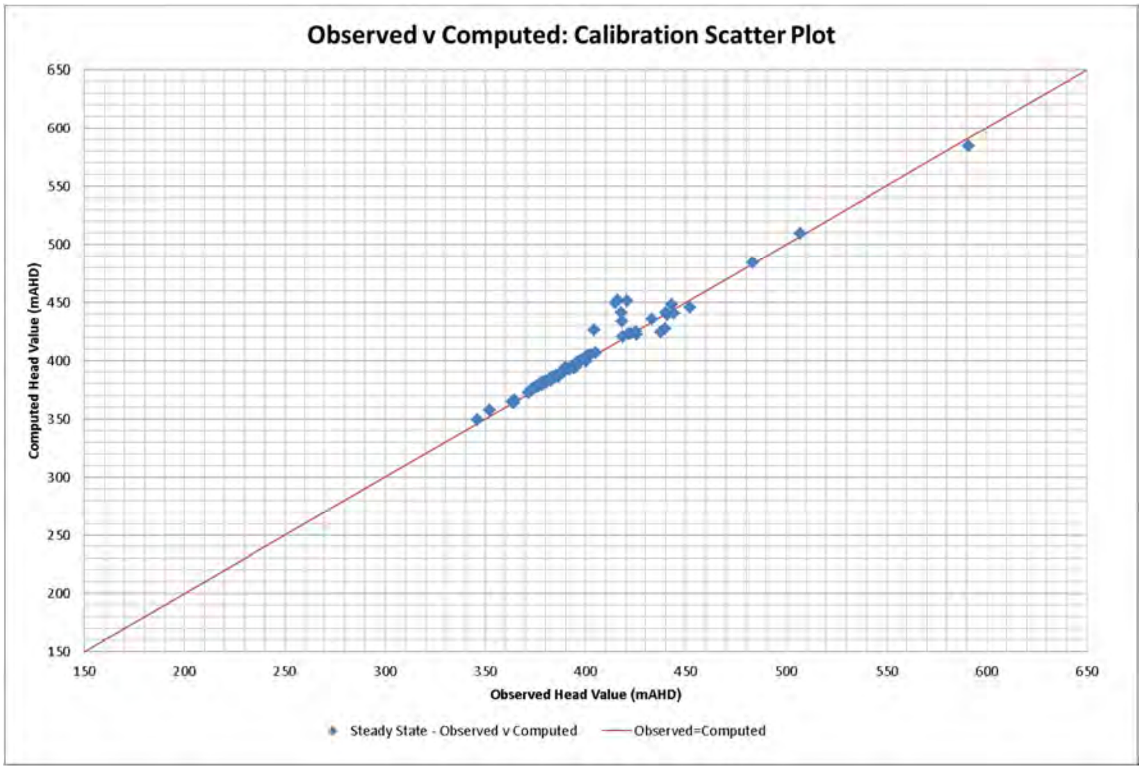


Figure 5-3 : Observed vs. Simulated Groundwater Levels (Steady State)

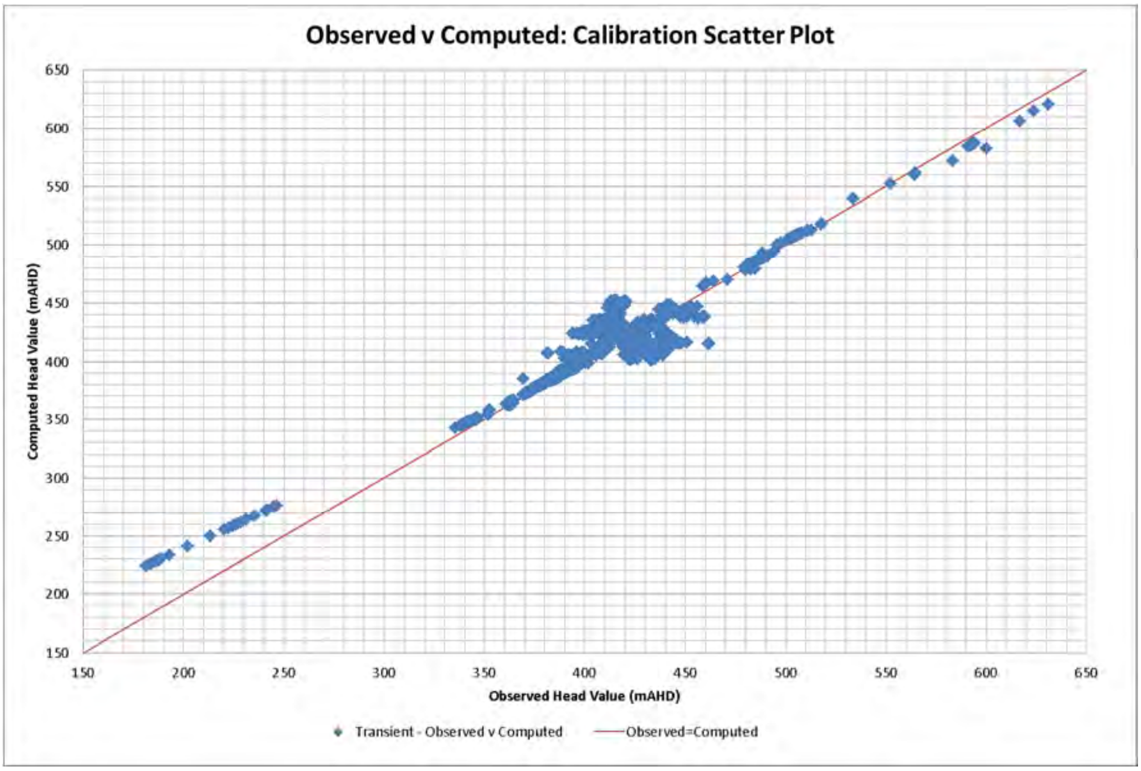


Figure 5-4 : Observed vs. Simulated Groundwater Levels (Transient)

Pre-mining steady state heads are not readily available and were reliant upon data collected form the DNRM database. As discussed previously in the report Jacobs are unable to verify the quality of this data. In addition the data available are not centred upon the project site but are more regional and thus calibration to pre-mining water levels can best be described as a means to provide regional flow directions.

In addition to the paucity of data available for pre-mining water levels, the model does not account for other historic activities in the area unknown or quantifiable to the project proponent. As such the model should be judged upon its ability to replicate regional flow gradients and drawdown magnitudes where information is available. Based upon this expectation the model calibration has been considered fit for the purpose for this assessment.

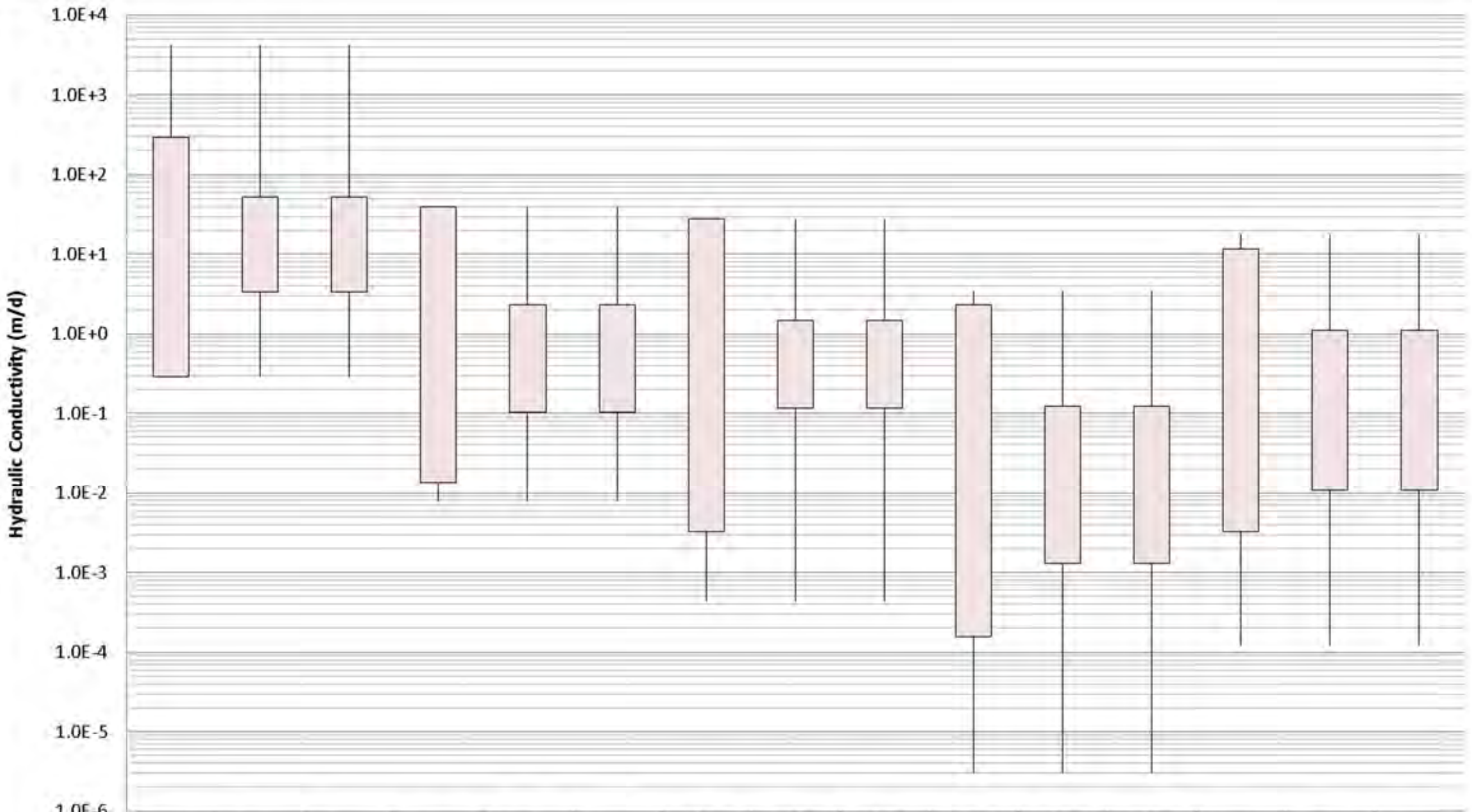
Additional calibration comparisons and information are provided in Appendix A. The additional analyses include hydrographs of observed and simulated groundwater levels for all bores with more than one data point. Given that the availability of water level data for the region is both scarce and transiently sporadic in an area of intense groundwater development, it was considered that developing pre-mining potentiometric surfaces to compare with modelled potentiometric surfaces is not appropriate as outlined above. Rather, maps showing the spatial distribution of calibration SRMS error at each target bore location are also provided in Appendix A, allowing the spatial distribution of calibration to be assessed without the need to develop highly unreliable maps of pre-mining potentiometric surfaces. The SRMS maps are provided for each model layer. As indicated by the hydrographs and SRMS maps the model is able to provide a reasonable replication of water levels across the model domain, and for most locations provides a good replication of drawdown from mining activities where information is available. .

5.4.3 Calibration Sensitivity Analysis

The input and calibrated parameter ranges are presented graphically and in tabular form in **Figure 5.5** through **Figure 5.10**. The calibrated ranges provide an indication of the model's sensitivity to changes in the parameter values while also providing an indication of the parameter value's uncertainty. For the calibrated datasets, model parameters with values that represent a lower percentage of the stochastic range indicate that model calibration is more sensitive to these parameters.

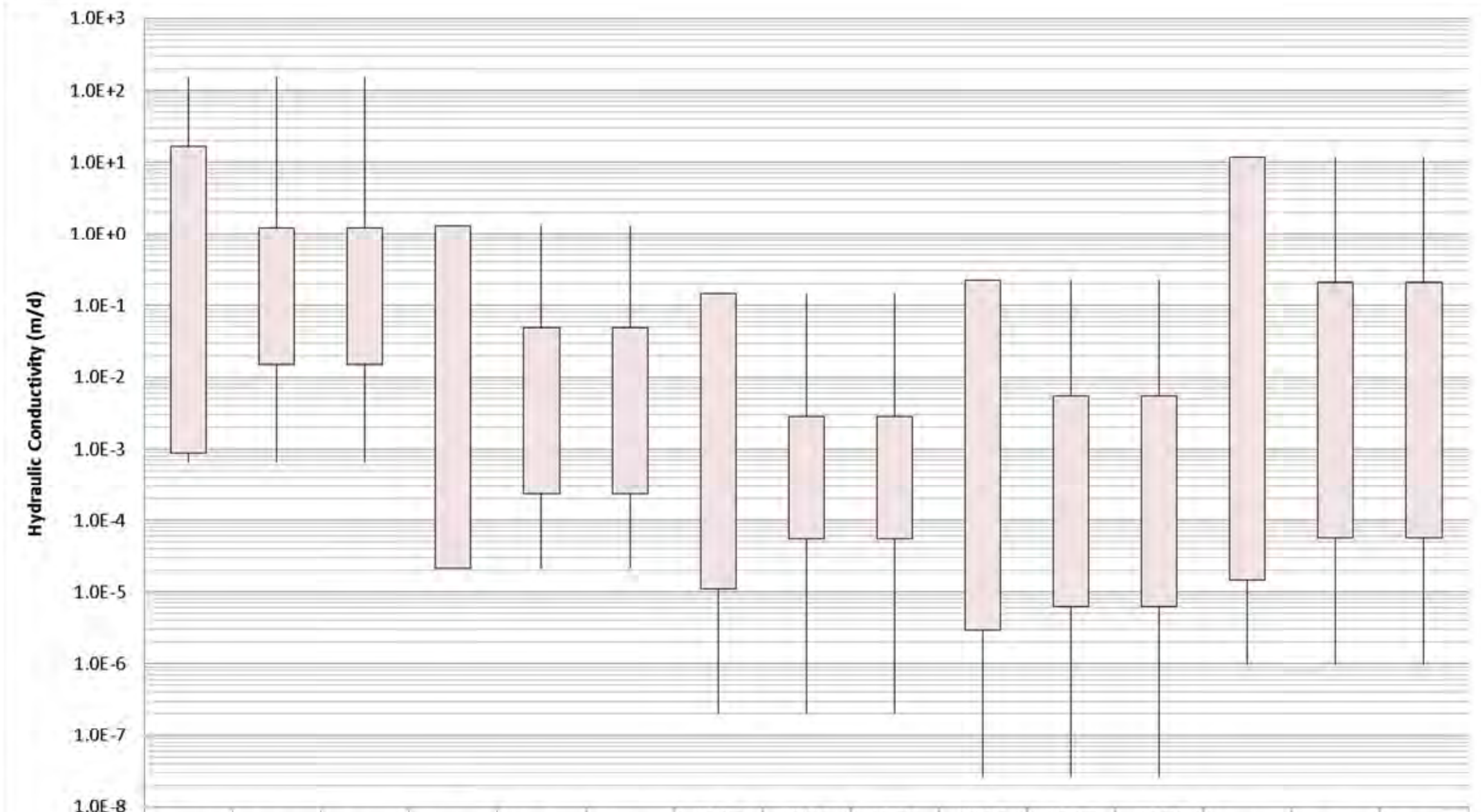
The box and whisker plots (**Figure 5.5** through **5.10**) provide three box and whiskers for each parameter. The different box and whiskers represent the dataset ranges from each calibration objective (matching SRMS and pit inflows) individually and then the final distribution with them both combined.

Additional plots are provided in **Appendix B** that provide a comparison of the distribution of parameter values before and after calibration. These graphs, in some instances, provide an indication of skewing or bias within the calibrated parameter ranges. A summary of observations for each of the parameters tested for sensitivity is provided in **Table 5.5**.



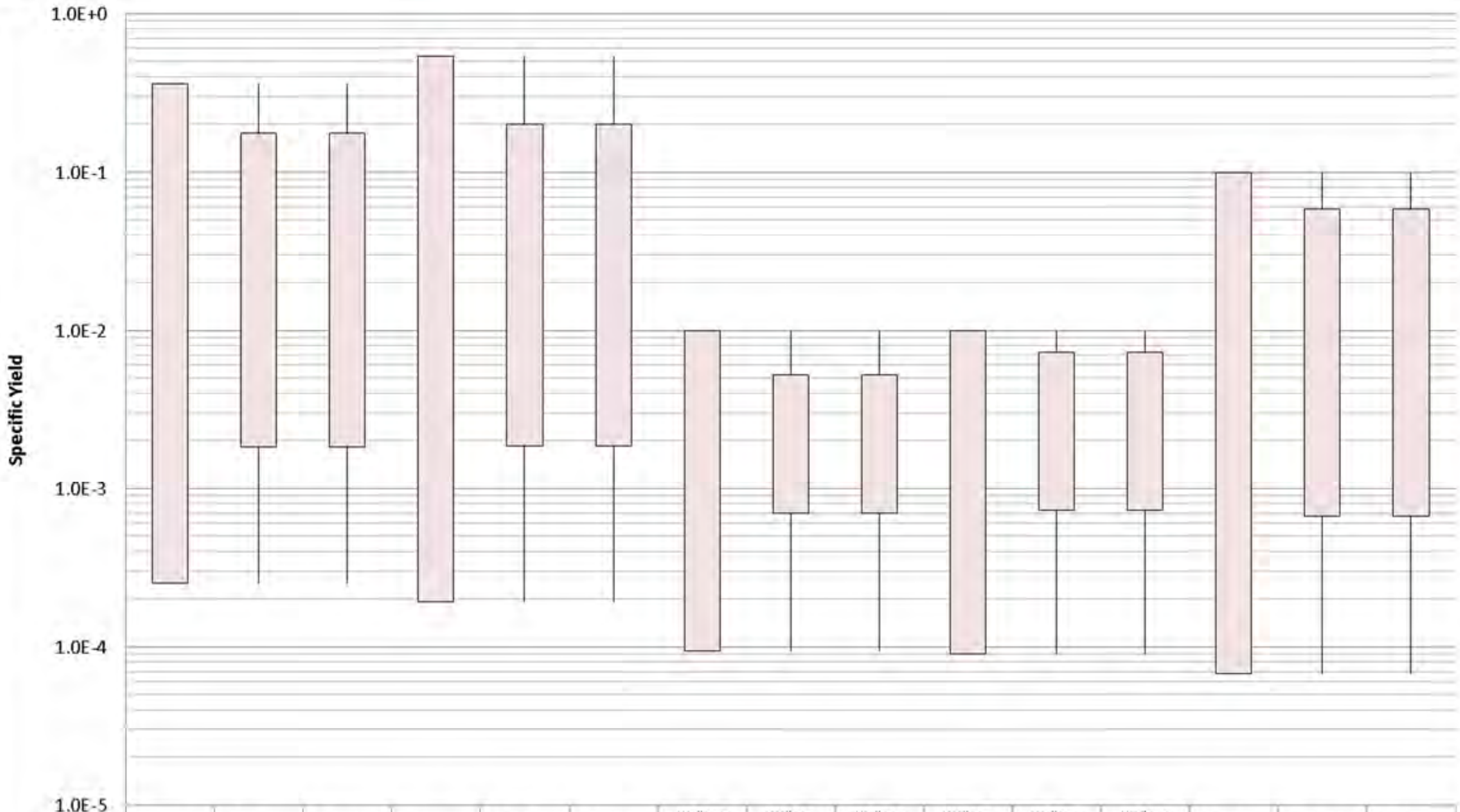
	Alluvium - SRMS	Alluvium - Inflows	Alluvium - Combined	Basalt - SRMS	Basalt - Inflows	Basalt - Combined	Walloon (upper) - SRMS	Walloon (upper) - Inflows	Walloon (upper) - Combined	Walloon (lower) - SRMS	Walloon (lower) - Inflows	Walloon (lower) - Combined	Marburg - SRMS	Marburg - Inflows	Marburg - Combined
Calibration Min	2.9E-01	3.4E+00	3.4E+00	1.4E-02	1.0E-01	1.0E-01	3.3E-03	1.2E-01	1.2E-01	1.6E-04	1.3E-03	1.3E-03	3.3E-03	1.1E-02	1.1E-02
Input Max	4.1E+03	4.1E+03	4.1E+03	4.0E+01	4.0E+01	4.0E+01	2.8E+01	2.8E+01	2.8E+01	3.5E+00	3.5E+00	3.5E+00	1.9E+01	1.9E+01	1.9E+01
Input Min	2.9E-01	2.9E-01	2.9E-01	7.9E-03	7.9E-03	7.9E-03	4.4E-04	4.4E-04	4.4E-04	3.0E-06	3.0E-06	3.0E-06	1.2E-04	1.2E-04	1.2E-04
Calibration Max	2.9E+02	5.3E+01	5.3E+01	4.0E+01	2.3E+00	2.3E+00	2.8E+01	1.5E+00	1.5E+00	2.3E+00	1.2E-01	1.2E-01	1.2E+01	1.1E+00	1.1E+00

Figure 5-5 : Model Parameter Sensitivity: Horizontal Hydraulic Conductivity



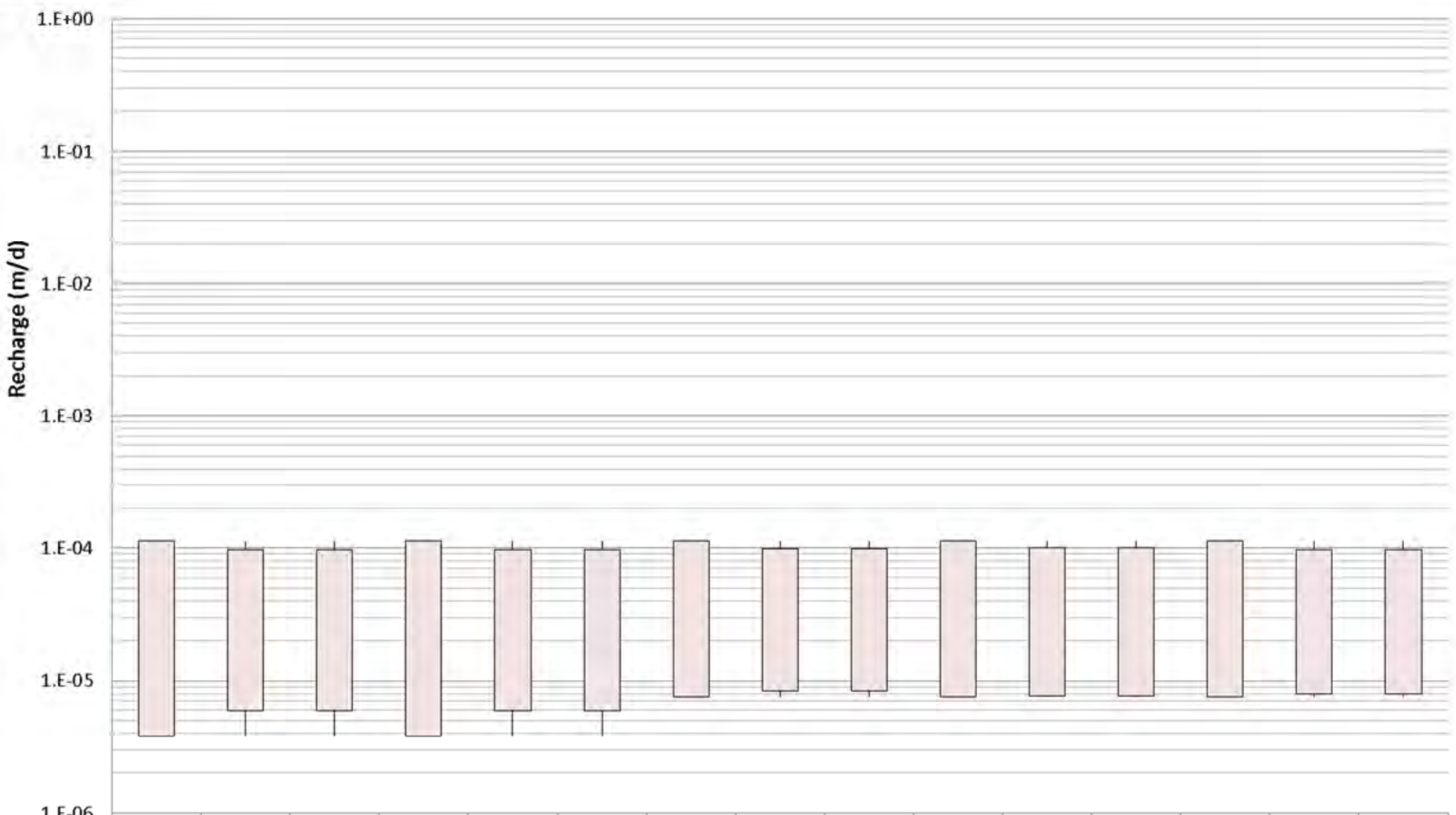
	Alluvium - SRMS	Alluvium - Inflows	Alluvium - Combined	Basalt - SRMS	Basalt - Inflows	Basalt - Combined	Walloon (upper) - SRMS	Walloon (upper) - Inflows	Walloon (upper) - Combined	Walloon (lower) - SRMS	Walloon (lower) - Inflows	Walloon (lower) - Combined	Marburg - SRMS	Marburg - Inflows	Marburg - Combined
Calibration Min	8.8E-04	1.5E-02	1.5E-02	2.1E-05	2.4E-04	2.4E-04	1.1E-05	5.5E-05	5.5E-05	2.9E-06	6.3E-06	6.3E-06	1.5E-05	5.7E-05	5.7E-05
Input Max	1.6E+02	1.6E+02	1.6E+02	1.3E+00	1.3E+00	1.3E+00	1.5E-01	1.5E-01	1.5E-01	2.2E-01	2.2E-01	2.2E-01	1.2E+01	1.2E+01	1.2E+01
Input Min	6.6E-04	6.6E-04	6.6E-04	2.1E-05	2.1E-05	2.1E-05	2.0E-07	2.0E-07	2.0E-07	2.6E-08	2.6E-09	2.6E-08	9.9E-07	9.9E-07	9.9E-07
Calibration Max	1.7E+01	1.2E+00	1.2E+00	1.3E+00	4.9E-02	4.9E-02	1.5E-01	2.8E-03	2.8E-03	2.2E-01	5.3E-03	5.3E-03	1.2E+01	2.1E-01	2.1E-01

Figure 5-6 : Model Parameter Sensitivity: Vertical Hydraulic Conductivity



	Alluvium - SRMS	Alluvium - Inflows	Alluvium - Combined	Basalt - SRMS	Basalt - Inflows	Basalt - Combined	Walloon (upper) - SRMS	Walloon (upper) - Inflows	Walloon (upper) - Combined	Walloon (lower) - SRMS	Walloon (lower) - Inflows	Walloon (lower) - Combined	Marburg - SRMS	Marburg - Inflows	Marburg - Combined
Calibration Min	2.5E-04	1.9E-03	1.9E-03	1.9E-04	1.9E-03	1.9E-03	9.4E-05	6.9E-04	6.9E-04	9.0E-05	7.3E-04	7.3E-04	6.7E-05	6.7E-04	6.7E-04
Input Max	3.6E-01	3.6E-01	3.6E-01	5.3E-01	5.3E-01	5.3E-01	1.0E-02	1.0E-02	1.0E-02	1.0E-02	1.0E-02	1.0E-02	9.9E-02	9.9E-02	9.9E-02
Input Min	2.5E-04	2.5E-04	2.5E-04	1.9E-04	1.9E-04	1.9E-04	9.4E-05	9.4E-05	9.4E-05	9.0E-05	9.0E-05	9.0E-05	6.7E-05	6.7E-05	6.7E-05
Calibration Max	3.6E-01	1.8E-01	1.8E-01	5.3E-01	2.0E-01	2.0E-01	1.0E-02	5.2E-03	5.2E-03	1.0E-02	7.2E-03	7.2E-03	9.9E-02	5.8E-02	5.8E-02

Figure 5-7 : Model Parameter Sensitivity: Specific Yield

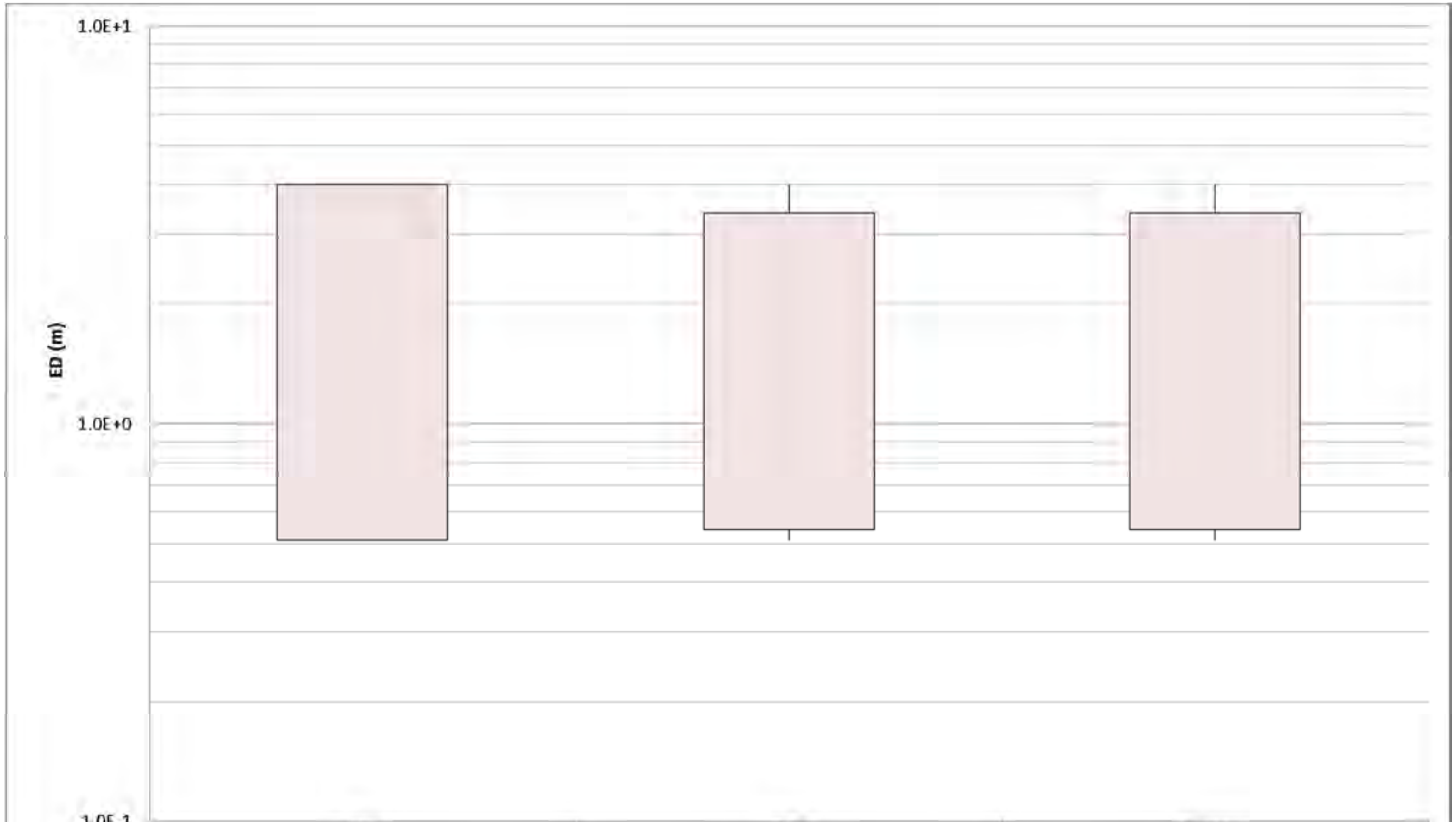


	Alluvium - SRMS	Alluvium - Inflows	Alluvium - Combined	Basalt - SRMS	Basalt - Inflows	Basalt - Combined	Walloon (upper) - SRMS	Walloon (upper) - Inflows	Walloon (upper) - Combined	Walloon (lower) - SRMS	Walloon (lower) - Inflows	Walloon (lower) - Combined	Marburg - SRMS	Marburg - Inflows	Marburg - Combined
Calibration Min	3.8E-06	6.0E-06	6.0E-06	3.8E-06	6.0E-06	6.0E-06	7.6E-06	8.3E-06	8.3E-06	7.6E-06	7.6E-06	7.6E-06	7.6E-06	8.0E-06	8.0E-06
Input Max	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04
Input Min	3.8E-06	3.8E-06	3.8E-06	3.8E-06	3.8E-06	3.8E-06	7.6E-06	7.6E-06	7.6E-06	7.6E-06	7.6E-06	7.6E-06	7.6E-06	7.6E-06	7.6E-06
Calibration Max	1.1E-04	9.7E-05	9.7E-05	1.1E-04	9.7E-05	9.7E-05	1.1E-04	9.9E-05	9.9E-05	1.1E-04	1.0E-04	1.0E-04	1.1E-04	9.7E-05	9.7E-05

Figure 5-8 : Model Parameter Sensitivity: Recharge

	SRMS	Inflows	Combined	SRMS	Inflows	Combined
Calibration Min	1.2E-03	4.7E-02	4.7E-02	1.4E-04	1.7E-02	1.7E-02
Input Max	2.3E+03	2.3E+03	2.3E+03	1.1E+03	1.1E+03	1.1E+03
Input Min	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04
Calibration Max	2.3E+03	1.3E+02	1.3E+02	1.1E+03	1.5E+02	1.5E+02

Figure 5-9 : Model Parameter Sensitivity: Boundary Conductance



	SRMS	Inflows	Combined
Calibration Min	5.1E-01	5.4E-01	5.4E-01
Input Max	4.0E+00	4.0E+00	4.0E+00
Input Min	5.1E-01	5.1E-01	5.1E-01
Calibration Max	4.0E+00	3.4E+00	3.4E+00

Figure 5-10 : Model Parameter Sensitivity: ET Extinction Depth

Table 5.5 : Summary of Calibration Parameter Sensitivity

Parameter	Geologic unit	Comments
K_h (m/d)	Alluvium	Horizontal conductivity for the alluvium is only slightly constrained at the low and high ranges. The distribution of calibrated values has not been skewed or biased in any direction.
K_h (m/d)	Basalt	Horizontal conductivity for the Basalt is slightly constrained at the low and high ranges. The distribution of calibrated values is slightly skewed or biased towards the higher range in values – as indicated by a minor increase in the 50th percentile value.
K_h (m/d)	Upper WCM	Horizontal conductivity for the Upper WCM is highly constrained at the low and high ranges. The distribution of calibrated values is highly skewed or biased towards the lower range in values – as indicated by a decrease in the 50th percentile value of nearly an order of magnitude.
K_h (m/d)	Lower WCM	Horizontal conductivity for the Lower WCM is slightly constrained at the low and high ranges. The distribution of calibrated values is slightly skewed or biased towards the lower range in values – as indicated by a minor decrease in the 50th percentile value.
K_h (m/d)	Marburg Sandstone	Horizontal conductivity for the Marburg Sandstone is only slightly constrained at the low and high ranges. The distribution of calibrated values has not been skewed or biased in any direction.
K_z (m/d)	Alluvium	Vertical conductivity for the alluvium is only slightly constrained at the low and high ranges. The distribution of calibrated values has not been skewed or biased in any direction.
K_z (m/d)	Basalt	Vertical conductivity for the Basalt is slightly constrained at the low and high ranges. The distribution of calibrated values is slightly skewed or biased towards the higher range in values – as indicated by a minor increase in the 50th percentile value.
K_z (m/d)	Upper WCM	Vertical conductivity for the Upper WCM is highly constrained at the low and high ranges. The distribution of calibrated values is highly skewed or biased towards the lower range in values – as indicated by a decrease in the 50th percentile value and a reduction in the maximum value by nearly three orders of magnitude.
K_z (m/d)	Lower WCM	Vertical conductivity for the Lower WCM is slightly constrained at the low and high ranges. The distribution of calibrated values is slightly skewed or biased towards the lower range in values – as indicated by a minor decrease in the 50th percentile value.
K_z (m/d)	Marburg Sandstone	Vertical conductivity for the Marburg Sandstone is only slightly constrained at the low and high ranges. The distribution of calibrated values has not been skewed or biased in any direction.
S_y	Alluvium	Specific yield for the alluvium is only slightly constrained at the low and high ranges. The distribution of calibrated values has not been skewed or biased in any direction.
S_y	Basalt	Specific yield for the Basalt is slightly constrained at the low and high ranges. The distribution of calibrated values is slightly skewed or biased towards the higher range in values – as indicated by a minor increase in the 50th percentile value.
S_y	Upper WCM	Specific yield for the Upper WCM is slightly constrained at the low and high ranges. The distribution of calibrated values is slightly skewed or biased towards the lower range in values – as indicated by a minor decrease in the 50th percentile value.
S_y	Lower WCM	Specific yield for the Lower WCM is not constrained at the low and high ranges. The distribution of calibrated values is not skewed or biased in any direction.

Parameter	Geologic unit	Comments
S_y	Marburg Sandstone	Specific yield for the Marburg Sandstone is not constrained at the low and high ranges. The distribution of calibrated values is not skewed or biased in any direction.
River Conductance (m^2/d)	Myall Creek	River Conductance for Myall Creek is slightly constrained at the low and high ranges. The distribution of calibrated values is slightly skewed or biased towards the lower range in values – as indicated by a decrease in the 50th percentile value.
River Conductance (m^2/d)	Oakey Creek	River Conductance for Oakey Creek is slightly constrained at the low and high ranges. The distribution of calibrated values is slightly skewed or biased towards the middle and higher range in values – as indicated by the significant increase in the 10th and 40th percentile values.
ET Extinction Depth	Model Domain	ET Extinction Depth is not constrained at the low and high ranges. The distribution of calibrated values is slightly skewed or biased towards the higher range in values – as indicated by an increase in the 50th percentile value.
Recharge	Alluvium and Basalt	Recharge to the alluvium and Basalt is not constrained at the low and high ranges. The distribution of calibrated values is skewed or biased towards the lower range in values – as indicated by a decrease in the 50th percentile value.
Recharge	Upper WCM	Recharge to the Upper WCM is not constrained at the low and high ranges. The distribution of calibrated values is skewed or biased towards the lower range in values – as indicated by a decrease in the 50th percentile value.
Recharge	Marburg Sandstone	Recharge to the Upper WCM is not constrained at the low and high ranges. The distribution of calibrated values is skewed or biased towards the higher range in values – as indicated by an increase in the 50th percentile value.

6. Predictive simulation results

The parameters sets from the stochastic calibration were used for the predictive simulations in order to provide a stochastic based prediction of potential impacts. All results, where practical, are reported using the median results to present the most likely impacts. Uncertainty bounds are presented using plus and minus one standard deviation. For results, such as potentiometric maps, that are not conducive to this type of presentation the results from the best calibrated realisation is presented.

6.1 Prediction of mine dewatering

The predictive simulation allows all water to flow into the mine pit, from where the water would then be managed. The seepage into the pit was simulated with the lowering of Drain cells to the pit floor according to the mine plans provided. Evapotranspiration surface elevations are also adjusted with the mining depth, along with an extinction depth of 0.5m to account for evaporative losses within the pit. Final estimated pit inflow (all pits combined) is provided in **Figure 6-1**.

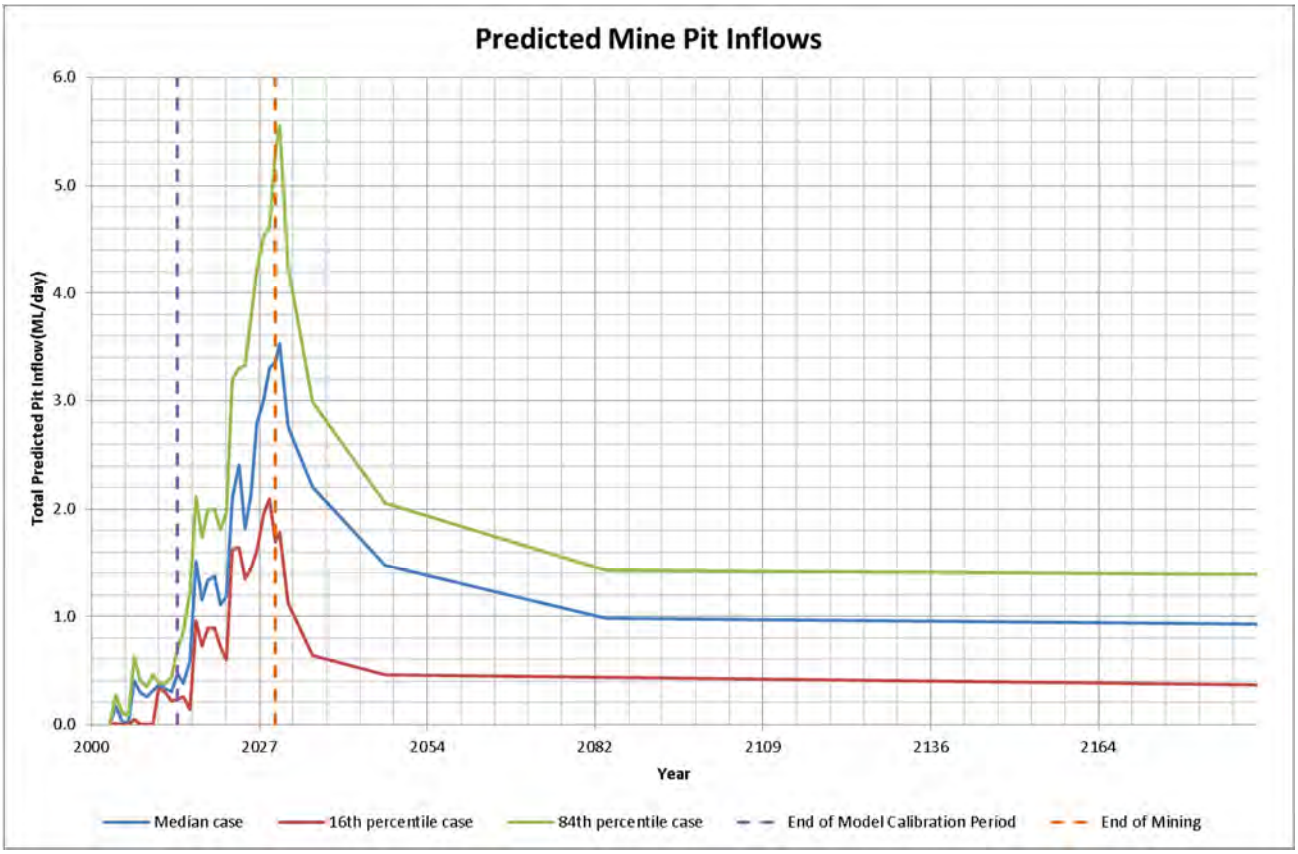


Figure 6-1 : Estimated Pit Inflows

6.2 Water balance

A transient water balance for the best calibrated realisation is provided in **Figure 6-2**. Percent discrepancy is within acceptable bounds (<2%) for the entire model simulation (i.e. time steps and stress periods).

Recharge to model domain is the primary source of net inflow, with ET and flow to drain features (mining and tributaries) comprising the majority of outflow from the model.

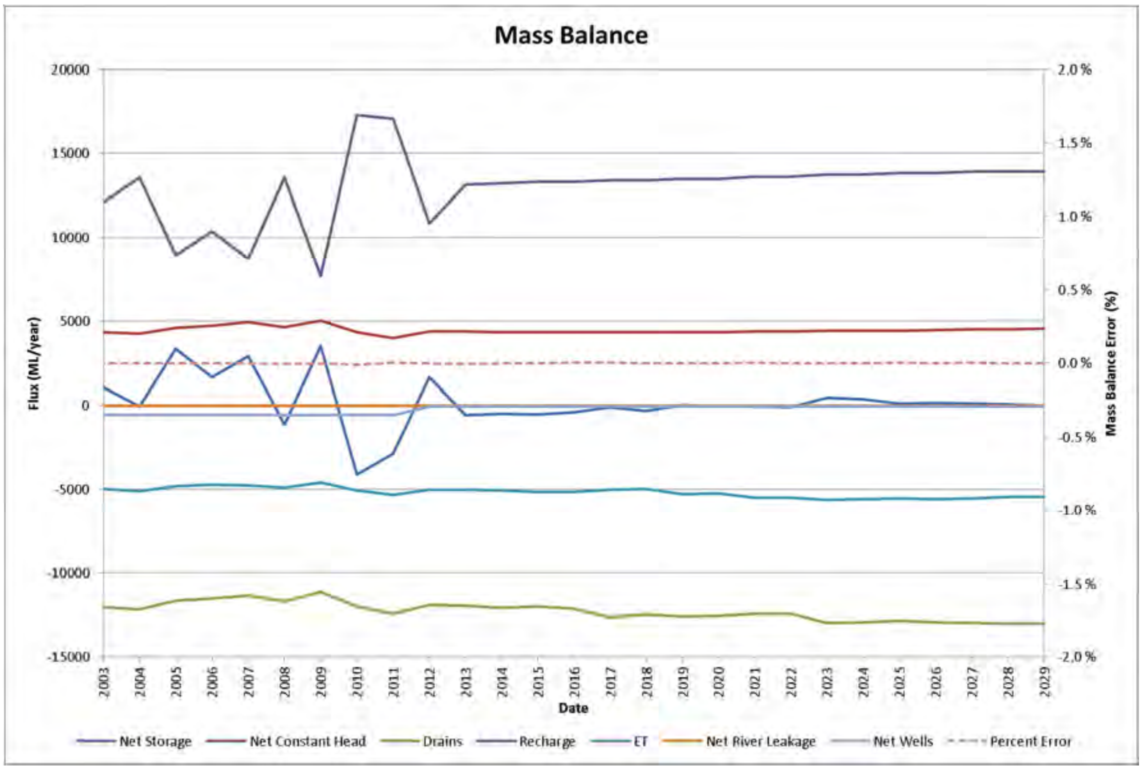


Figure 6-2 : Predictive Mass Balance

The mass balance for the River cells representing Myall Creek and Oakey Creek were assessed for potential induced losses associated with the revised Project. The results indicate that no additional losses are expected to occur above any historic or current impacts as shown in **Figure 6-3**.

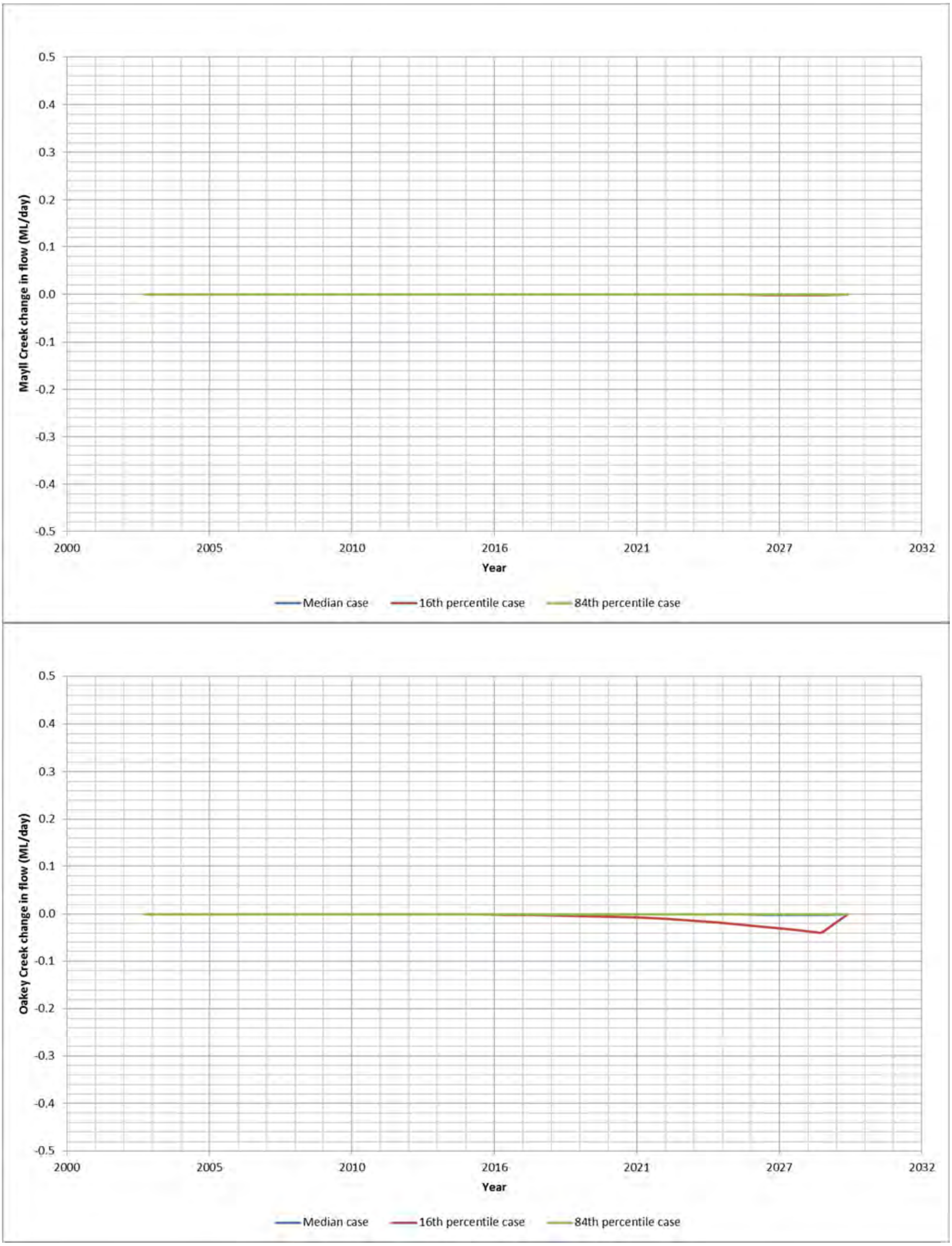


Figure 6-3 : Summary of Potential Baseflow Losses

6.3 Predicted water levels, drawdown and potential impact areas

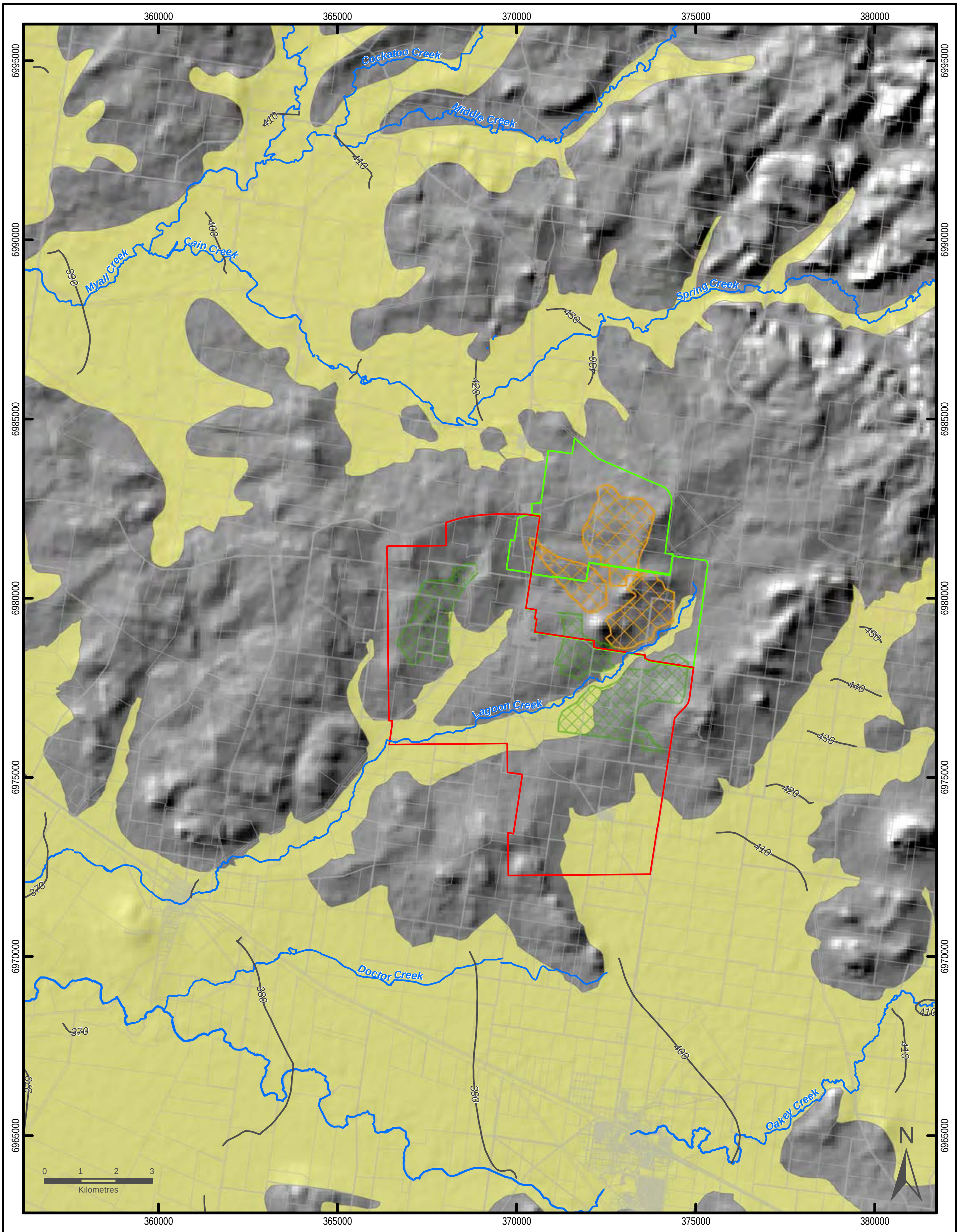
Predicted water level maps for selected periods of mining and post mining for each geologic unit represented in the model are provided in **Figure 6-4** through **Figure 6-19**. The water levels presented are from the best calibrated realisation.

Drawdown maps for selected periods of mining and post mining for each geologic unit represented in the model are provided in **Figure 6-20** through **Figure 6-31**. The drawdown presented is the most *likely* (i.e. median) drawdown based upon the stochastic results.

Potential impact zones for selected periods of mining and post mining for each geologic unit represented in the model are provided in **Figure 6-32** through **Figure 6-42**. The potential impact zones are presented with the most likely case (i.e. median results) and an upper and lower bound (plus and minus one standard deviation) based upon the stochastic results.

Predicted water level recovery within the final depressed landforms (voids) is provided in **Figure 6-43**. Again the results are presented with the most likely case (i.e. median results) and an upper and lower bound (plus and minus one standard deviation) based upon the stochastic results.

Figure 6-4 : Alluvium - Predicted Water Levels – 2017



LEGEND

- *Alluvium - Predicted Water Levels (mAHD)*
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Alluvium (Qa)

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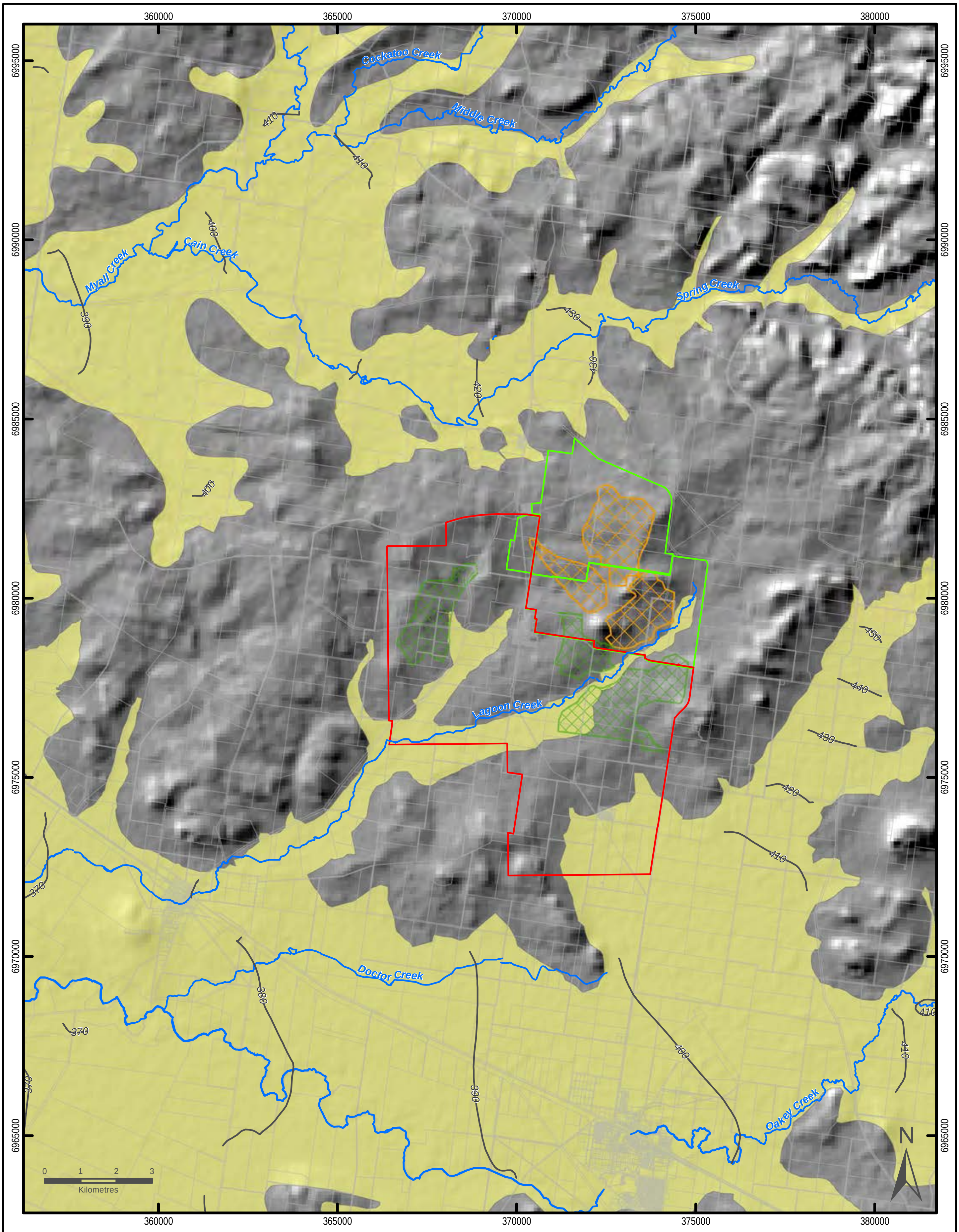
Figure 6-4 - Alluvium
Predicted Water Levels – 2017

Scale 1:140,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)



LEGEND

- Alluvium - Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Alluvium (Qa)

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Figure 6-5 - Alluvium Predicted Water Levels – 2021

Scale 1:140,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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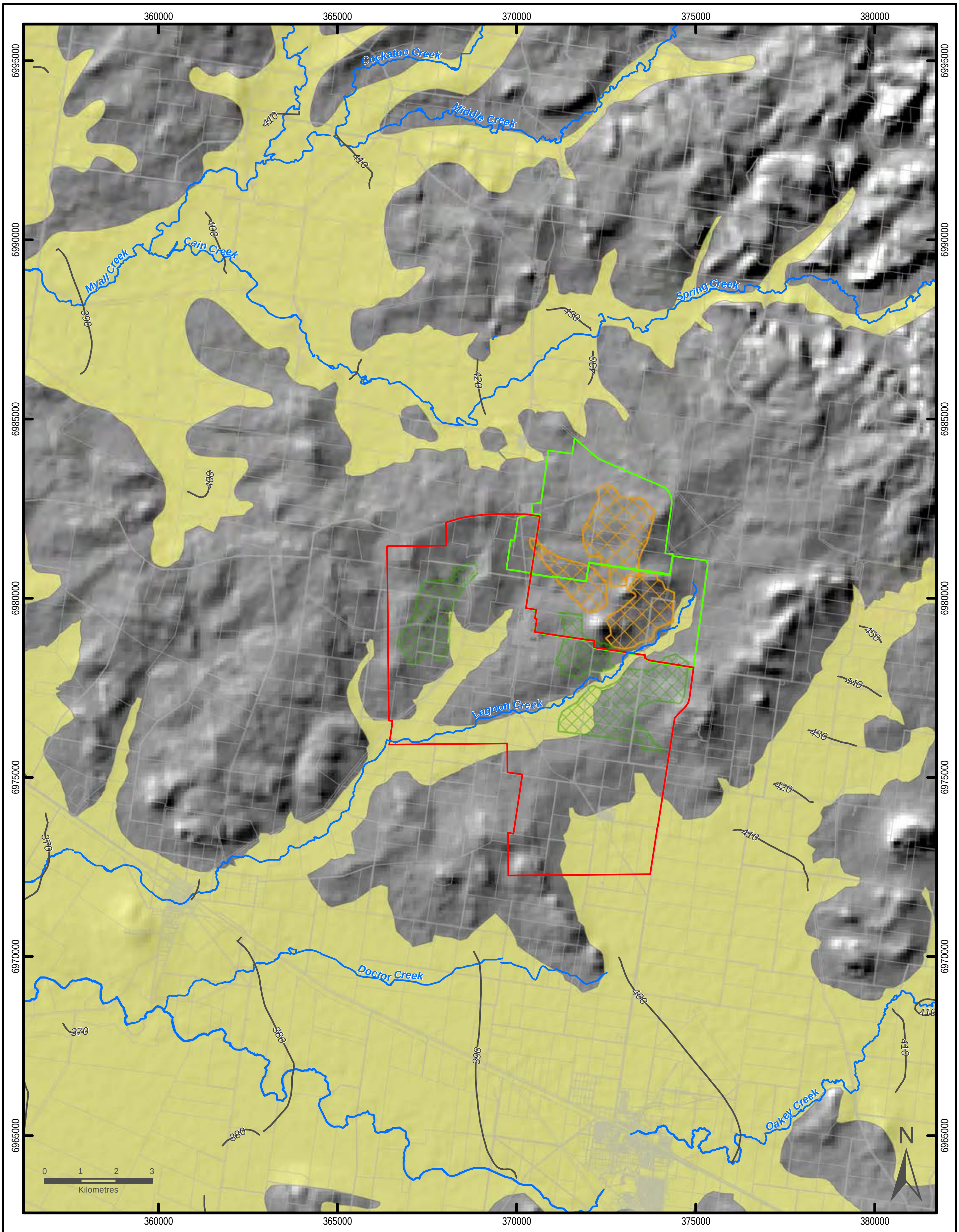

LEGEND

- Alluvium - Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Alluvium (Qa)

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Figure 6-6 - Alluvium Predicted Water Levels – 2030

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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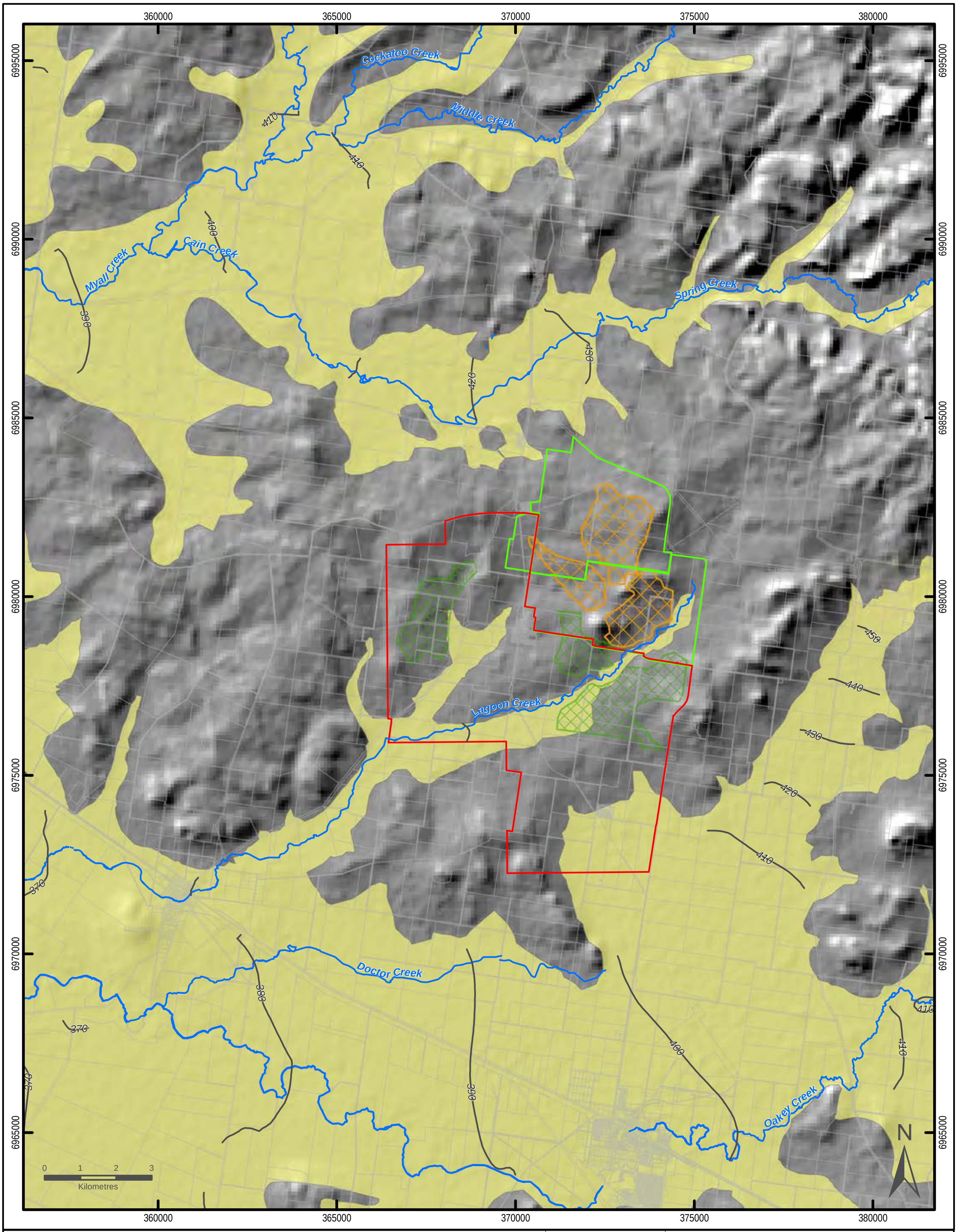

LEGEND

- Alluvium - Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Alluvium (Qa)

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Figure 6-7 - Alluvium
Predicted Water Levels – Post Mining

Scale 1:140,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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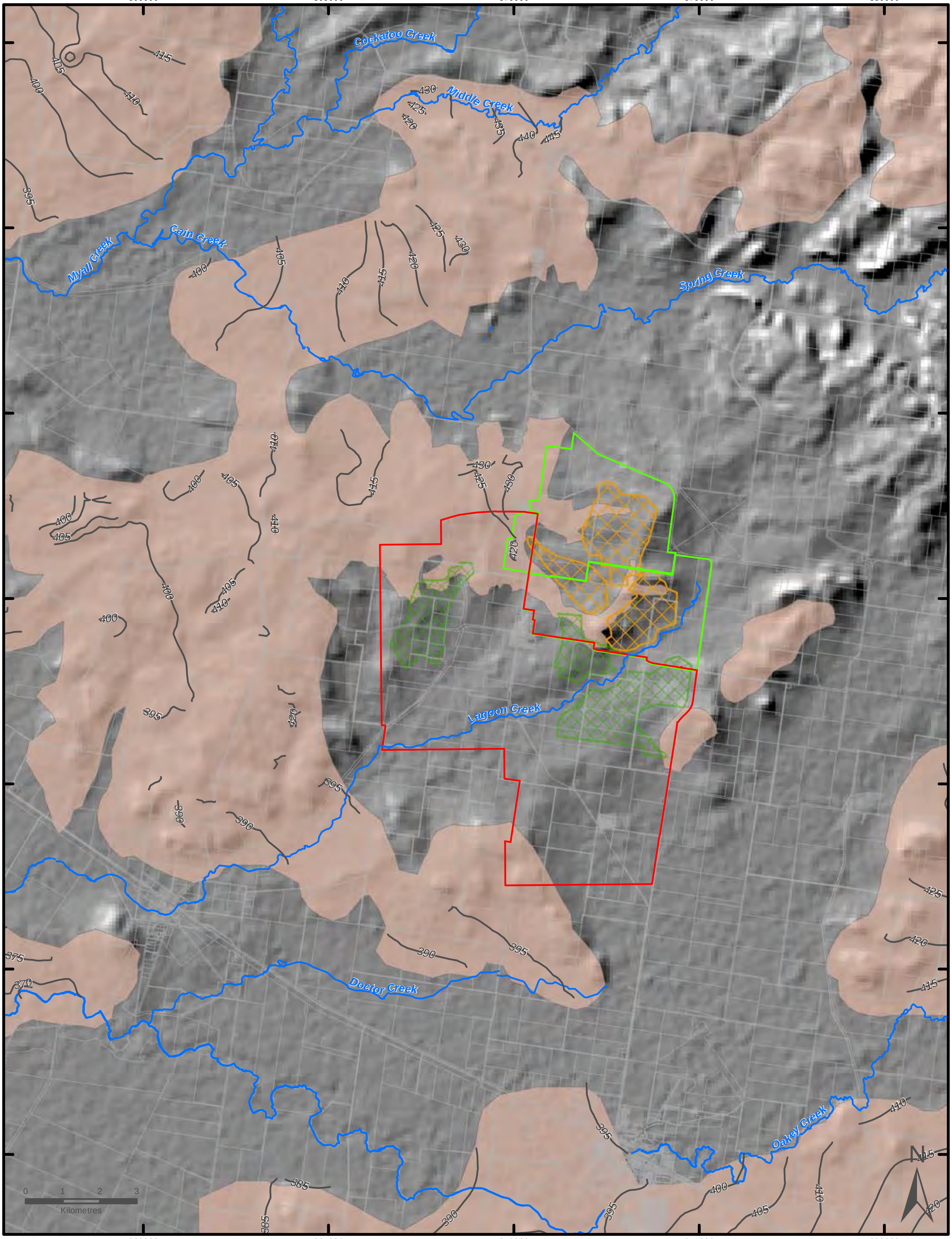
Produced: 28/08/2014



LEGEND

- Basalt - Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Basalt (Tm)

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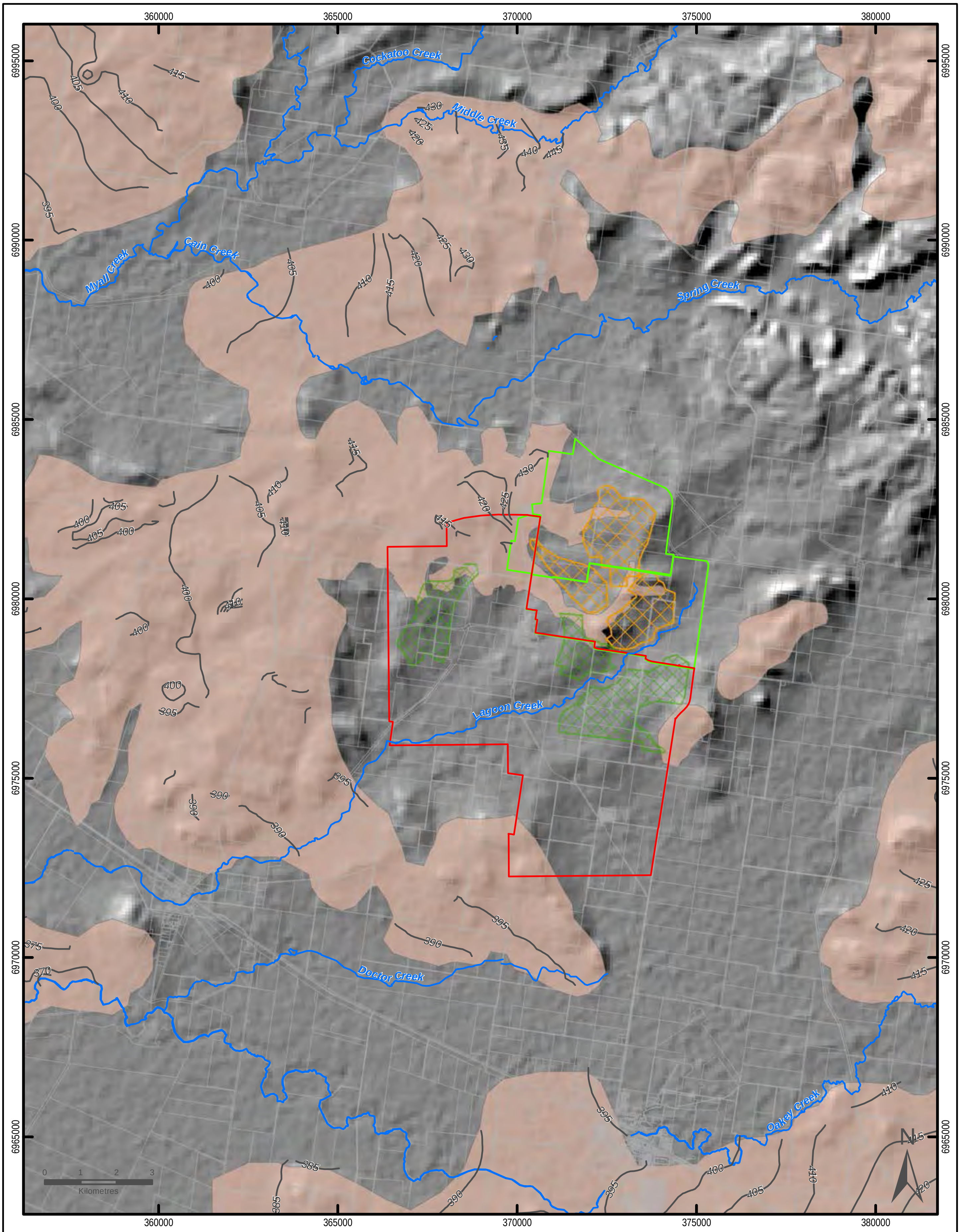
Figure 6-8 - Basalt Predicted Water Levels – 2017

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140617_NewHope_Groundwater_Figure6-8_PredictedWaterLevelsBasalt_2017.mxd

Produced: 28/08/2014



LEGEND

- Basalt - Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Basalt (Tm)

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Figure 6-9 - Basalt Predicted Water Levels – 2021

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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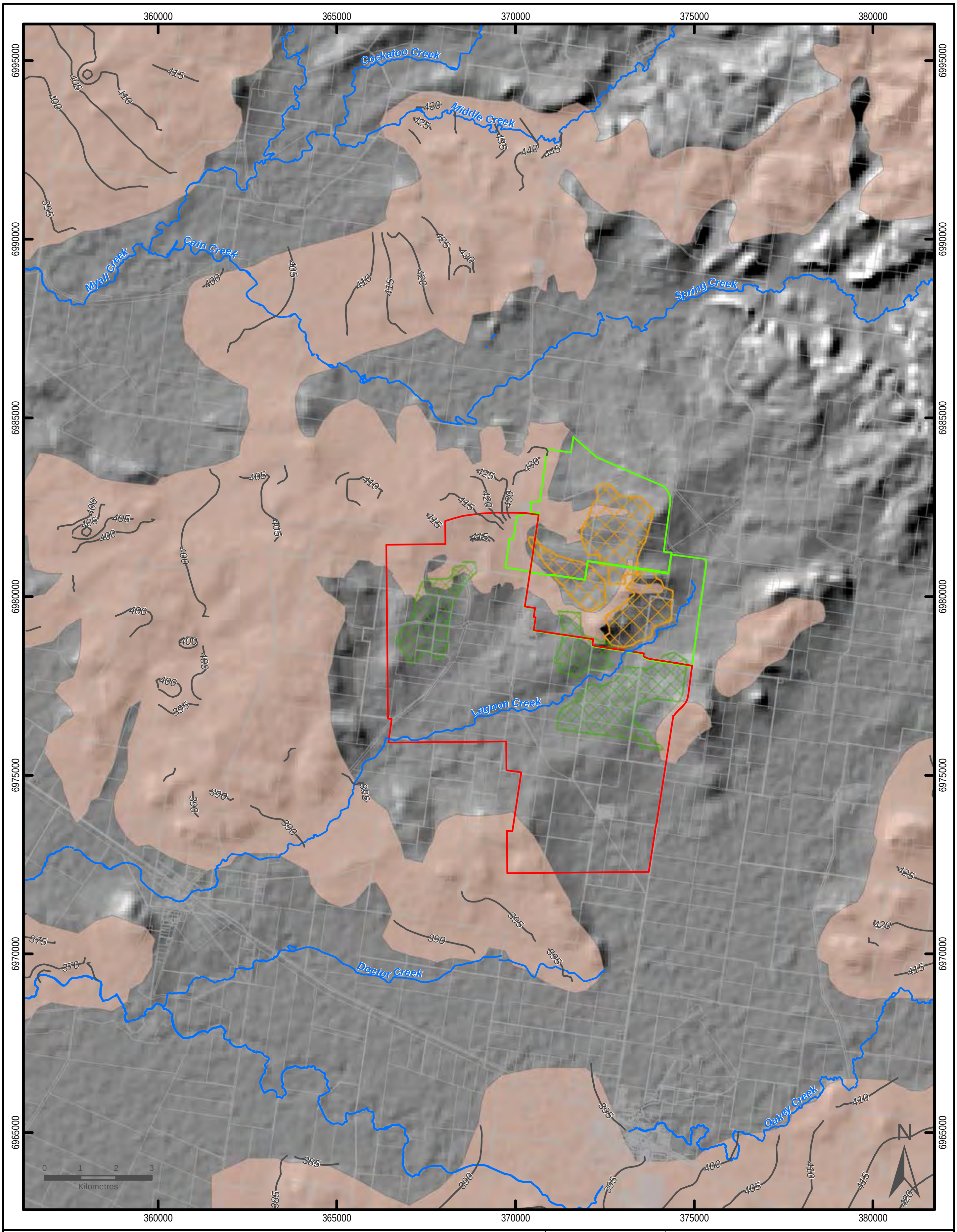
Produced: 28/08/2014



LEGEND

- Basalt - Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Basalt (Tm)

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Figure 6-10 - Basalt Predicted Water Levels – 2030

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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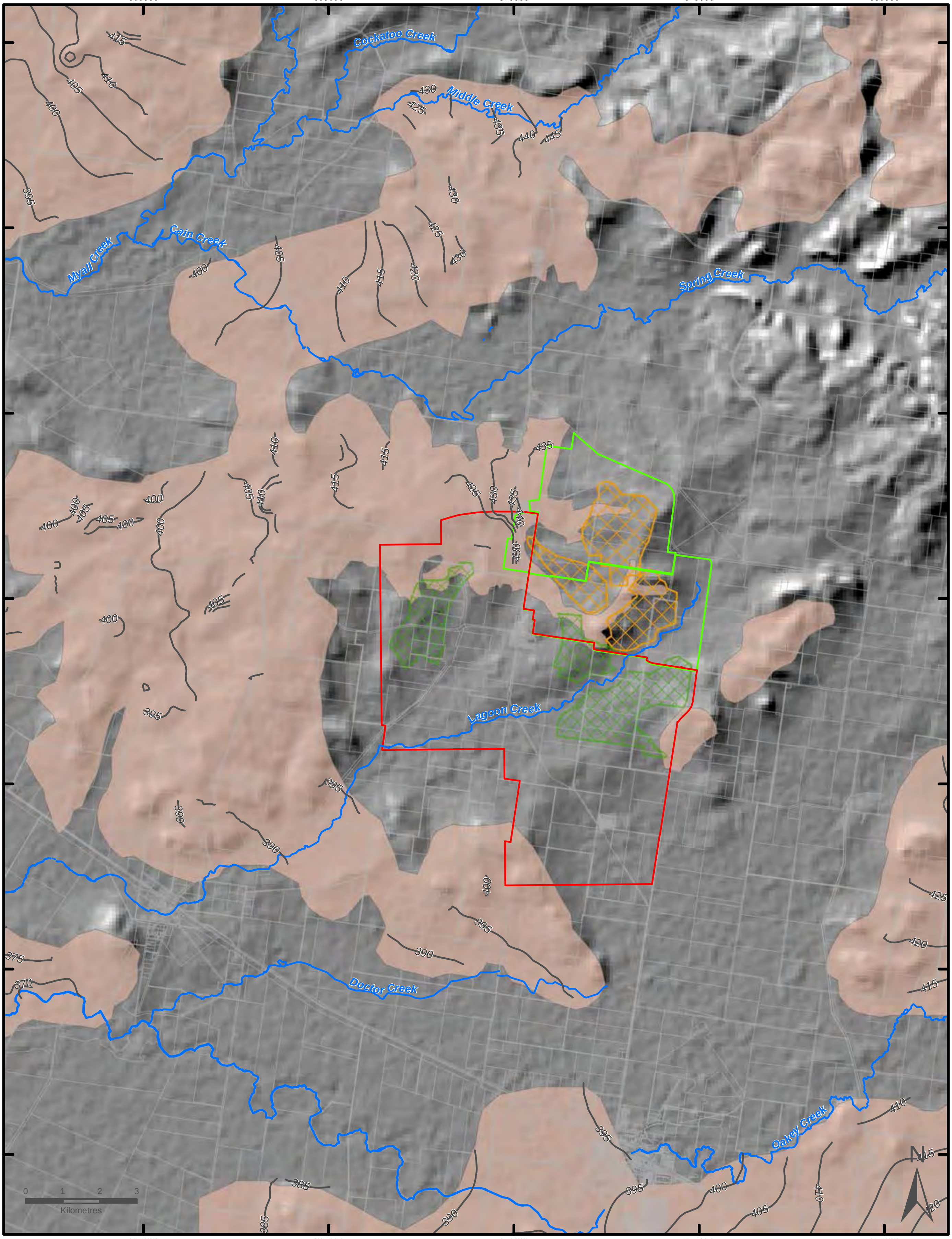

LEGEND

- Alluvium - Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Basalt (Tm)

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Figure 6-11 - Basalt Predicted Water Levels – Post Mining

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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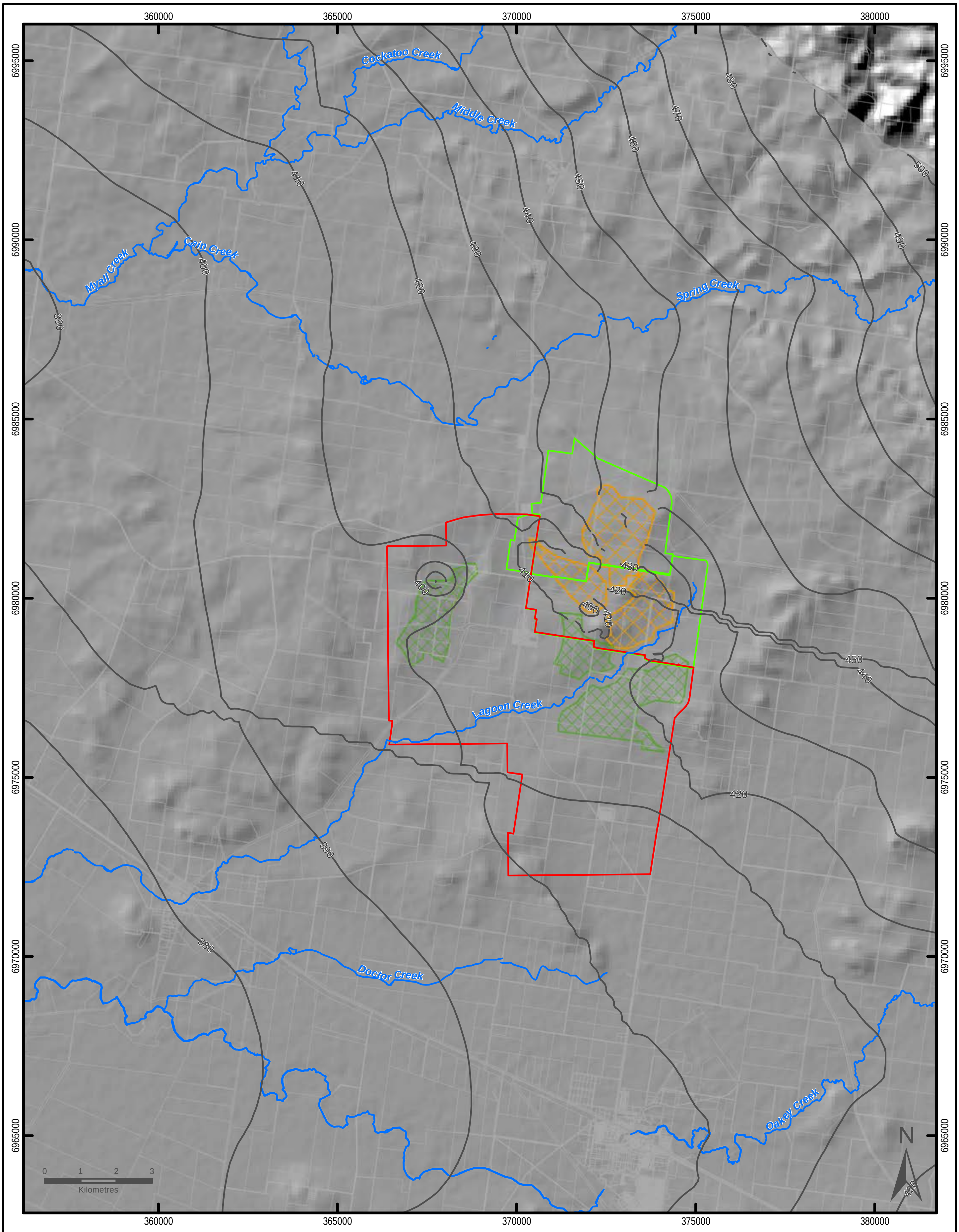

LEGEND

- Walloon Coal Measures Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

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Figure 6-12 - Walloon Coal Measures Predicted Water Levels – 2017

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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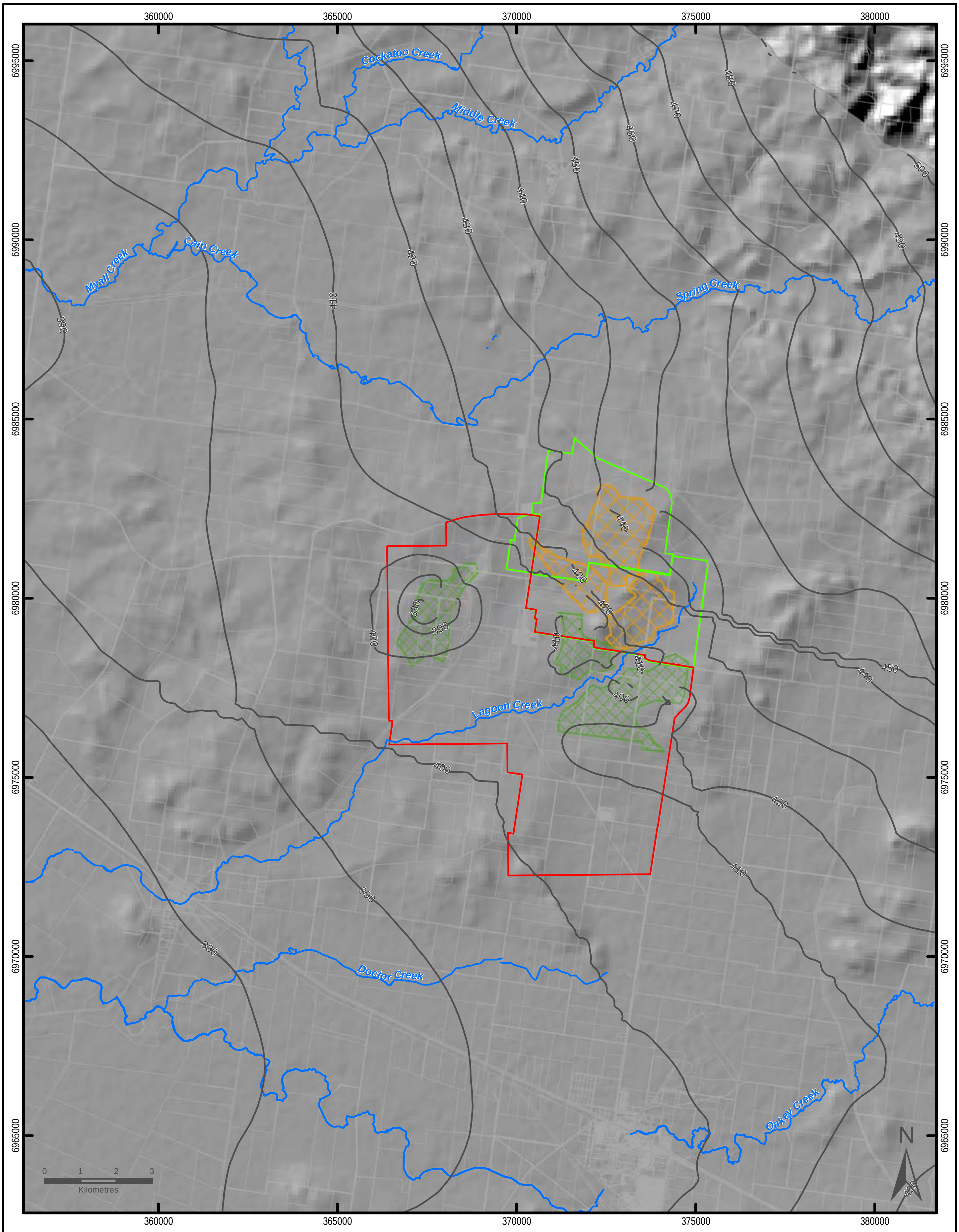

LEGEND

- Walloon Coal Measures Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

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Figure 6-13 - Walloon Coal Measures Predicted Water Levels – 2021

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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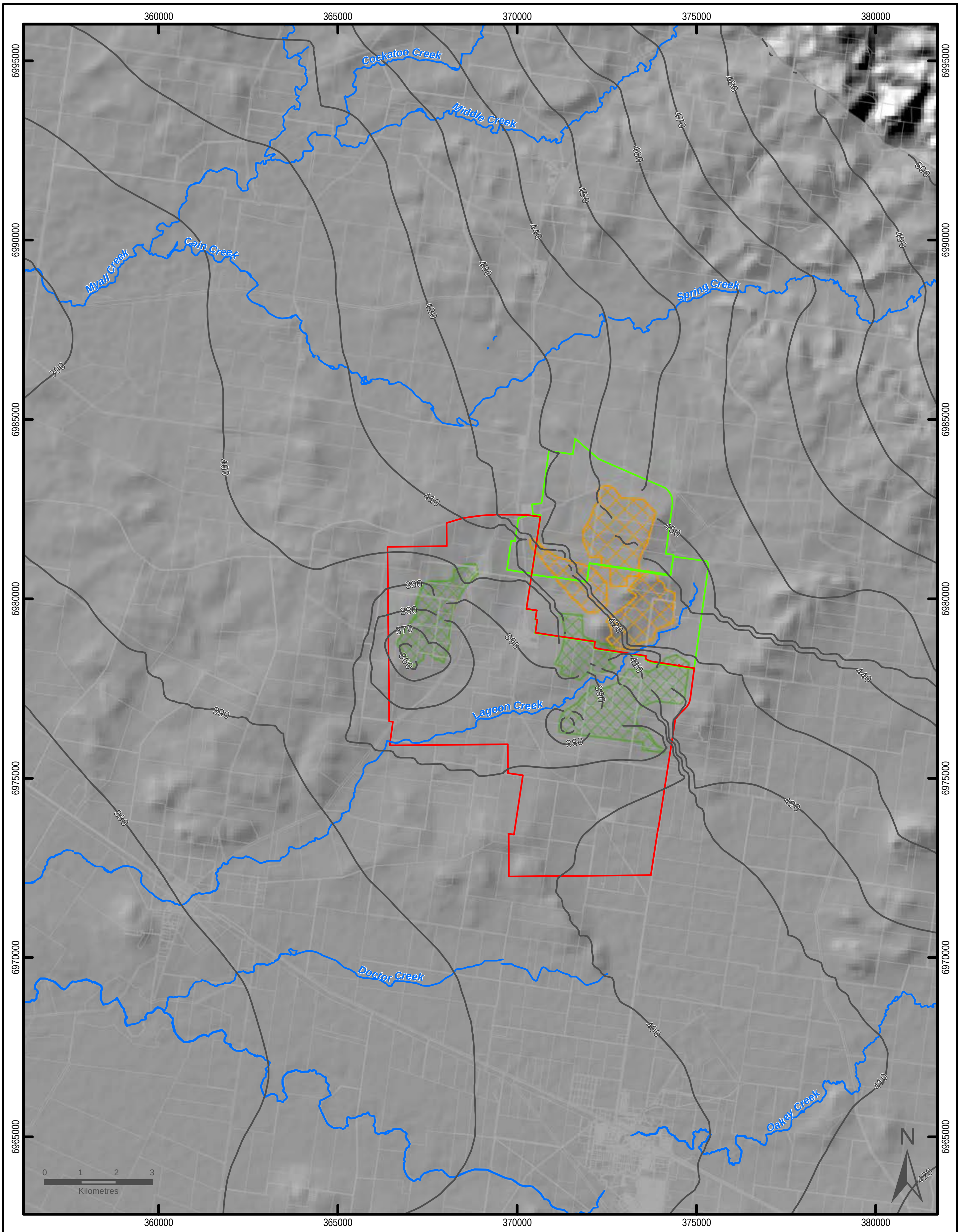

LEGEND

- Walloon Coal Measures Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

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STAGE 3 PROJECT

Figure 6-14 - Walloon Coal Measures Predicted Water Levels – 2030

Scale 1:140,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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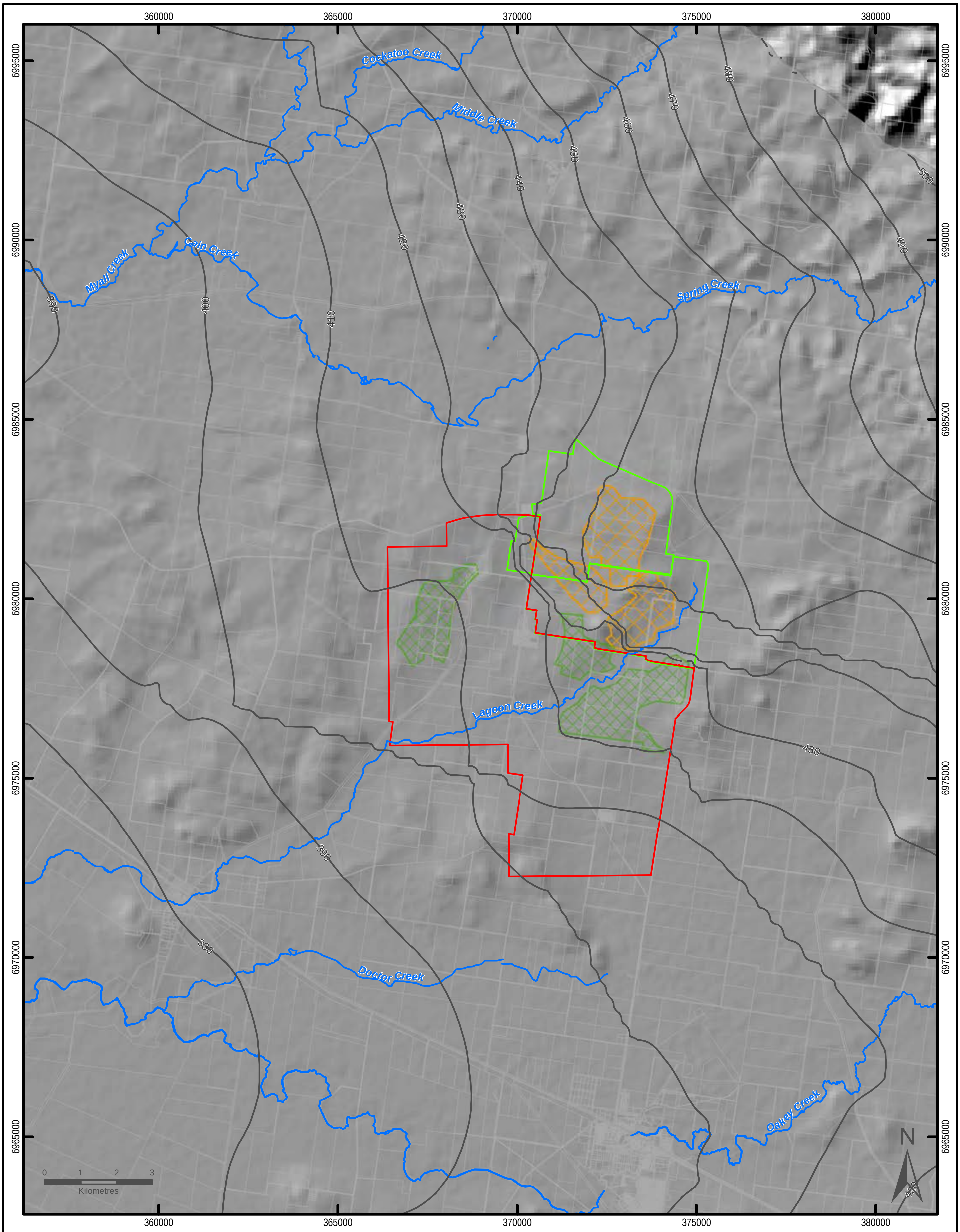

LEGEND

- Walloon Coal Measures Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

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STAGE 3 PROJECT

Figure 6-15 - Walloon Coal Measures Predicted Water Levels – Post Mining

Scale 1:140,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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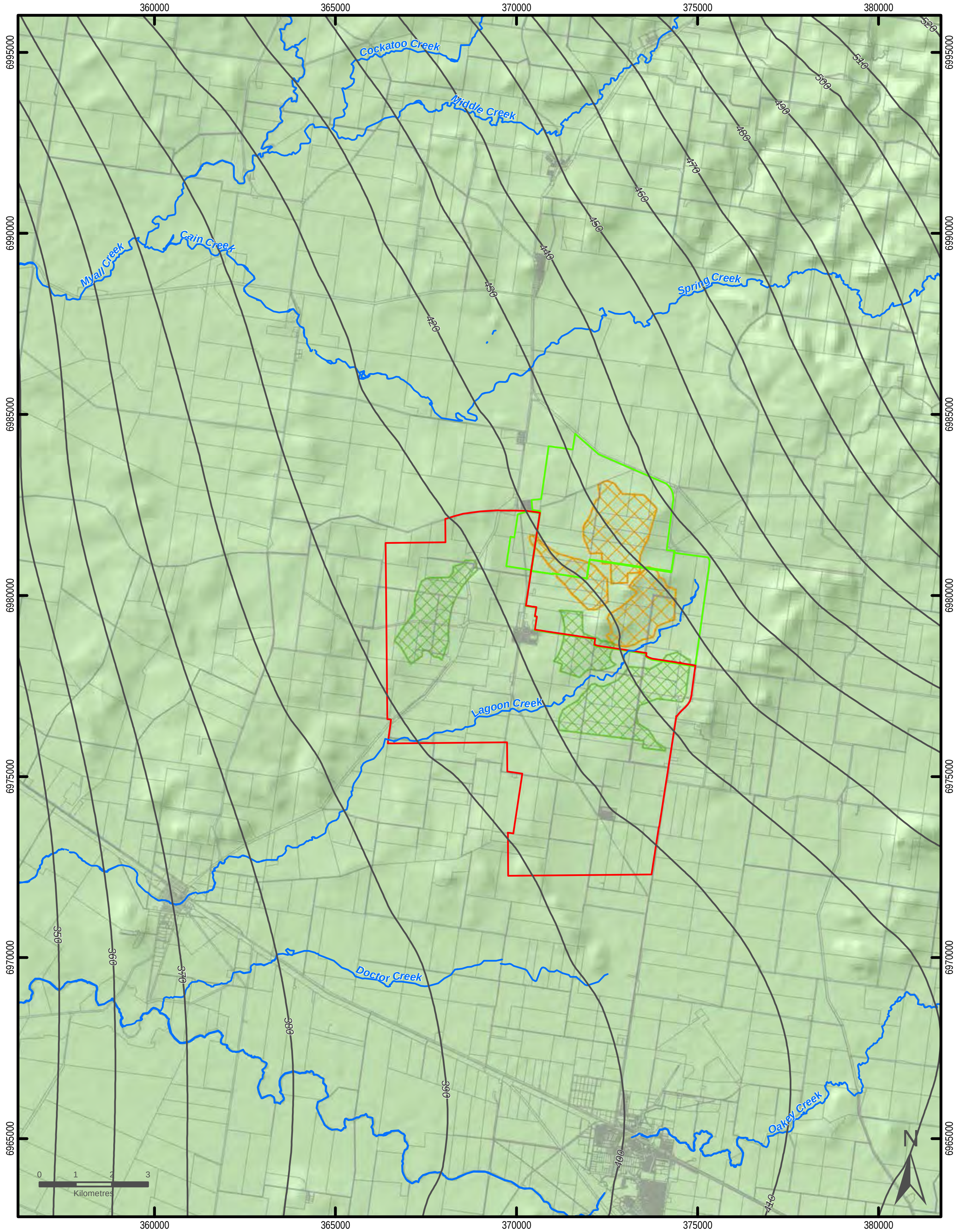

LEGEND

- Marburg Sandstone - Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Marburg Sandstone (Jbm)

NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 6-16 - Marburg Sandstone Predicted Water Levels – 2017

Scale 1:140,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140617_NewHope_Groundwater_Figure6-16_PredictedWaterLevelsMarburgSandstone_2017.mxd
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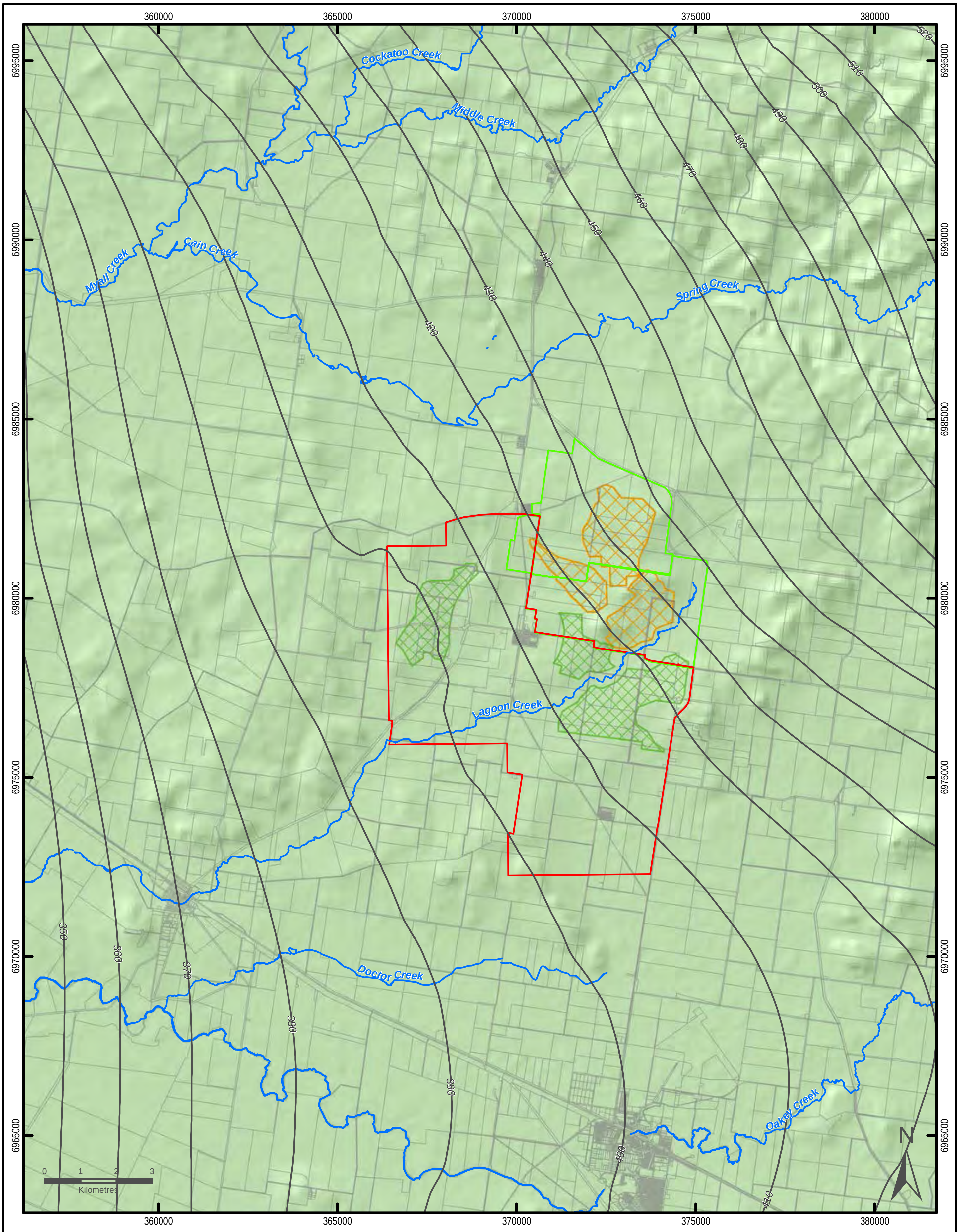


LEGEND

- Marburg Sandstone - Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Marburg Sandstone (Jbm)

NEW HOPE GROUP

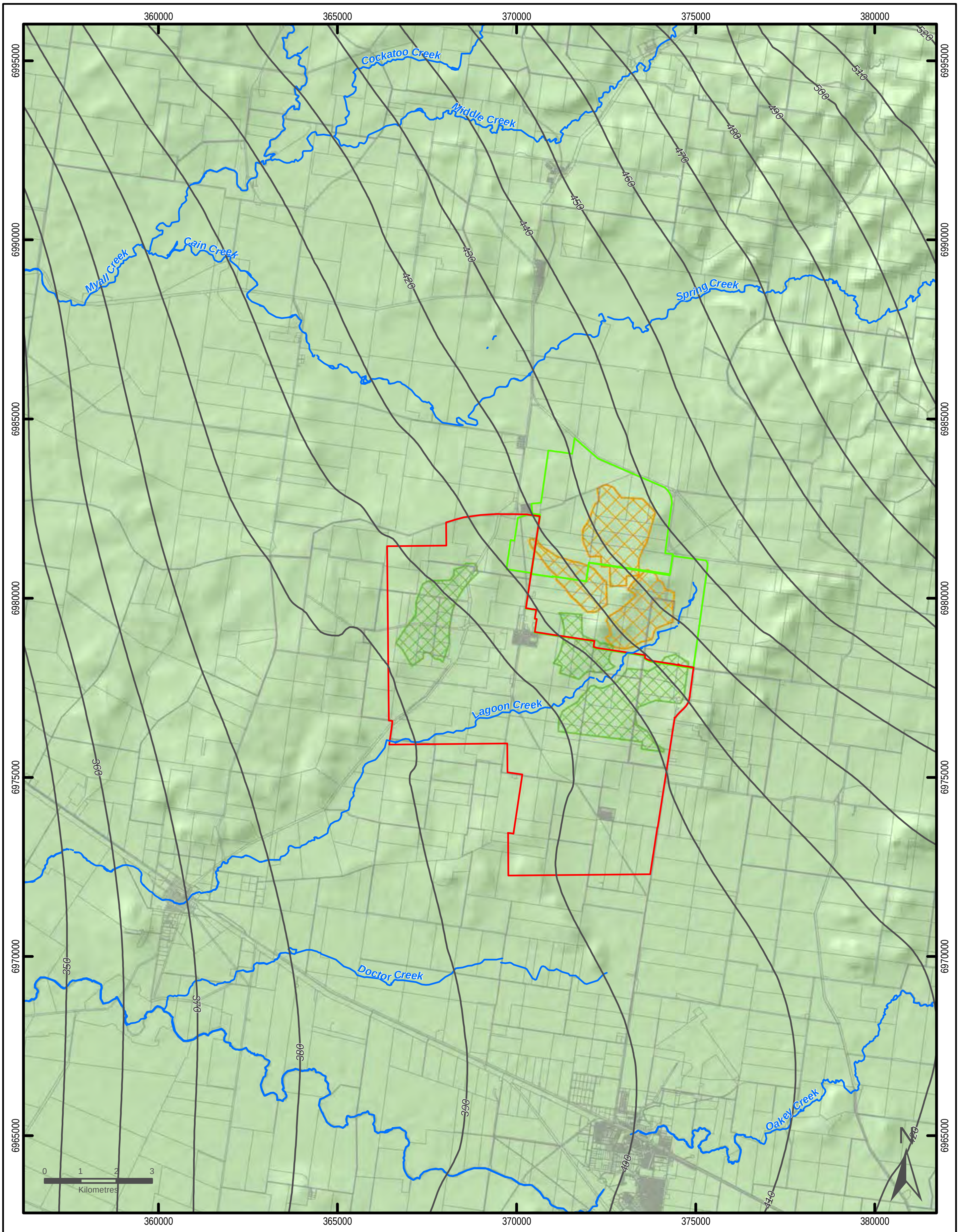
SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-17 - Marburg Sandstone Predicted Water Levels – 2021

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)



LEGEND

- Marburg Sandstone - Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-18 - Marburg Sandstone Predicted Water Levels – 2030

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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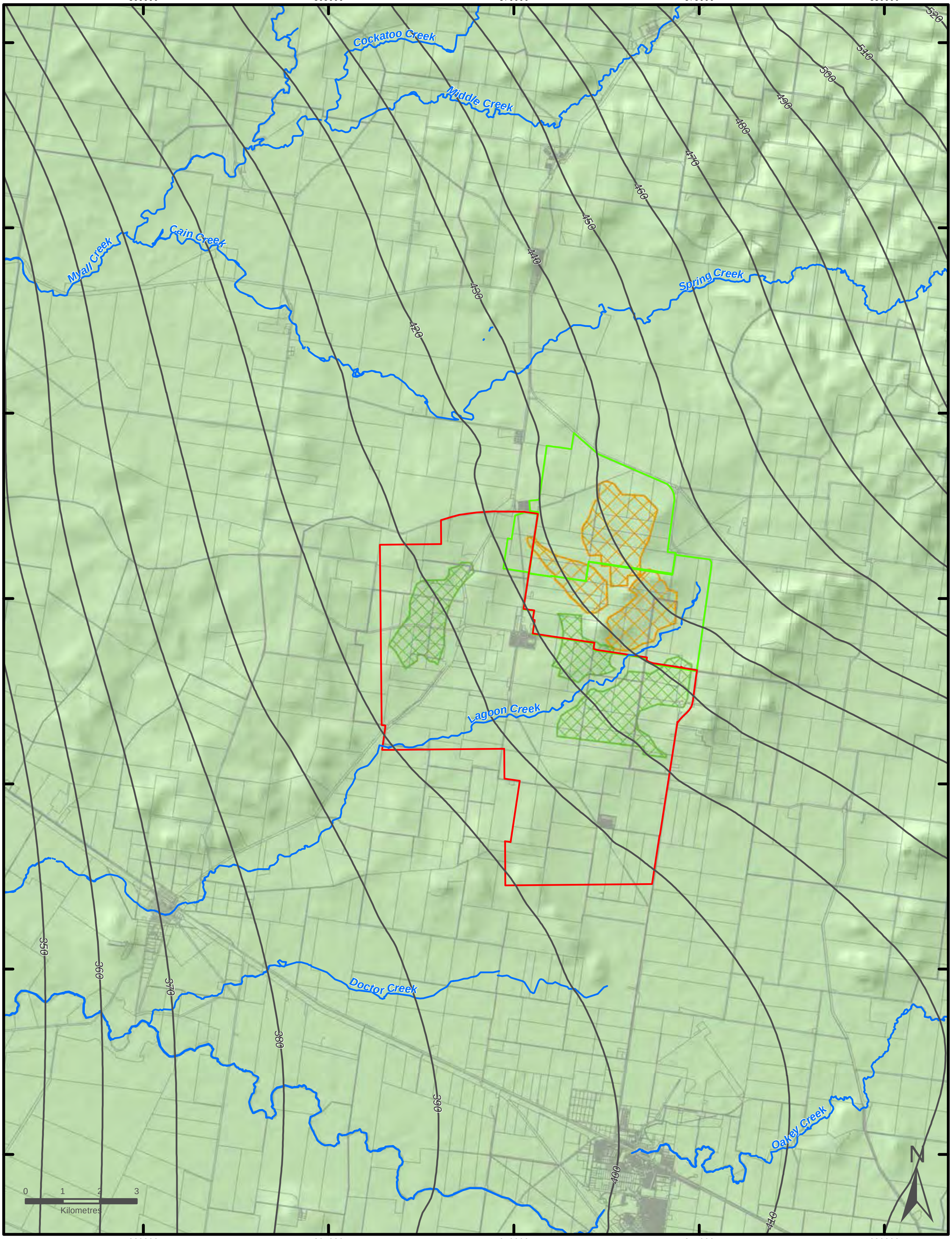

LEGEND

- Marburg Sandstone - Predicted Water Levels (mAHD)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-19 - Marburg Sandstone Predicted Water Levels – Post Mining

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140617_NewHope_Groundwater_Figure6-19_PredictedWaterLevelsMarburgSandstone_PostMining.mxd

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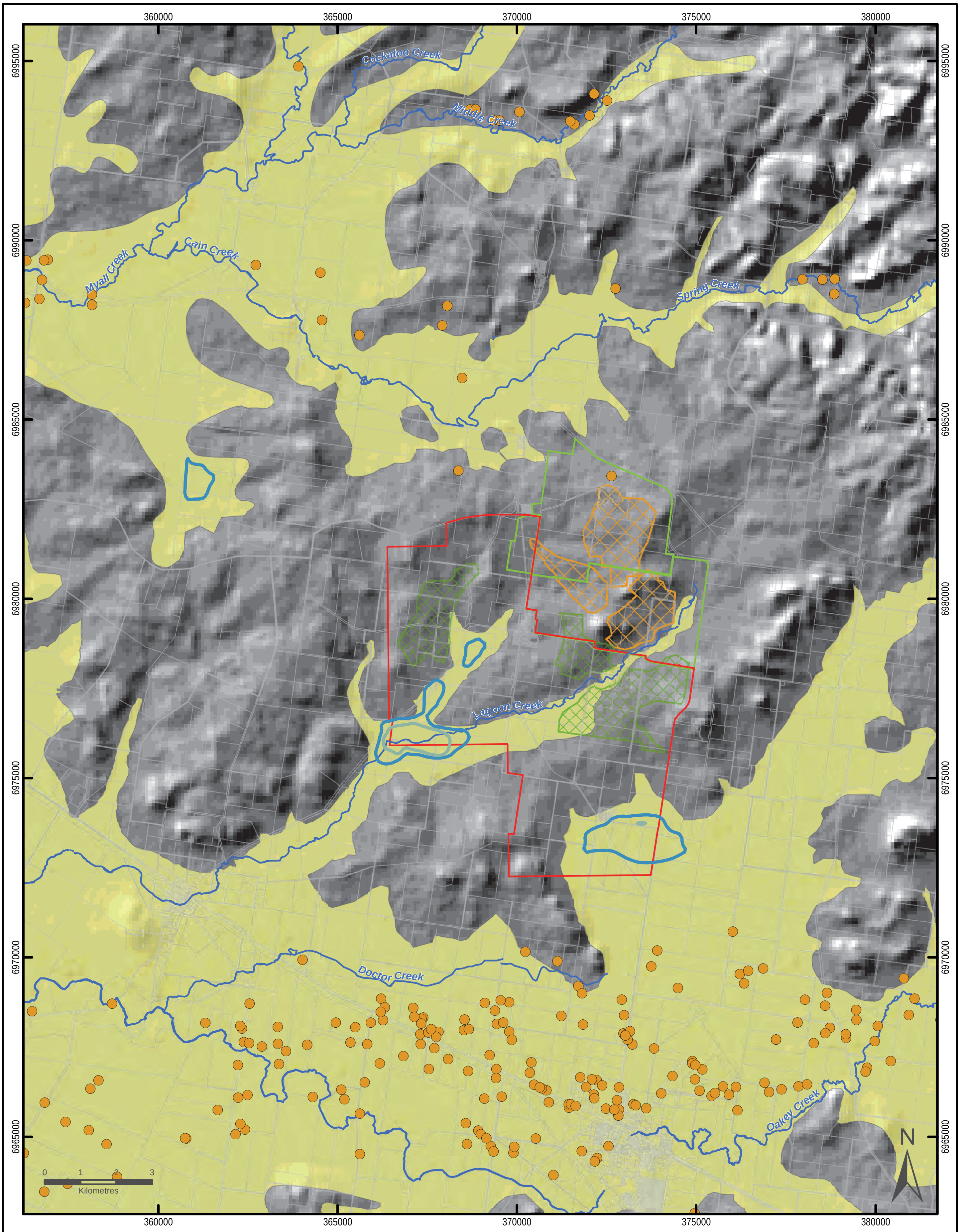

LEGEND

- DNRM Registered Bores - Alluvium

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Alluvium (Qa)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-20 - Alluvium Predicted Drawdown – 2030

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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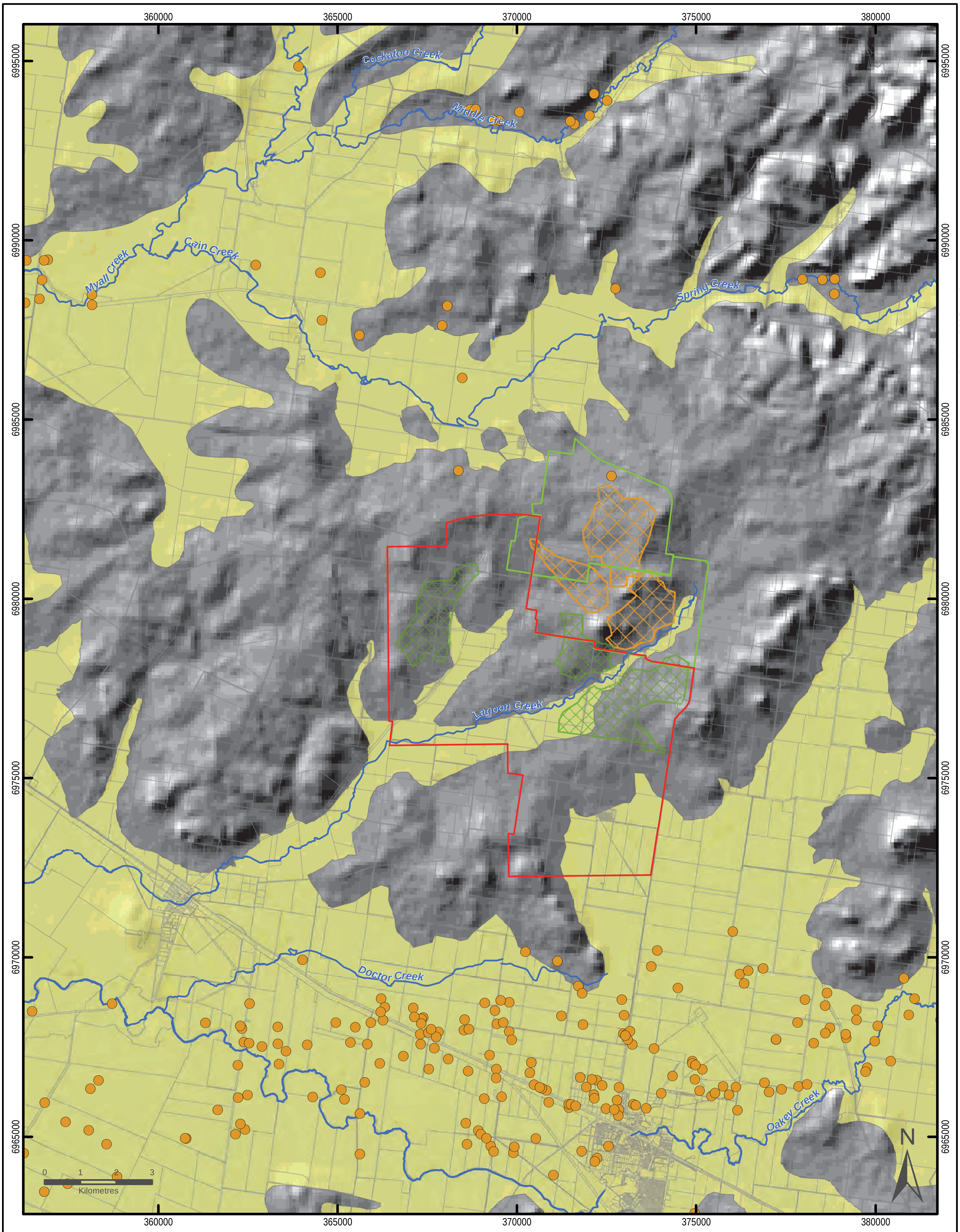


LEGEND

- DNRM Registered Bores - Alluvium

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Alluvium (Qa)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

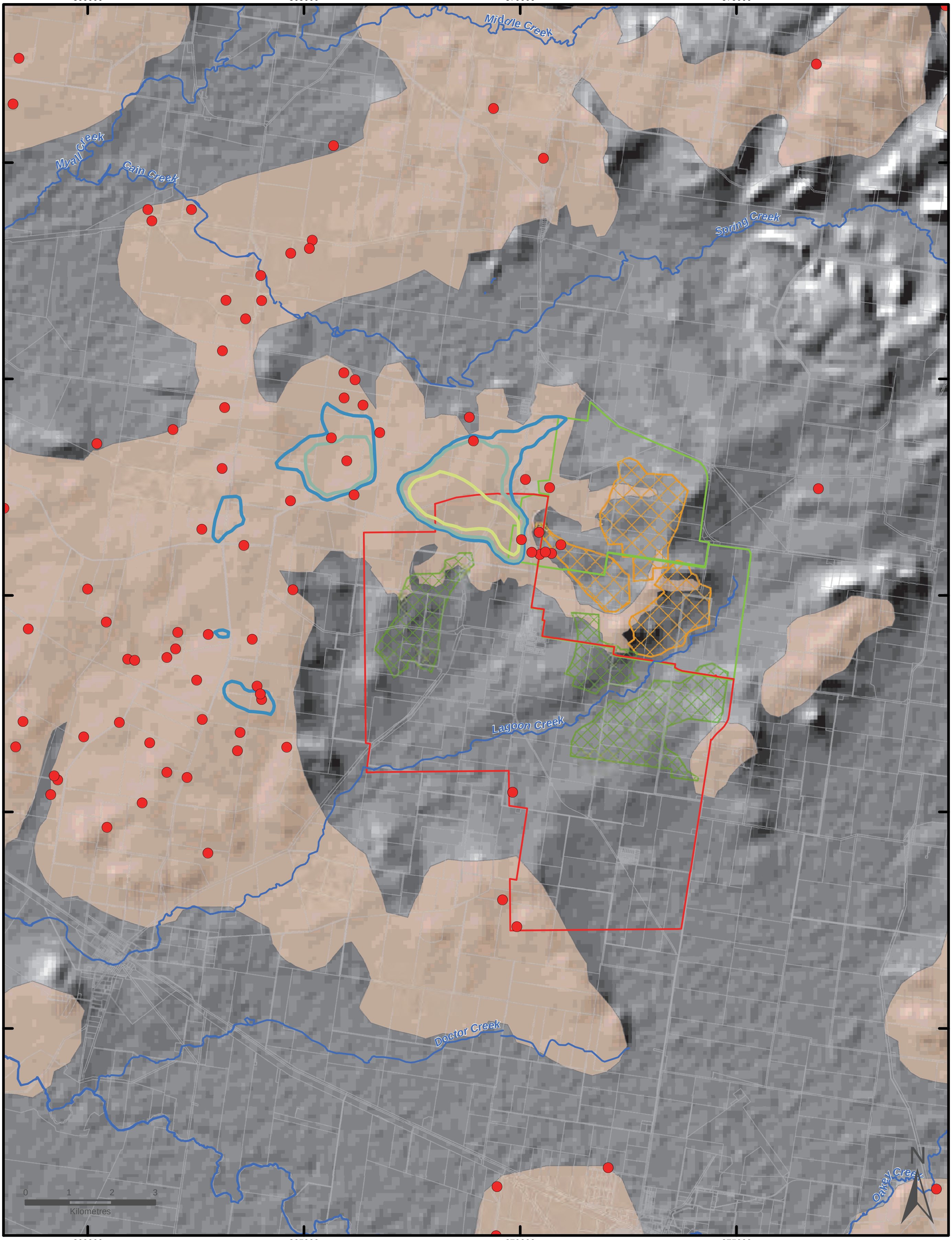
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-21 - Alluvium Predicted Drawdown – Post Mining

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 26/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-21_PredictedDrawdownInAlluvium_2330.mxd



LEGEND

- DNRM Registered Bores - Basalt

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Basalt (Tm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

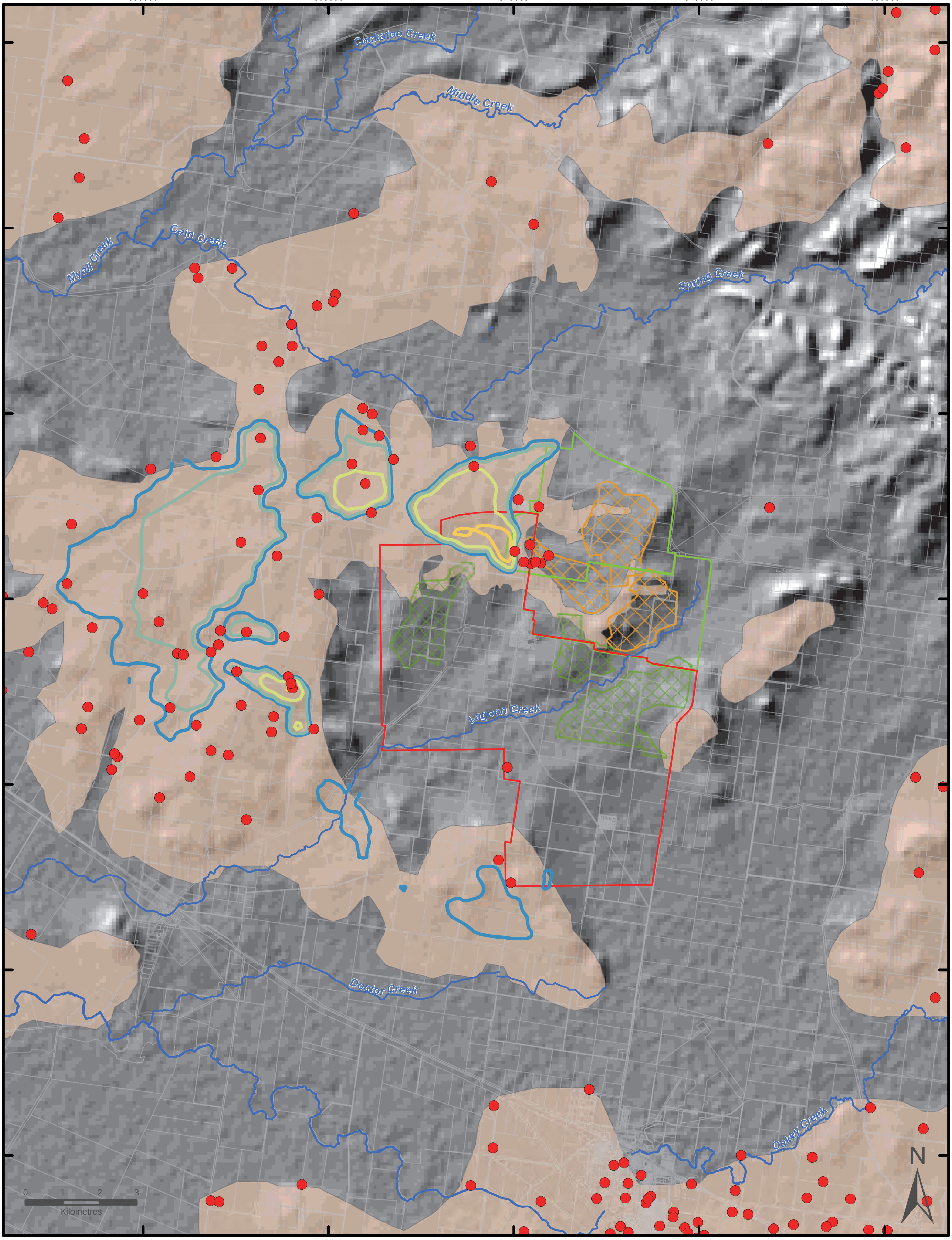
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-22 - Basalt Predicted Drawdown – 2021

Scale 1:120,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 26/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-22_PredictedDrawdownInTertiaryBasalt_2021.mxd



LEGEND

- DNRM Registered Bores - Basalt

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Basalt (Tm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 6-23 - Basalt Predicted Drawdown – 2030

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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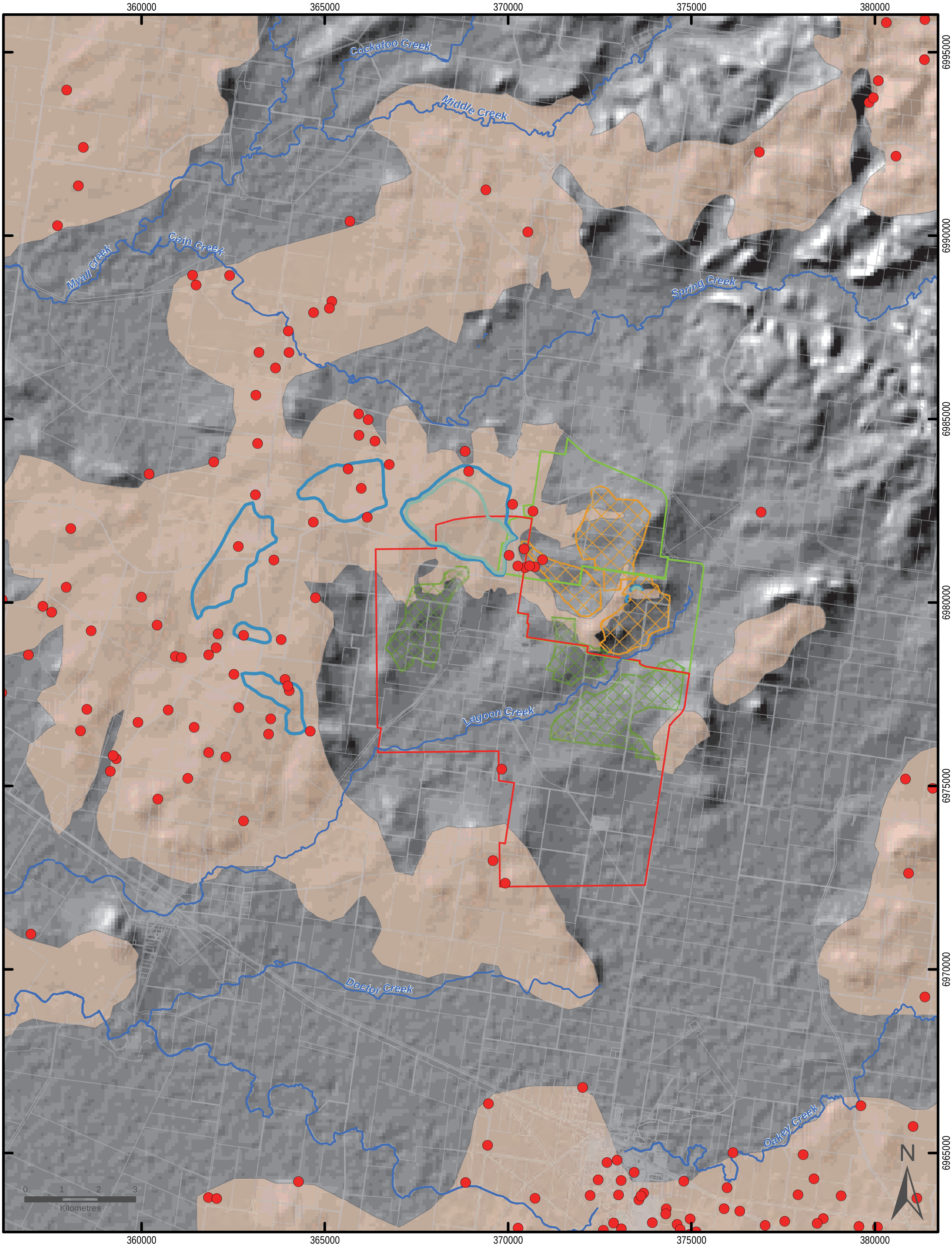

LEGEND

- DNRM Registered Bores - Basalt

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Basalt (Tm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-24 - Basalt Predicted Drawdown – Post Mining

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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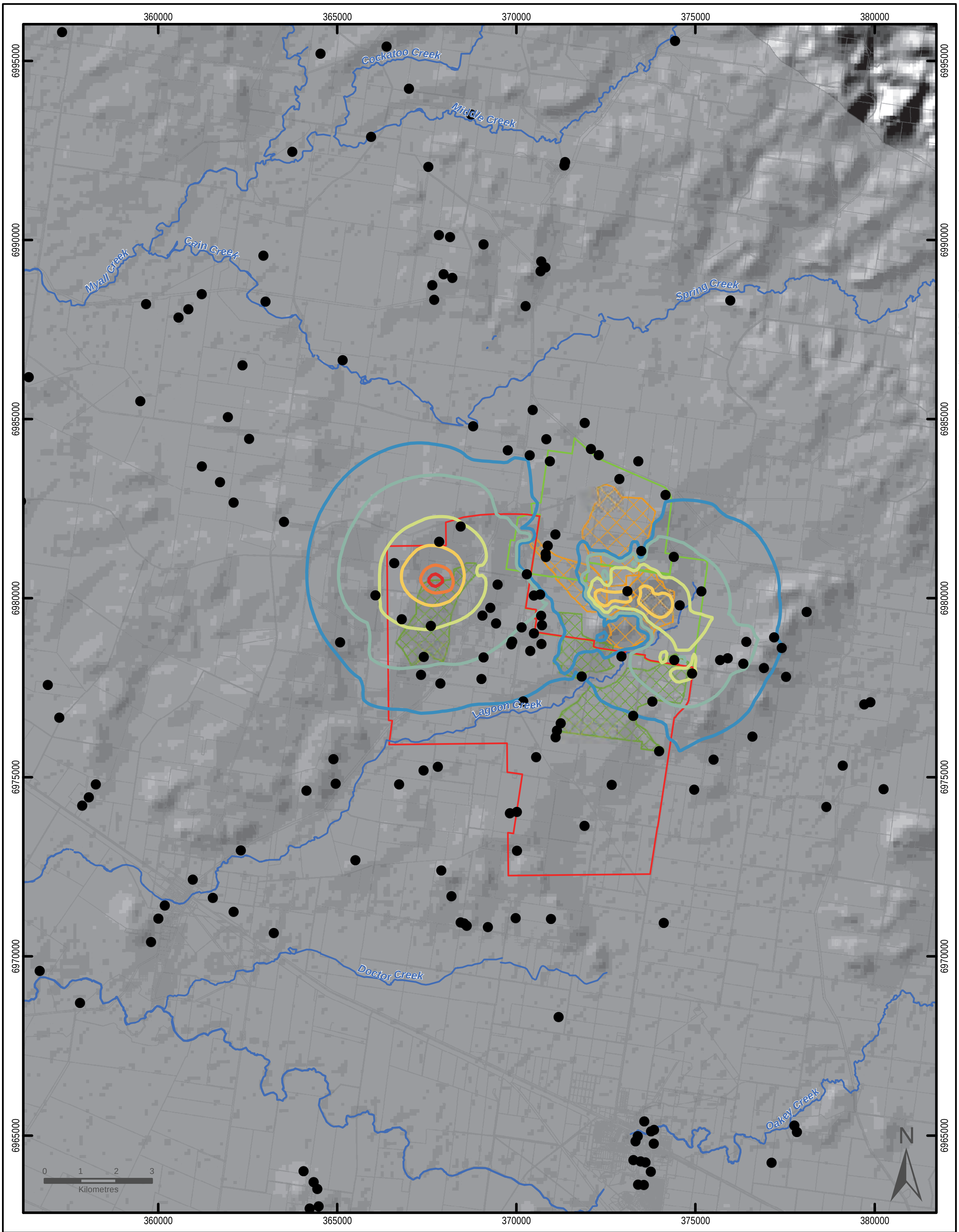


LEGEND

- DNRM Registered Bores - Walloons

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extent

- Walloon Subgroup (Jw)

NEW HOPE GROUP

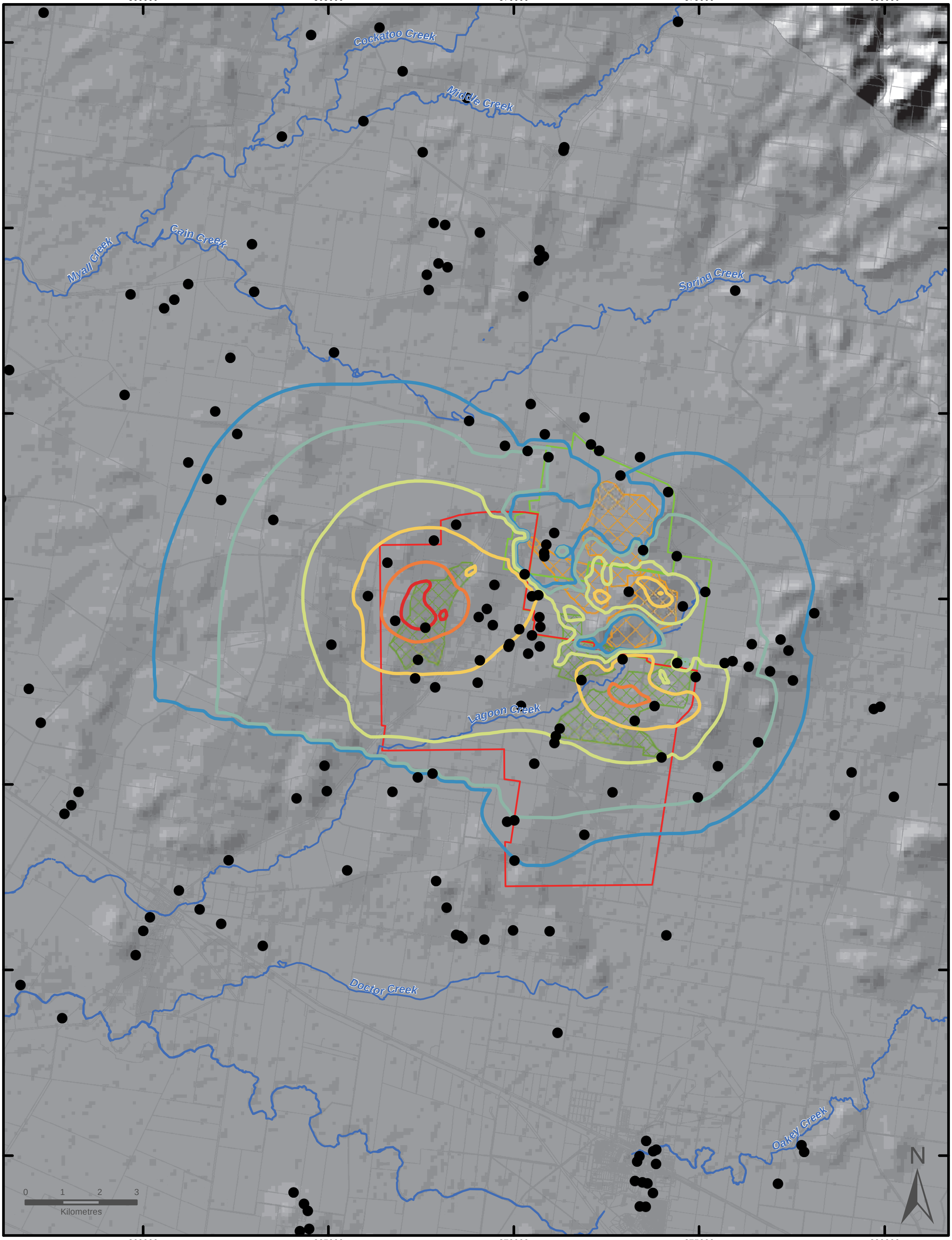
SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 6-25 - Walloon Coal Measures Predicted Drawdown – 2017

Scale 1:140,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 26/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_Groundwater\Resources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-25_PredictedDrawdownInWalloon_2017.mxd



LEGEND

- DNRM Registered Bores - Walloons

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-26 - Walloon Coal Measures Predicted Drawdown – 2021

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-26_PredictedDrawdownInWalloon_2021.mxd

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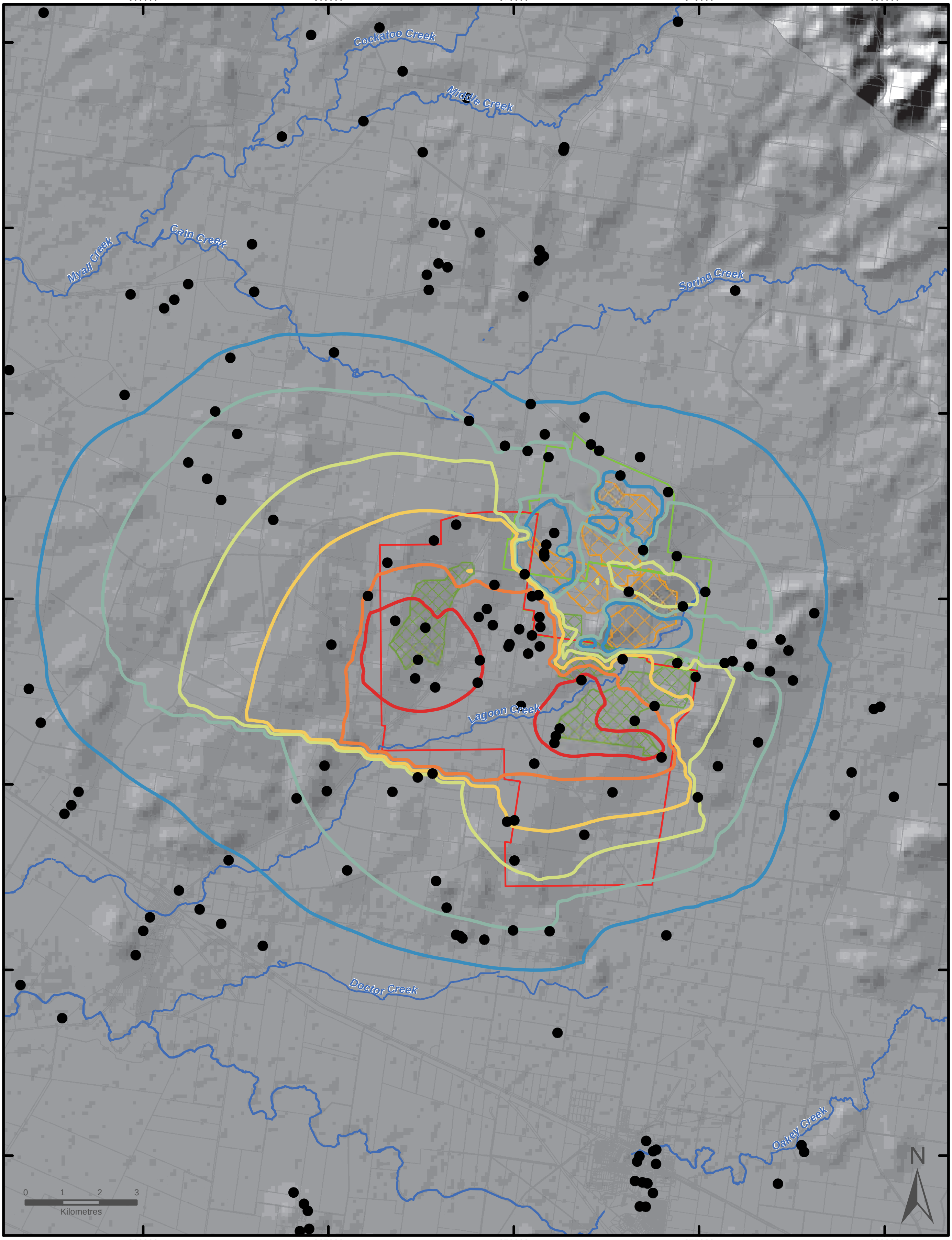

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Produced: 26/08/2014

LEGEND

- DNRM Registered Bores - Walloons

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

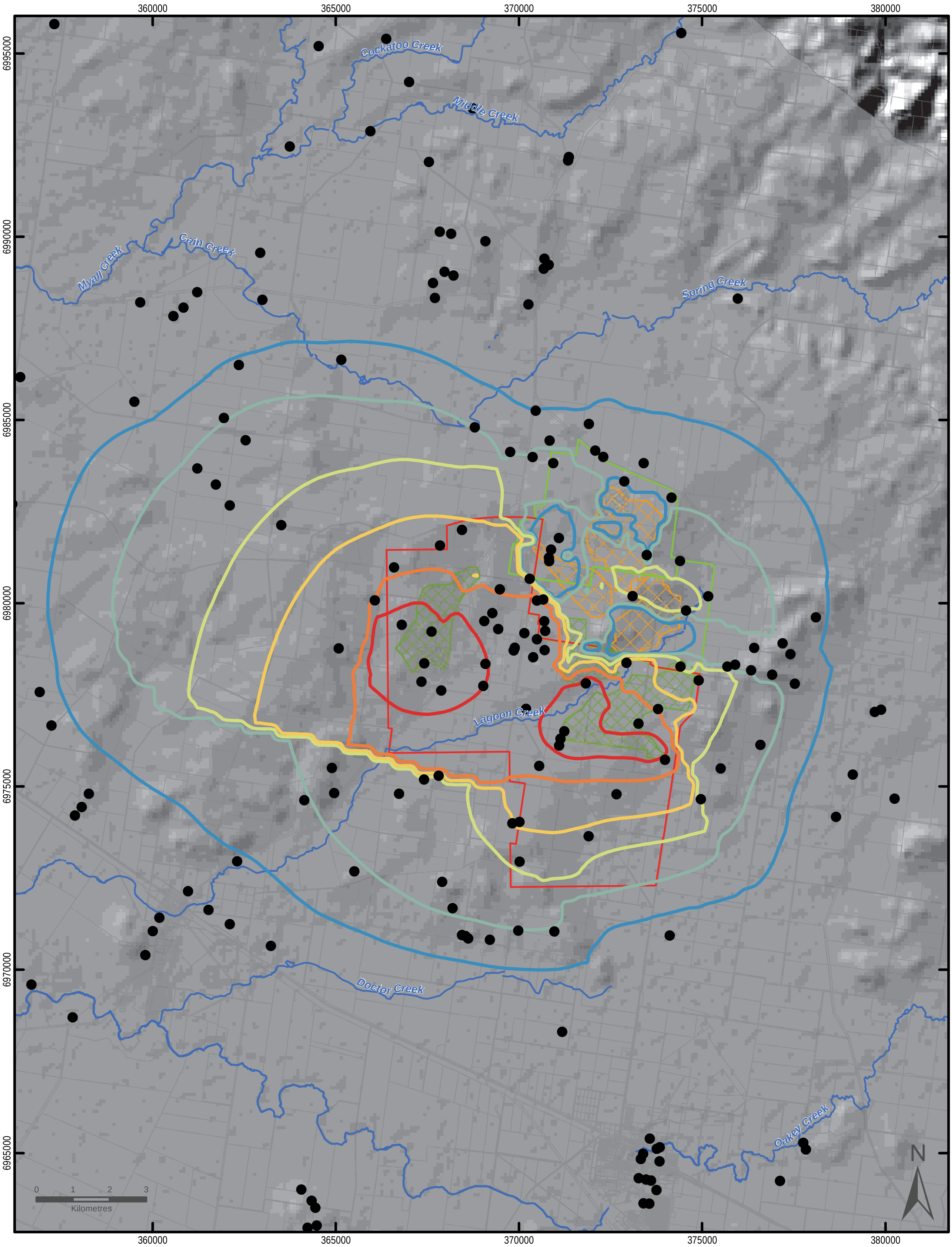
NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 6-27 - Walloon Coal Measures Predicted Drawdown – 2030

Scale 1:140,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)



LEGEND

- DNRM Registered Bores - Walloons

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 6-27 - Walloon Coal Measures Predicted Drawdown – 2030

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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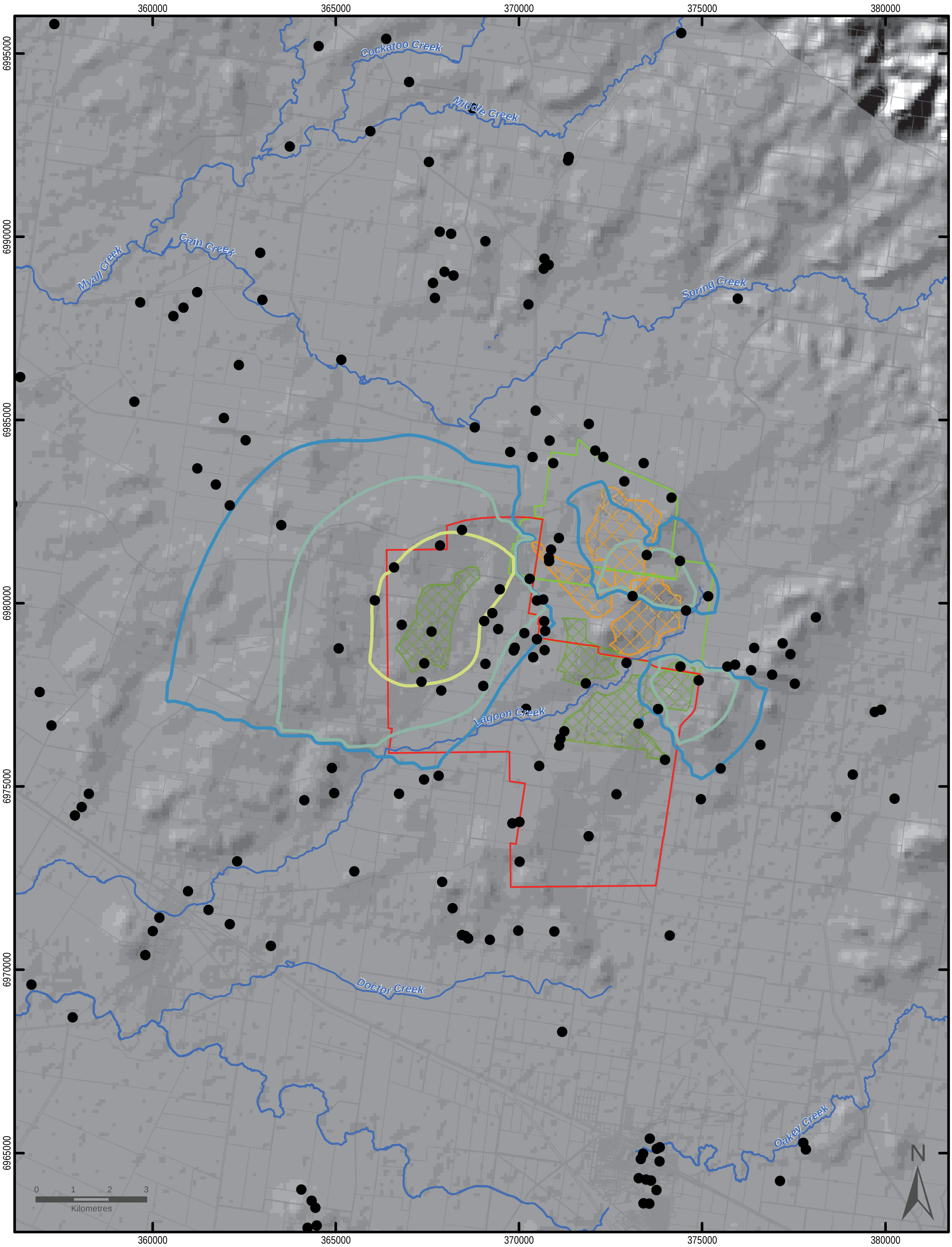


LEGEND

- DNRM Registered Bores - Walloons

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

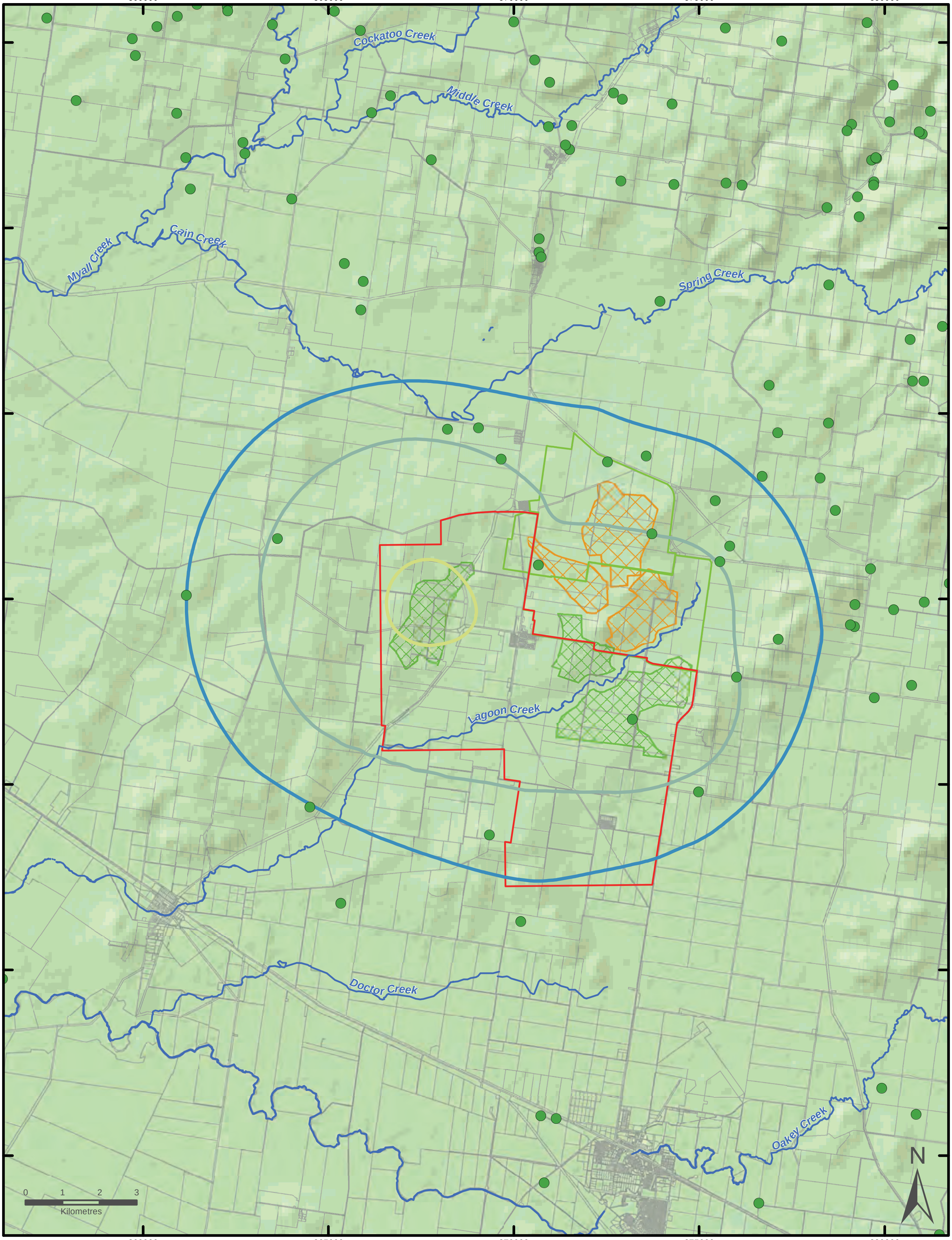
NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 6-28 - Walloon Coal Measures Predicted Drawdown – Post Mining

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 26/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-28_PredictedDrawdownInWalloon_2330.mxd



LEGEND

- DNRM Registered Bores - Marburg Sst

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-29 - Marburg Sandstone Predicted Drawdown – 2021

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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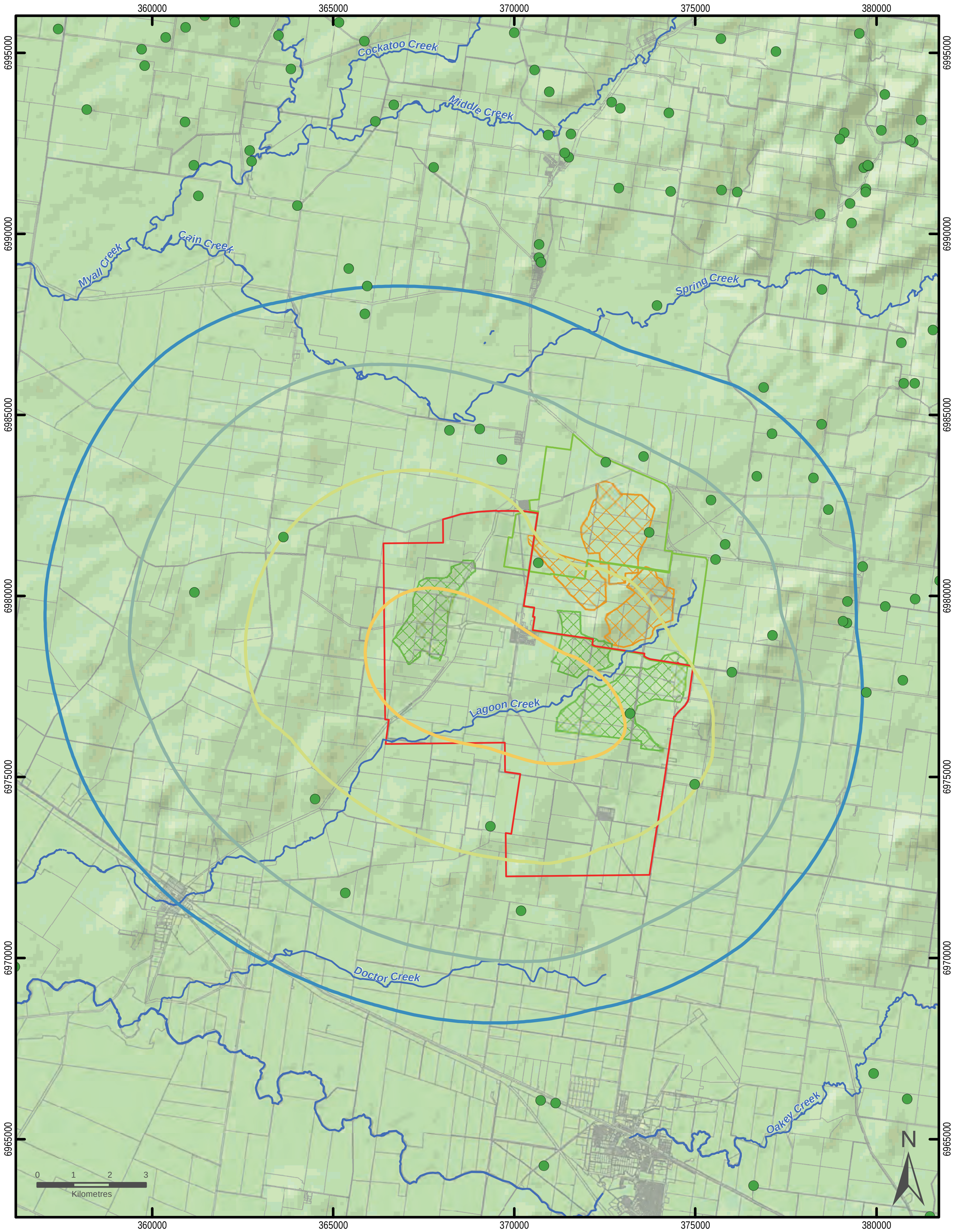

LEGEND

- DNRM Registered Bores - Marburg Sst

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-30 - Marburg Sandstone Predicted Drawdown – 2030

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-30_PredictedDrawdownInMarburgSandstone_2030.mxd

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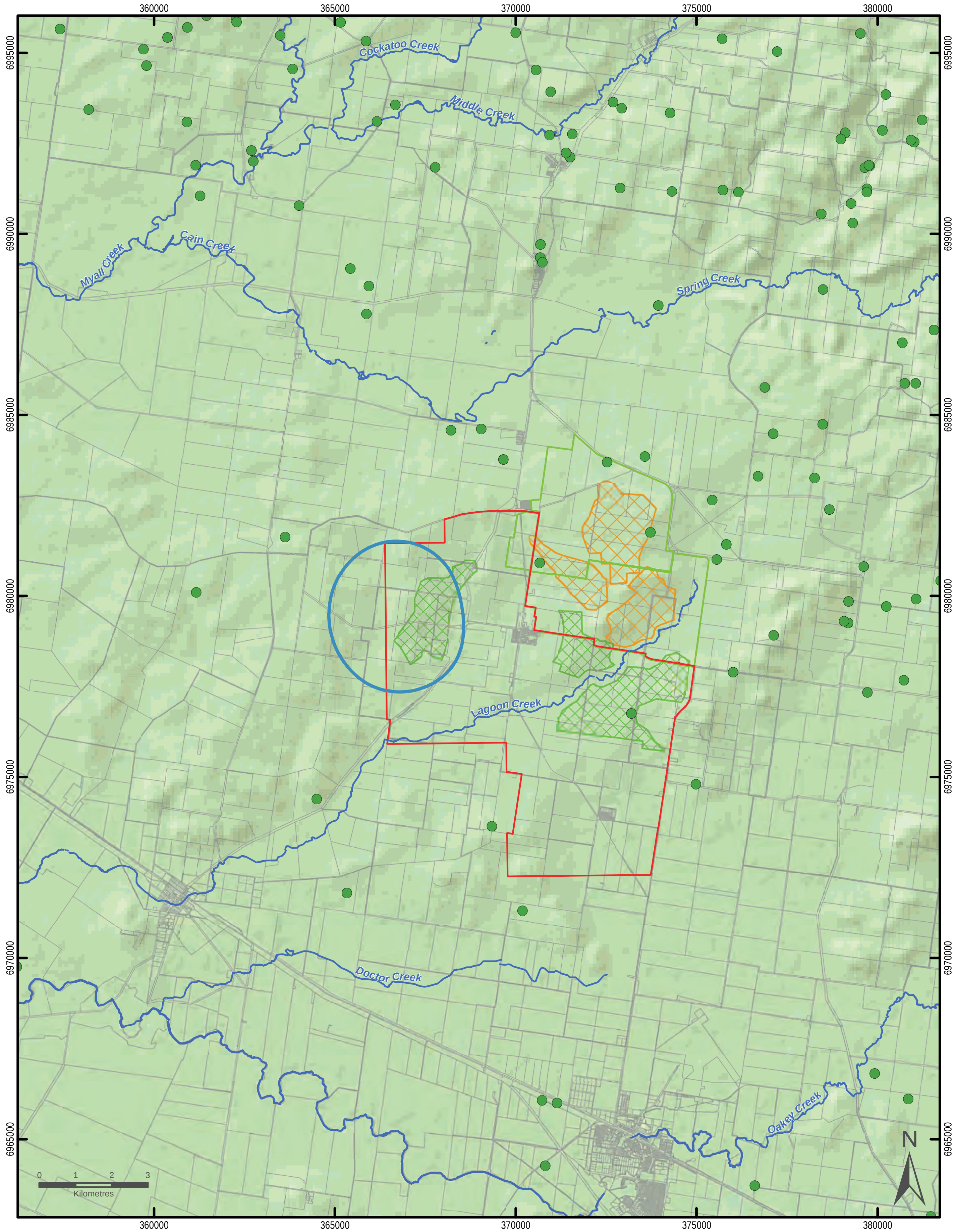

LEGEND

- DNRM Registered Bores - Marburg Sst

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-31 - Marburg Sandstone Predicted Drawdown – Post Mining

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-31_PredictedDrawdownInMarburgSandstone_2330.mxd

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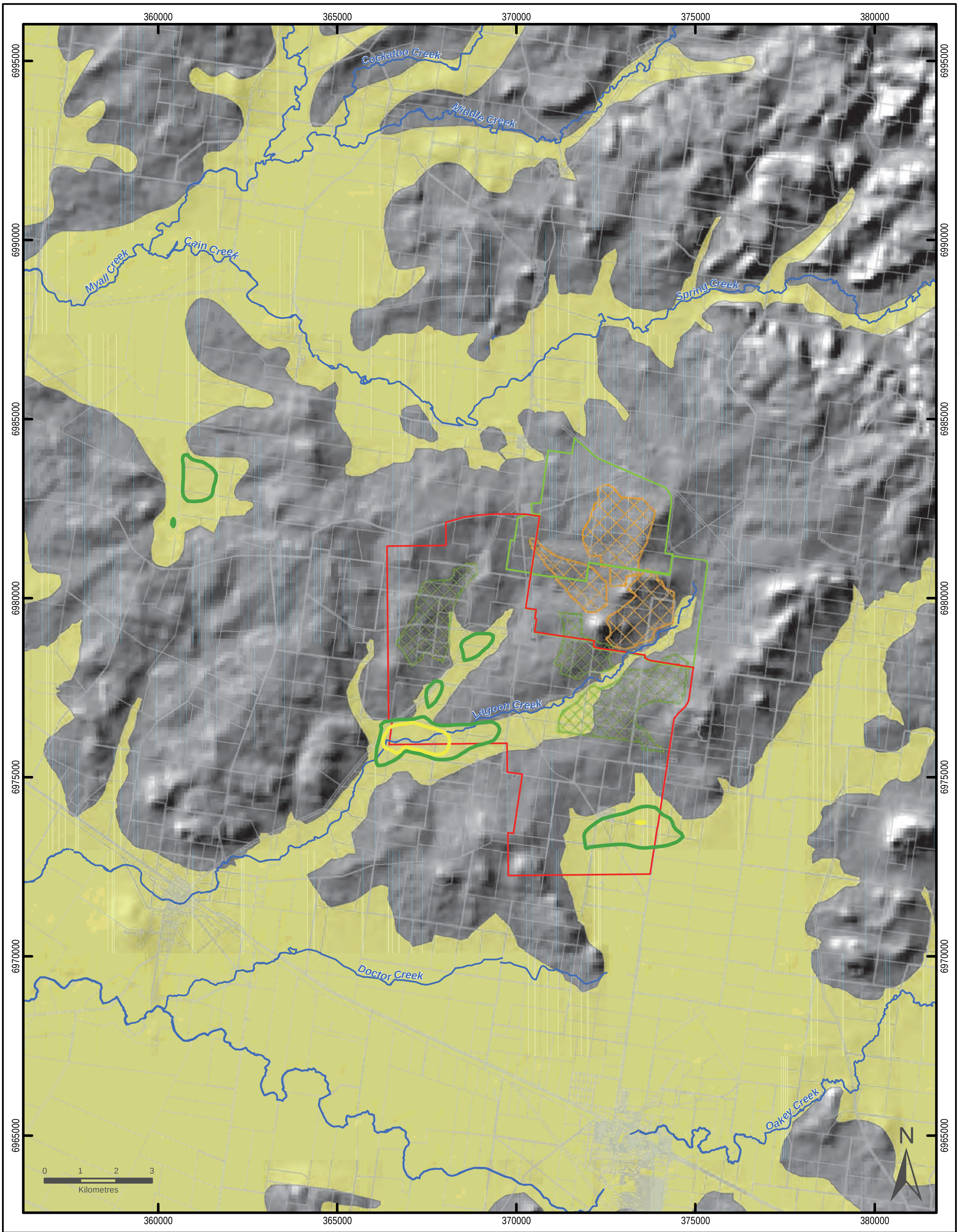


LEGEND

Maximum impact extent in the Alluvium

- 2 metre contour (50th Percentile)
- 2 metre contour (84th Percentile)
- Watercourse

- New Aland Coal Mine-Stage 3
- New Acland Coal
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Alluvium (Qa)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

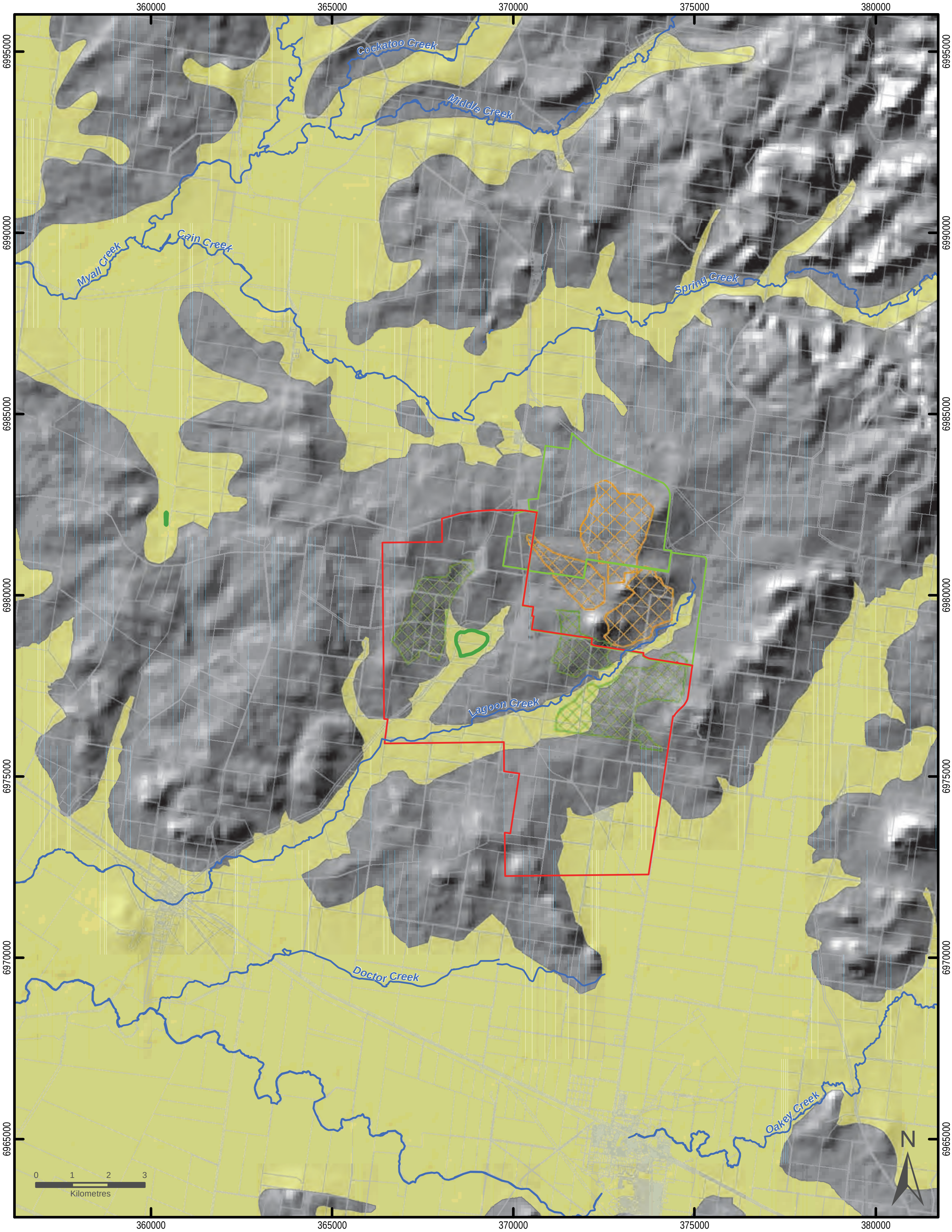
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-32 - Alluvium Maximum Impact Extent - 2030

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 26/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-32_MaxImpactExtentAlluvium_2030.mxd



LEGEND

Maximum impact extent in the Alluvium
- 1 metre contour (84th Percentile)
- Watercourse
- Cadastre

- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents
- Alluvium (Qa)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-33 - Alluvium Maximum Impact Extent – Post Mining

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-33_MaxImpactExtentAlluvium_2330.mxd

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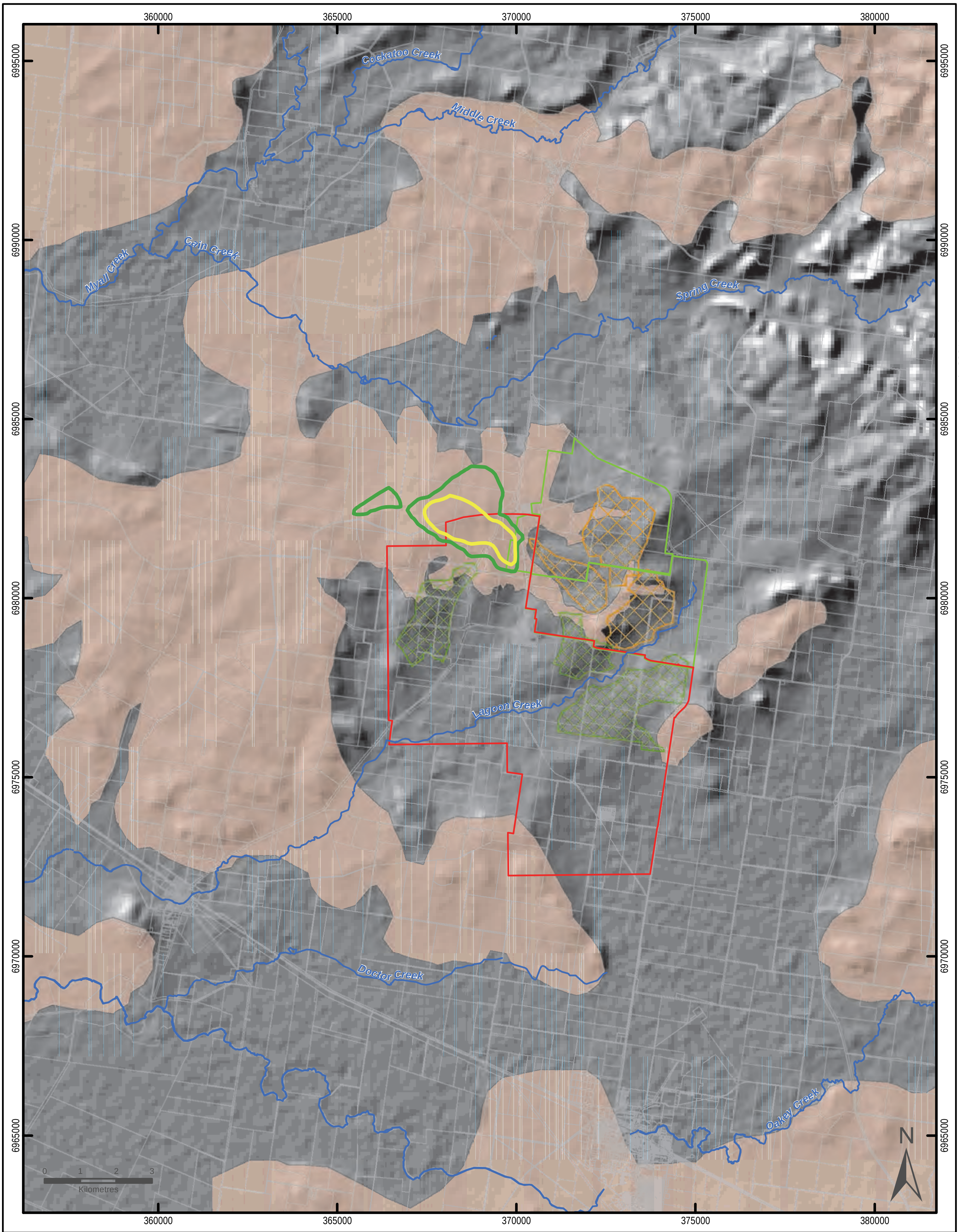


LEGEND

Maximum impact extent in the Tertiary Basalt

- 5 metre contour (50th Percentile)
- 5 metre contour (84th Percentile)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Basalt (Tm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

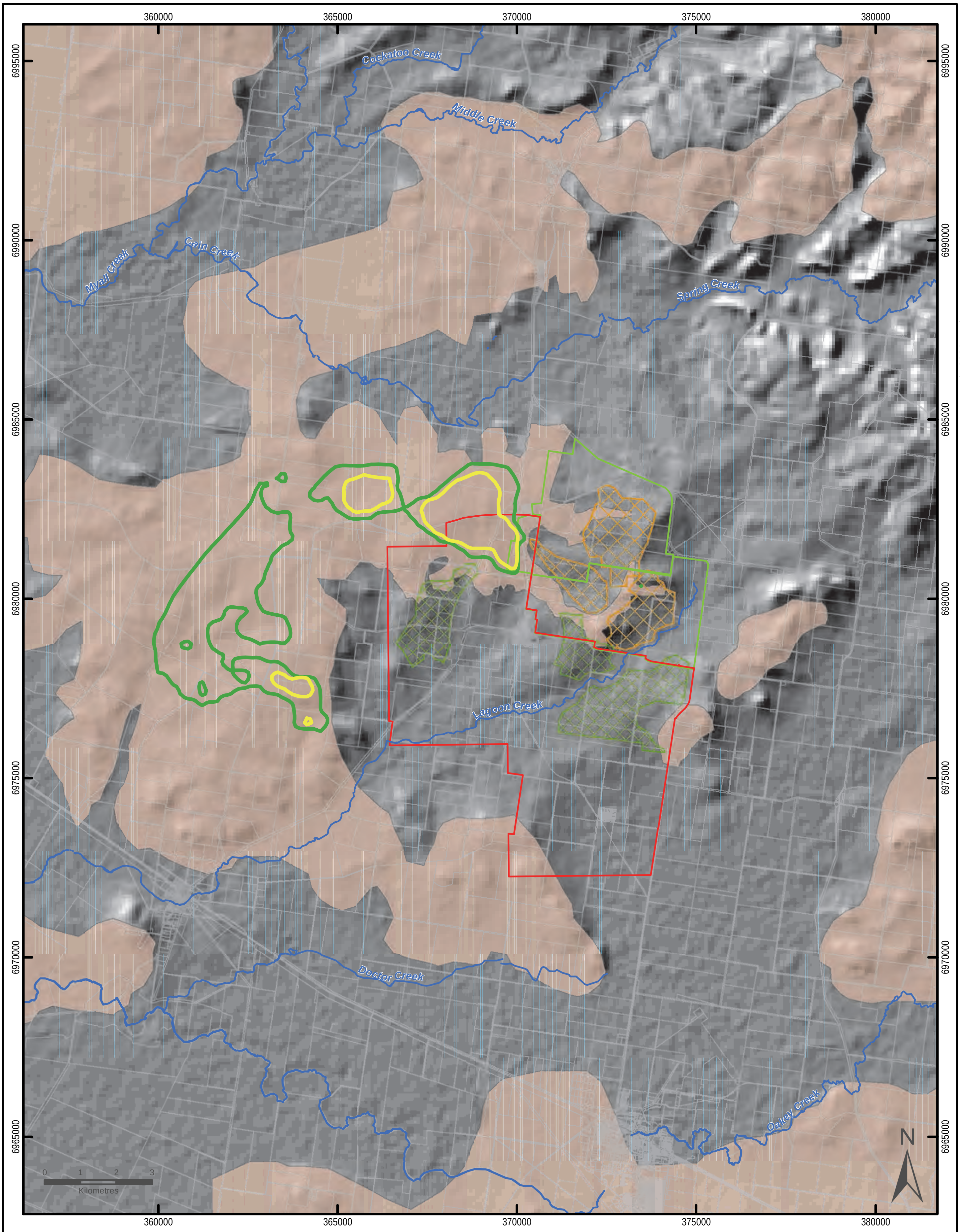
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-34 - Basalt Maximum Impact Extent - 2021

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 26/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-34_MaxImpactExtentBasalt_2021.mxd



LEGEND

Maximum impact extent in the Tertiary Basalt

- 5 metre contour (50th Percentile)
- 5 metre contour (84th Percentile)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Basalt (Tm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

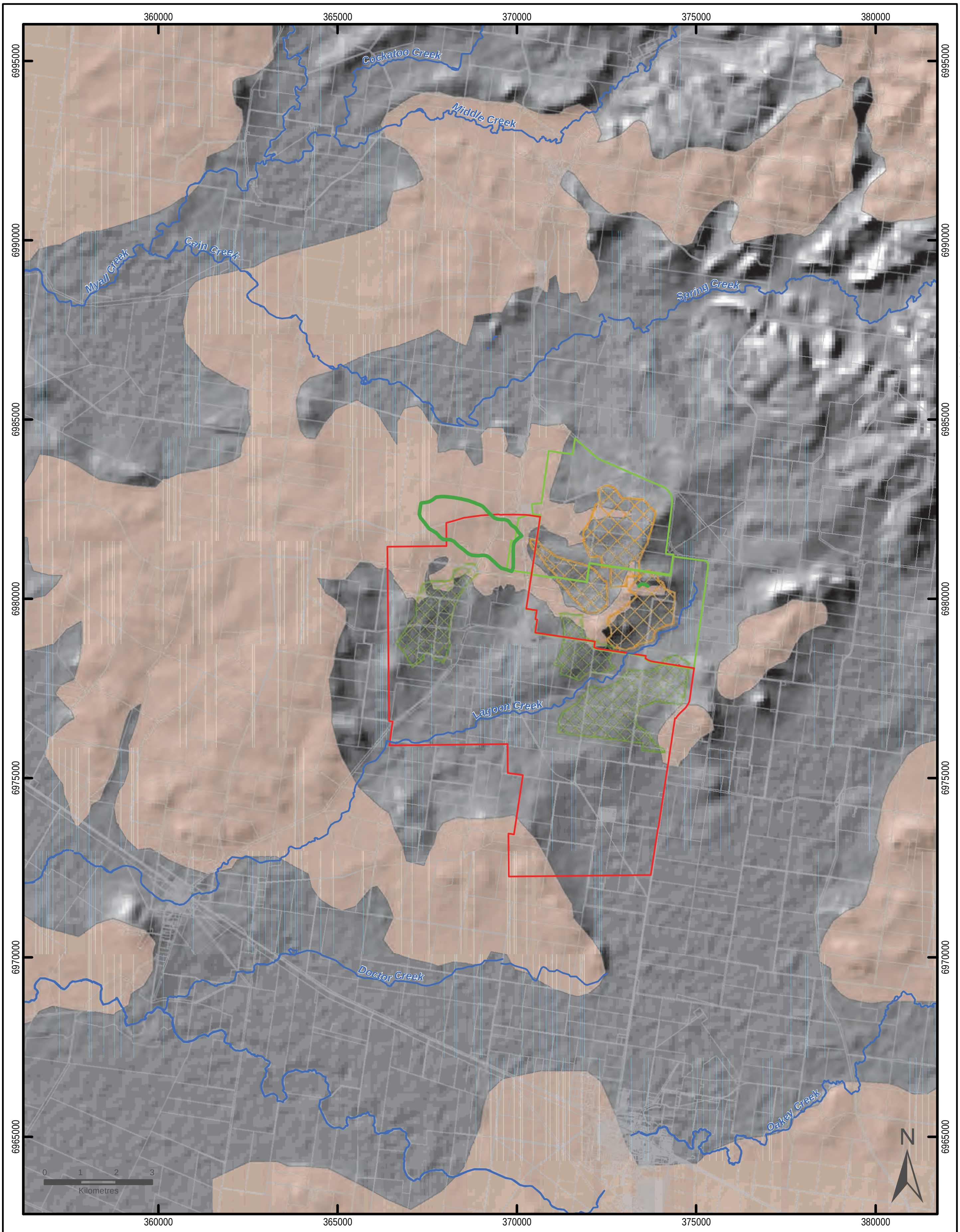
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-35 - Basalt Maximum Impact Extent - 2030

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 26/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-35_MaxImpactExtentBasalt_2030.mxd



LEGEND

Maximum impact extent in the Tertiary Basalt

- 5 metre contour (84th Percentile)
- Watercourse
- Cadastre
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Basalt (Tm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-36 - Basalt Maximum Impact Extent – Post Mining

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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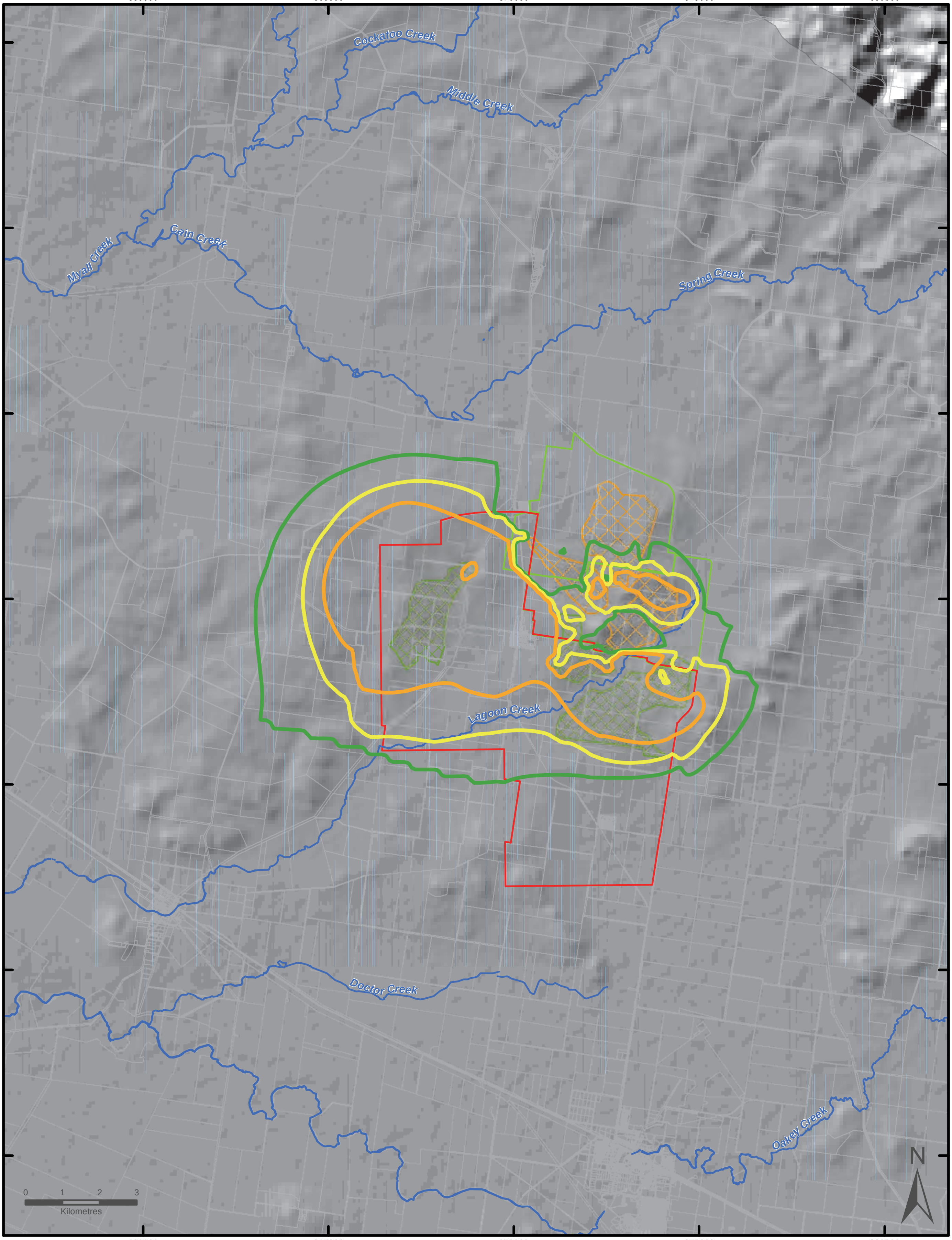

LEGEND

Maximum impact extent in the Walloon Coal Measures

- 5 metre contour (16th Percentile)
- 5 metre contour (50th Percentile)
- 5 metre contour (84th Percentile)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal
- Cadastre
- Stage 3 Pit
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-37 - Walloon Coal Measures Maximum Impact Extent - 2021

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-37_MaxImpactExtentWalloon_2021.mxd

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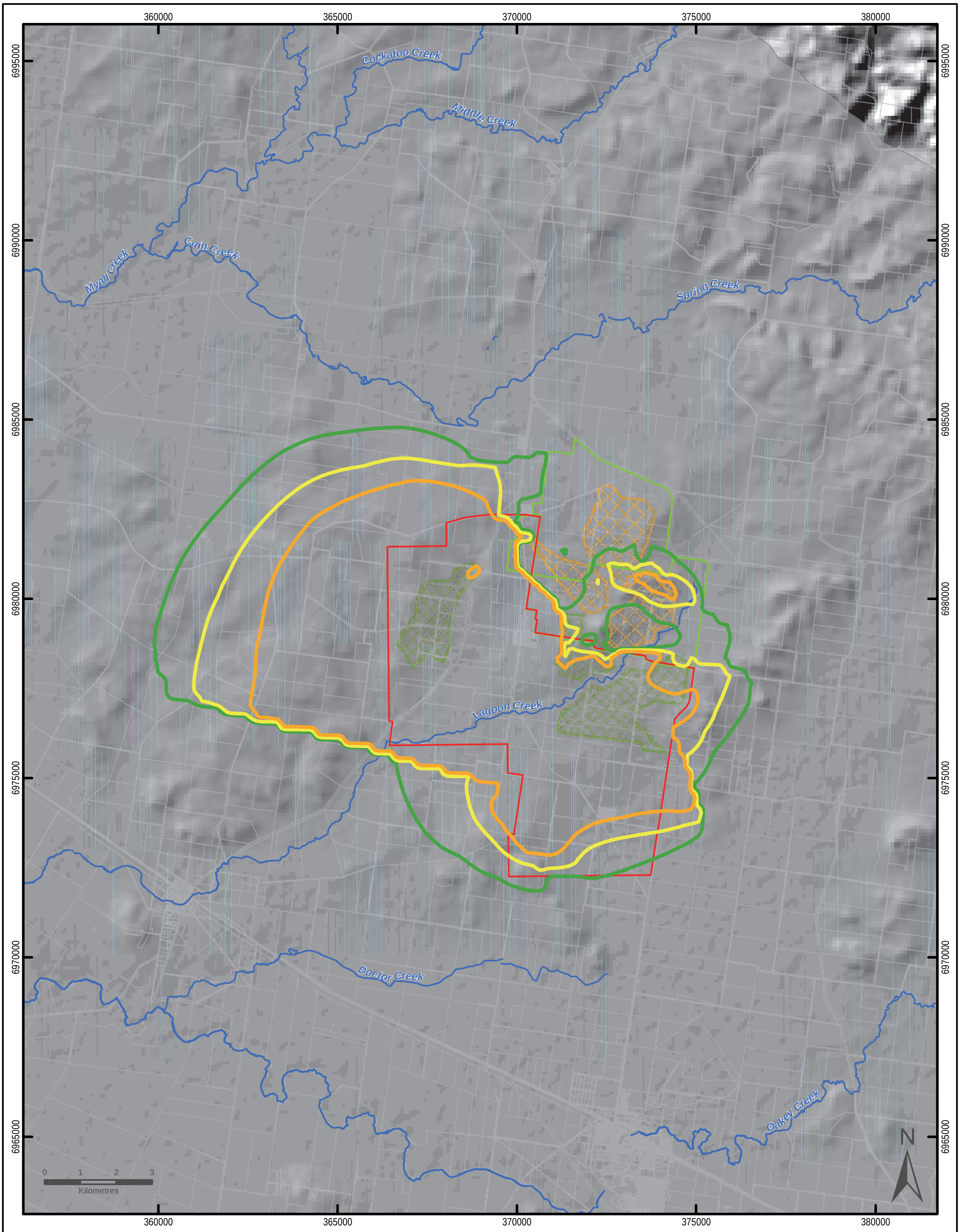

LEGEND

Maximum impact extent in the Walloon Coal Measures

- 5 metre contour (16th Percentile)
- 5 metre contour (50th Percentile)
- 5 metre contour (84th Percentile)

- Watercourse
- New Aland Coal Mine- Stage 3
- New Acland Coal
- Cadastre
- Stage 3 Pit
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-38 - Walloon Coal Measures Maximum Impact Extent - 2030

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-38_MaxImpactExtentWalloon_2030.mxd

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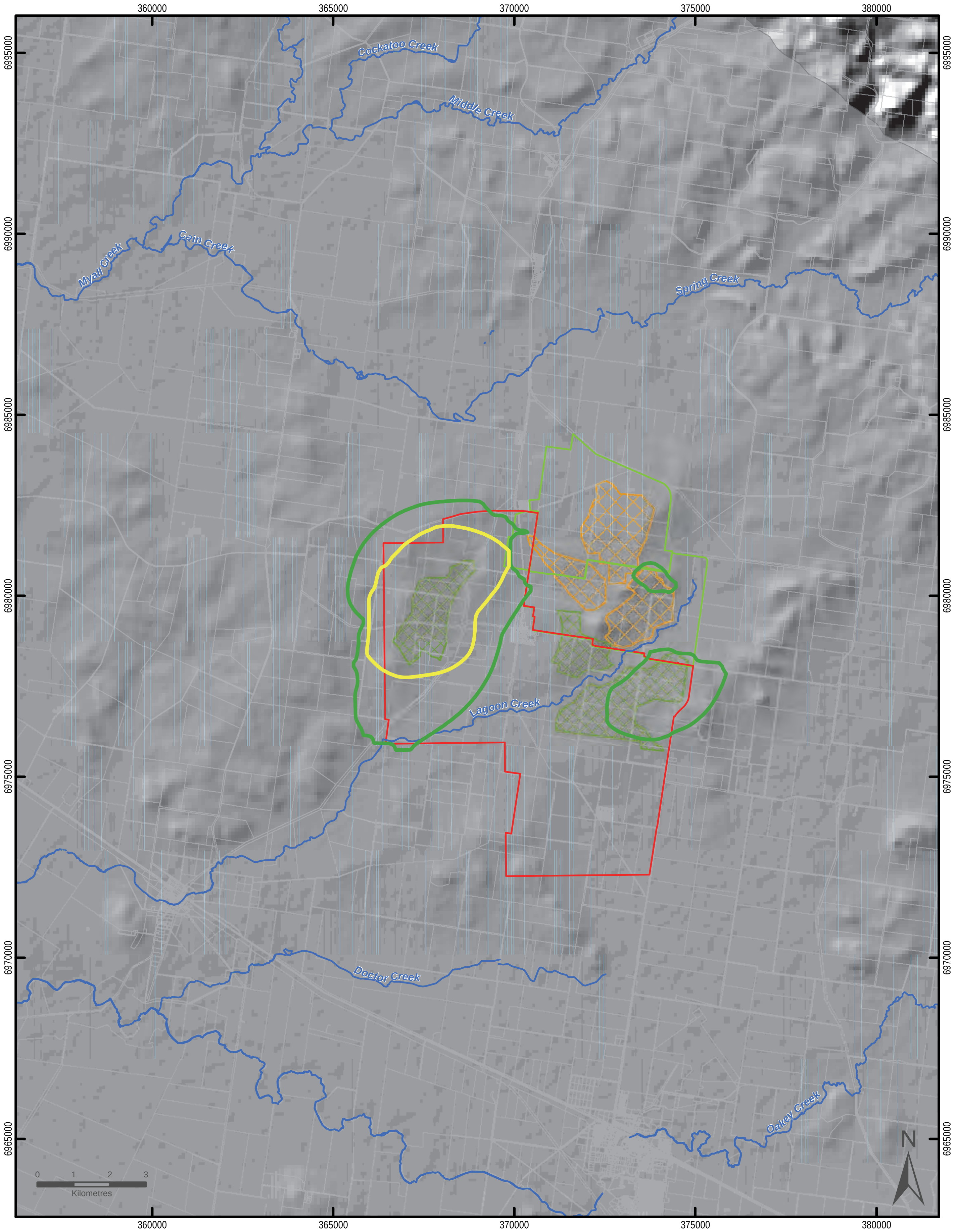


LEGEND

Maximum impact extent in the Walloon Coal Measures

- 5 metre contour (16th Percentile)
- 5 metre contour (50th Percentile)
- 5 metre contour (84th Percentile)

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

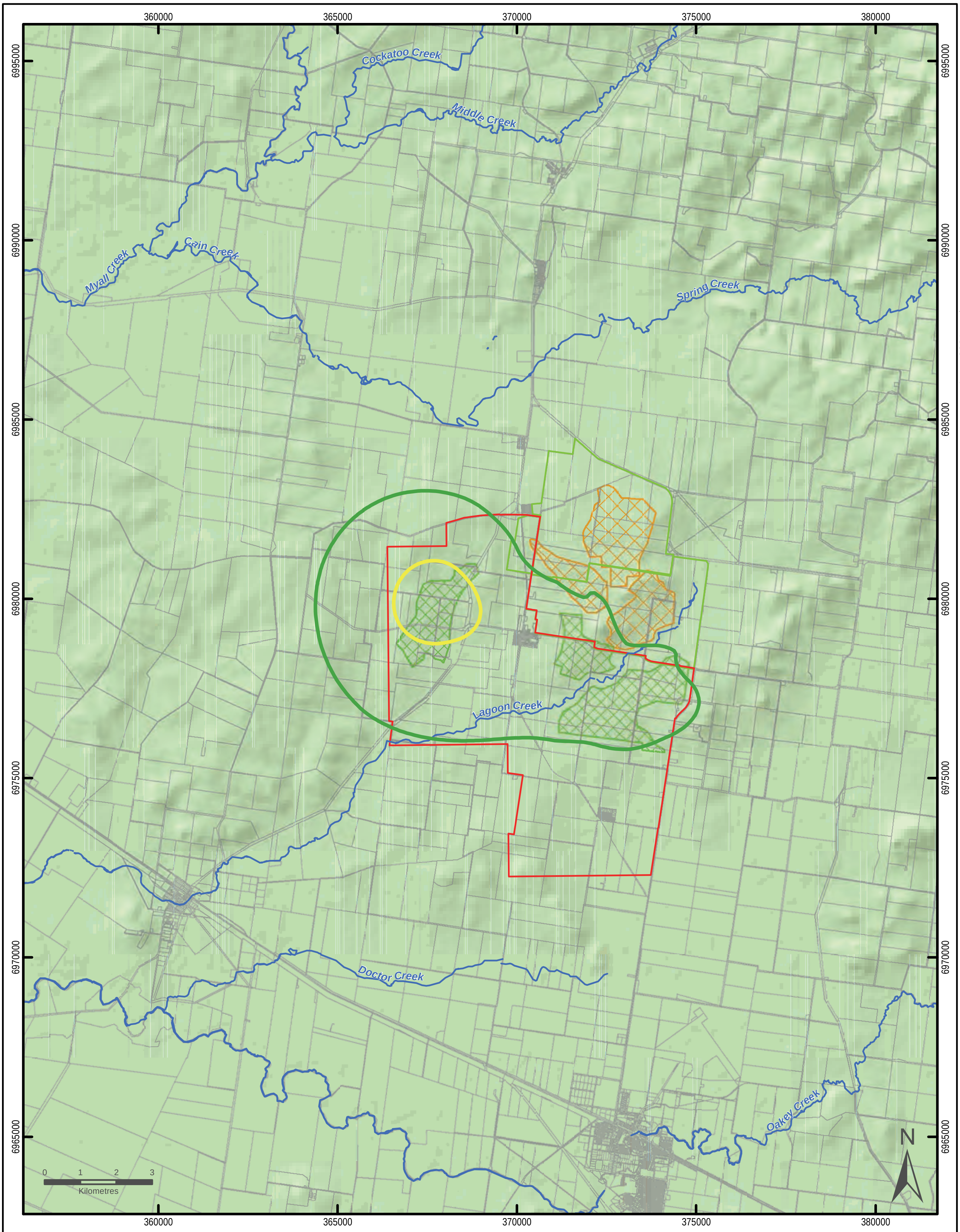
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-39 - Walloon Coal Measures Maximum Impact Extent – Post Mining

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 26/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-39_MaxImpactExtentWalloon_2330.mxd



LEGEND

Maximum impact extent in the Marburg Sandstone

- 5 metre contour (50th Percentile)
- 5 metre contour (84th Percentile)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

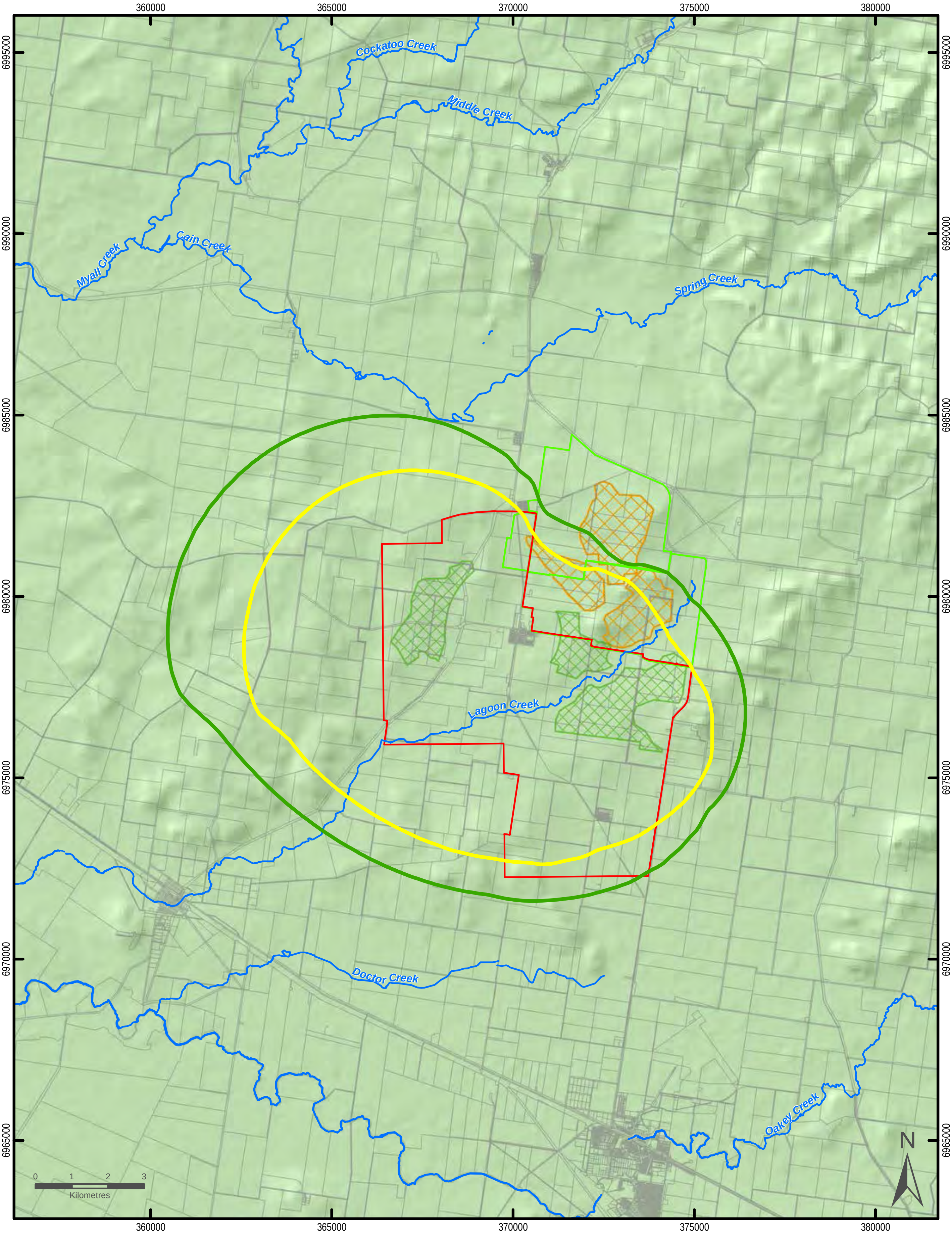
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-40 - Marburg Sandstone Maximum Impact Extent - 2021

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 26/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-40_MaxImpactExtentMarburg_2021.mxd



LEGEND

Maximum impact extent in the Marburg Sandstone

- 5 metre contour (50th Percentile)
- 5 metre contour (84th Percentile)
- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

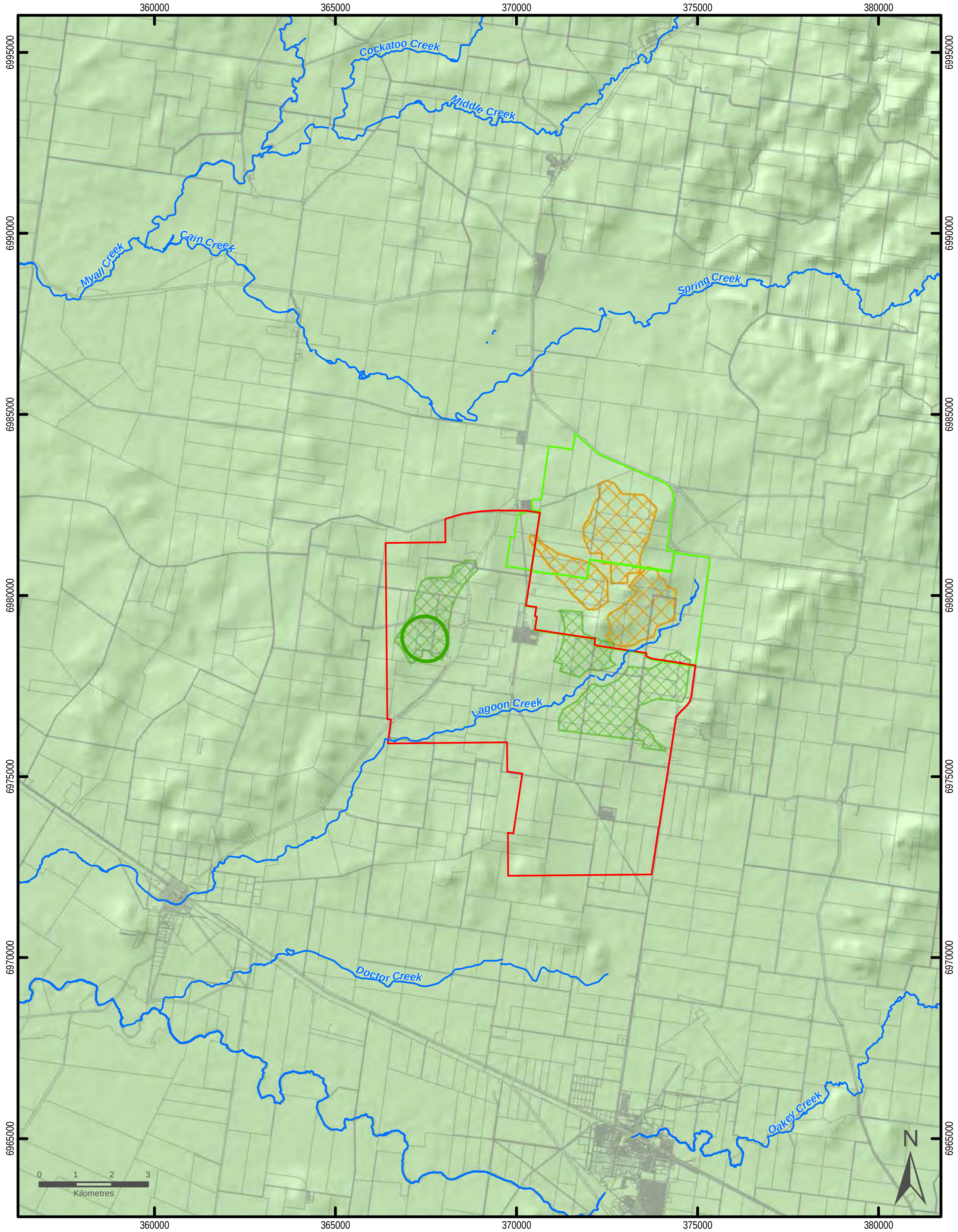
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-41 - Marburg Sandstone Maximum Impact Extent - 2030

Scale 1:140,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 28/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum140616_NewHope_Groundwater_Figure6-41_MaxImpactExtentMarburg_2030.mxd



LEGEND

Maximum impact extent in the Marburg Sandstone

- 5 metre contour (84th Percentile)
- Watercourse
- Cadastre
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 6-42 - Marburg Sandstone Maximum Impact Extent – Post Mining

Scale 1:140,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 28/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140616_NewHope_Groundwater_Figure6-42_MaxImpactExtentMarburg_2330.mxd

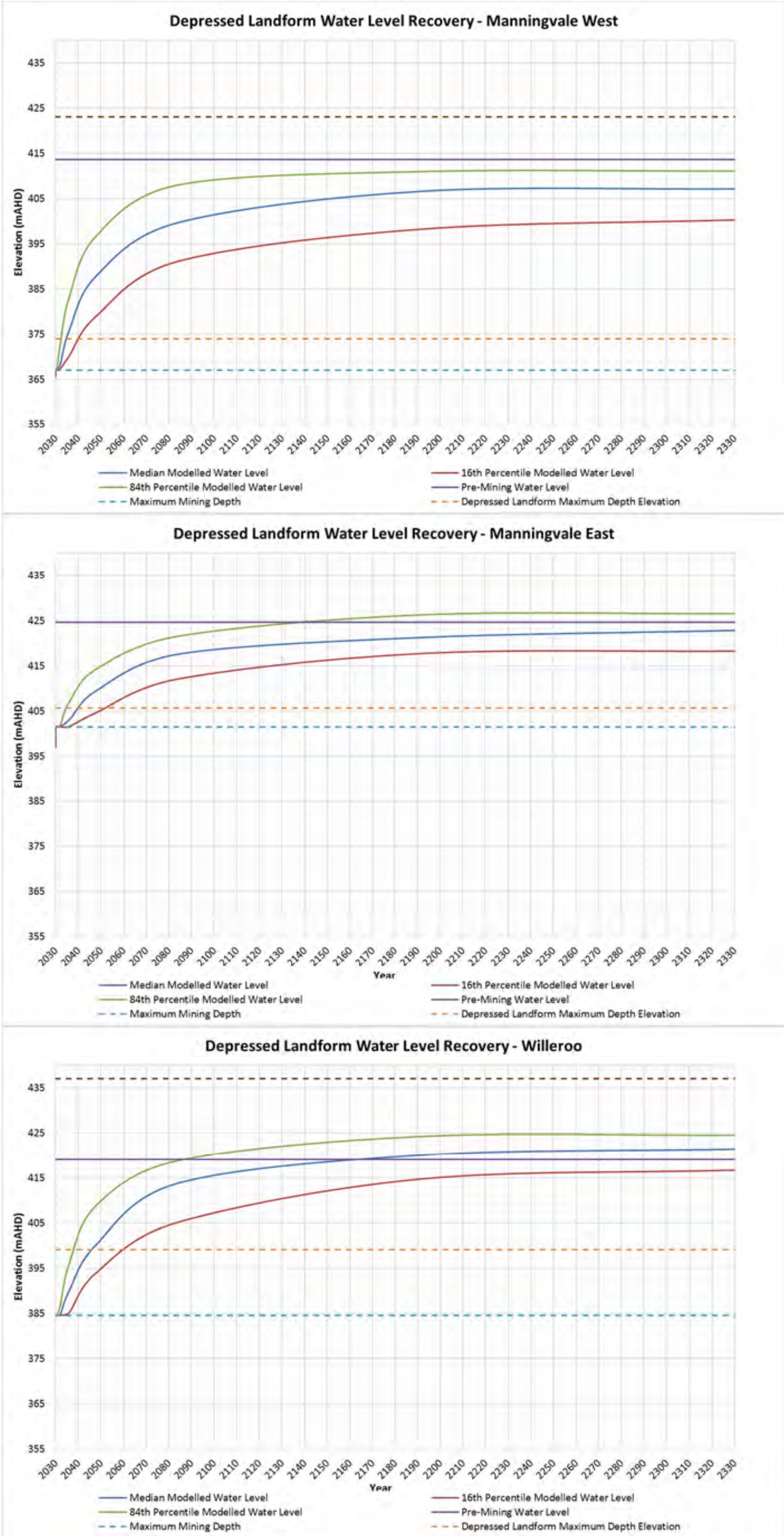


Figure 6-43 : Pit Lake Evolution

A mass balance for the model domain for post-mining recovery and pit lake evolution is provided in **Figure 6-44 : Post-Mining Mass BalanceFigure 6-44**. The primary source of inflow to the model is recharge. The main sources of outflow across the entire model are flows to tributaries and evapotranspiration. Evapotranspiration and change in storage have a relatively equal and opposite trend as the voids fill during the first 90-100 years. Once the voids have reached equilibrium, as indicated by a zero net change in storage, evapotranspiration also reaches a long-term equilibrium.

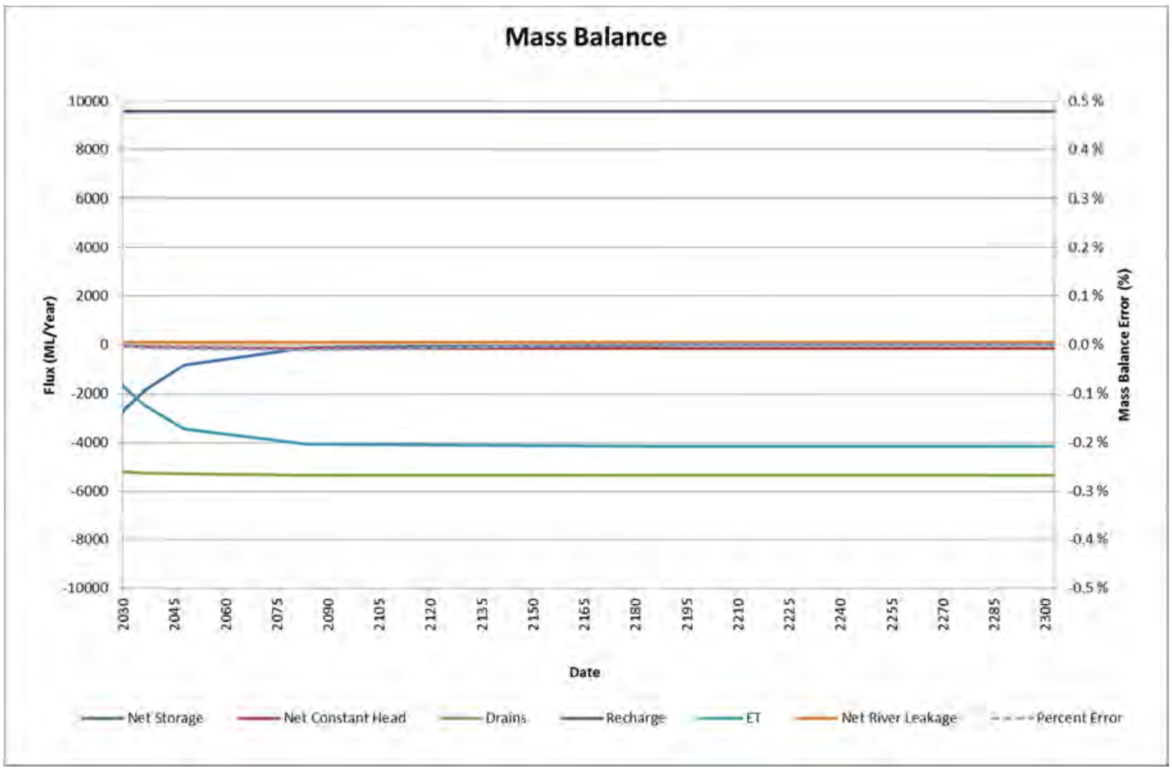


Figure 6-44 : Post-Mining Mass Balance

7. Uncertainty analysis

Understanding uncertainty is an inherent part of any qualitative and/or quantitative assessment. It is as important to understand the uncertainty of the assessments as it is to understand the conclusions derived from the results of the assessment, as it will put those conclusions into context.

To understand the uncertainty in this assessment, a comparison/evaluation was made for the following estimated output requirements:

- pit inflow and/or dewatering rates associated with the proposed mine plan
- drawdown, as indicated by potential impact zones, during and after the proposed mine operations.

7.1 Inflows

The uncertainty of inflow predictions, as indicated by the upper and lower bounds, is relatively small (< +/- 20% the median). These results are most likely a result of the restriction of parameter values for the Walloon Coal Measures during calibration. These results also indicate that inflows are much less sensitive to other parameters.

7.2 Drawdown

Drawdown extent, as indicated by the potential impacts zones **in Figure 6-32** through **Figure 6-42**, indicate a relatively minor uncertainty in areal extent of uncertainty for drawdown propagation. The level of uncertainty in each aquifer is relative to the level of constraint provided in the calibration process. For example, the uncertainty in impact zone extent for the Walloon Coal Measures is much less than that of the Marburg sandstone, as is the constraint in calibrated parameter values (**Figure 5.5** through **Figure 5.10**).

8. Summary and Conclusions

The level of constraint calibration has provided on parameter values is evident in the level of uncertainty indicated in the predictive results. Given that calibration is considered within acceptable limits and the level of uncertainty in the predictive results is considered minor, in hydrogeologic modelling terms, it is then concluded that the calibration process has provided enough rigor for predictive results to be considered fit for purpose and suitable for the assessment of potential impacts associated with the proposed project. .

9. References

Bear, Jacob (2007), *Hydraulics of Groundwater,* Dover Publications, Inc. United States of America.

Bureau of Meteorology (BoM) (2005), Average Aerial Evapotranspiration map, viewed in 2011, www.bom.gov.au/jsp/ncc/climate_averages/evapotranspiration/index.jsp.

Bureau of Meteorology (BoM) (2006), Average Pan Evaporation Annual, viewed in 2011, www.bom.gov.au/jsp/ncc/climate_averages/evapotranspiration/index.jsp.

Bureau of Meteorology (BoM), Streamflow data at Station 130107A, viewed in 2010, www.bom.com).

Environmental Simulations (2007), *Guide to Using Groundwater Vistas Version 5*, PA, United States of America.

GHD (2012), *Surat Cumulative Management Area Groundwater Model Report*, prepared for the Queensland Water Comission.

Mackie, CD (2009), *Hydrogeological Characterisation of Coal Measures and Overview of Impacts of Coal Mining on Groundwater Systems in the Hunter Valley of NSW*, thesis submitted for PhD at University of Technology, Sydney, NSW Australia.

McDonald, M.G., and Harbaugh, A.W. (December 28, 1983). A modular three-dimensional finite-difference ground-water flow model. Open-File Report 83-875. U.S. Geological Survey. http://pubs.er.usgs.gov/usgspubs/ofr/ofr83875.

Middlemis, H (2004), *Benchmarking Best Practice for Groundwater Flow Modelling*, prepared for The Winston Churchill Memorial Trust of Australia.

Murray Darling Basin Commission (MDBC) (2000), *Groundwater Flow Modelling Guideline*, prepared by Aquaterra.

Parsons Brinckerhoff (27 September 2010), *Draft Reporting for the Middlemount EIS on the interpreted geology and hydrogeology of the study area*, electronic transfer of file.

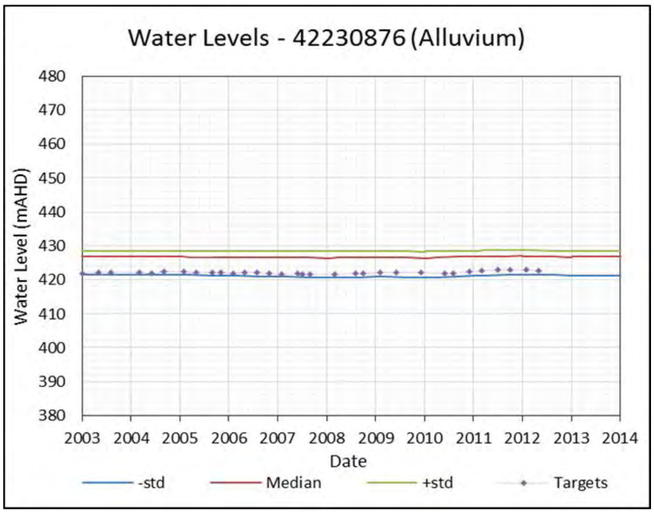
SRK Consulting (2006), *The Bowen & Surat Basin Structural Framework Study*.

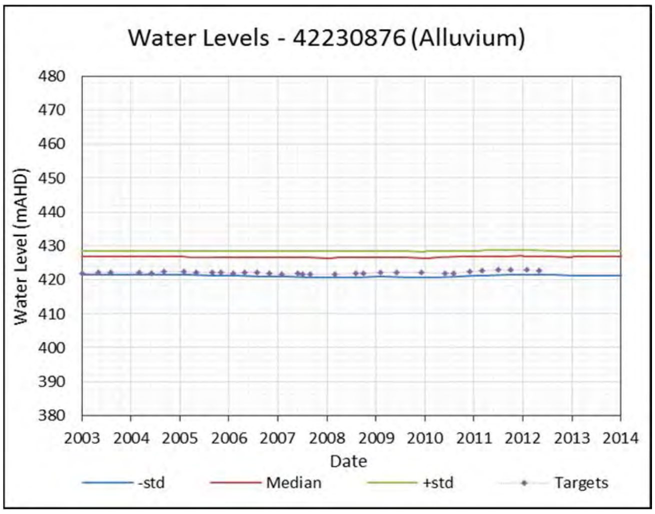
Sinclair Knight Merz and National Centre for Groundwater Research and Training (2012), *Australian Groundwater Modelling Guidelines: Waterlines Report Series No. 82*.

Appendix A. Calibration Information

Appendix A.1 Calibration Hydrographs

Alluvial Bores


Water Levels - 42230876 (Alluvium)
Water Level (mAHD)
480
470
460
450
440
430
420
410
400
390
380
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std Median +std Targets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Water Level (mAHD)
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470
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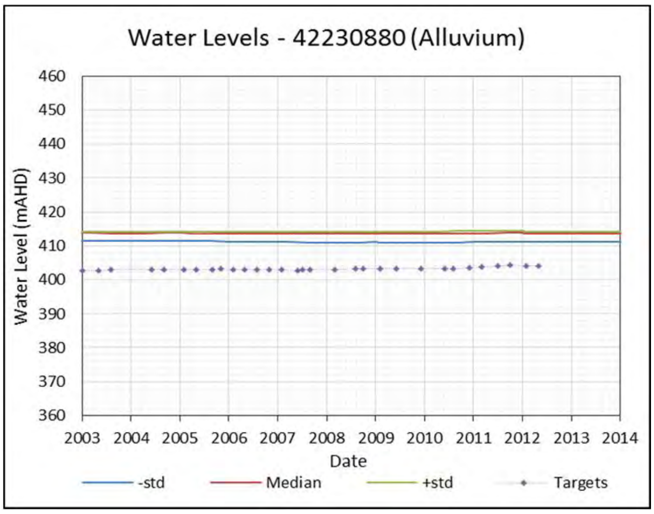
440
430
420
410
400
390
380
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std Median +std Targets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Water Level (mAHD)
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430
420
410
400
390
380
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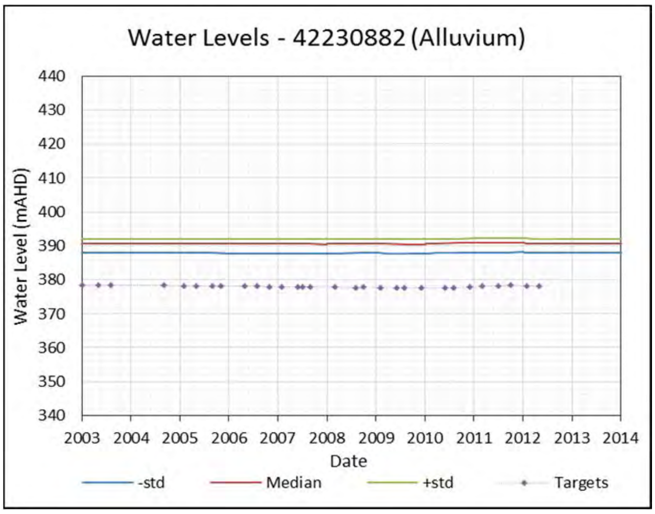
360
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std Median +std Targets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Water Level (mAHD)
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400
390
380
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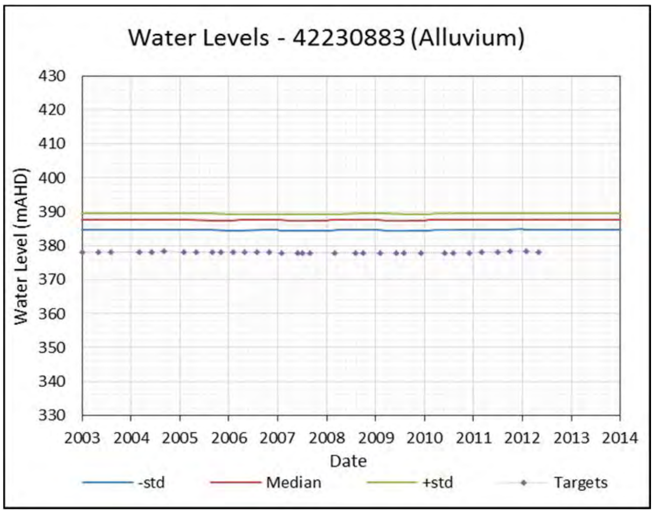
360
350
340
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std Median +std Targets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Water Level (mAHD)
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400
390
380
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360
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340
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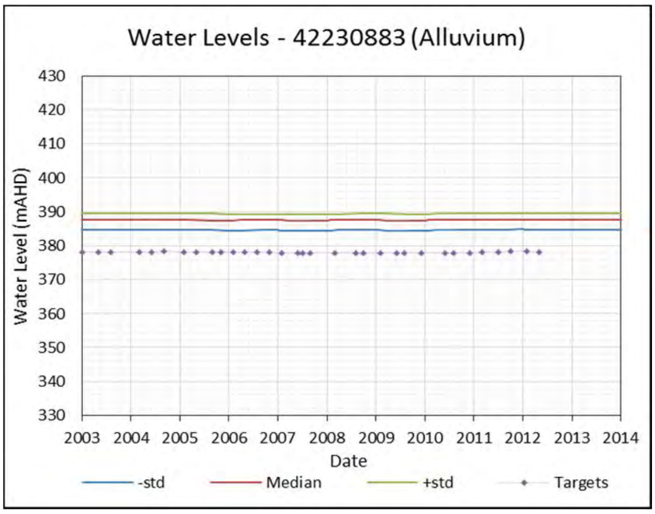
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std Median +std Targets


Water Levels - 42230883 (Alluvium)
Water Level (mAHD)
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420
410
400
390
380
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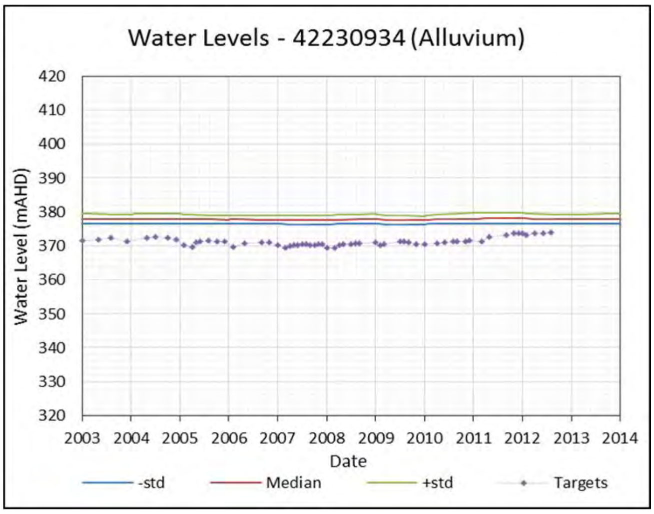
360
350
340
330
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std Median +std Targets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Median
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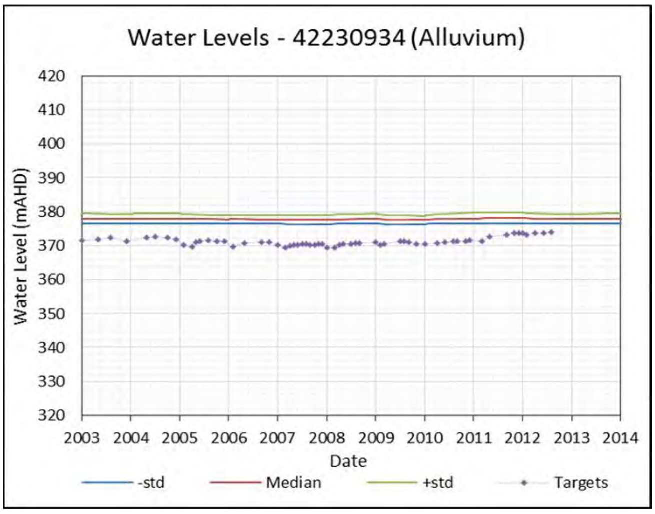
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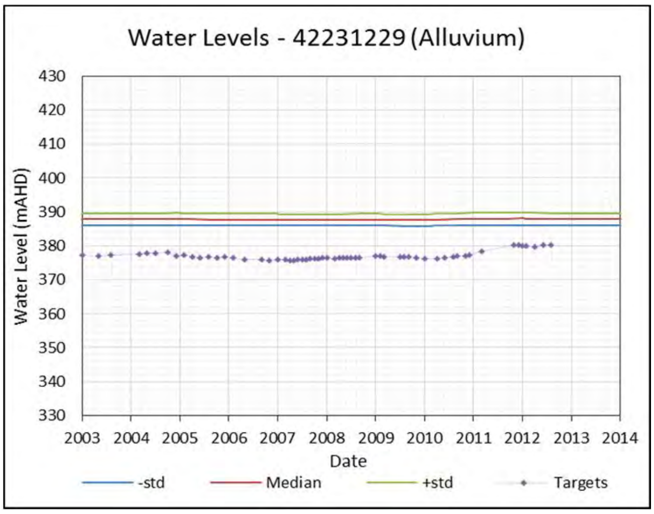
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Median
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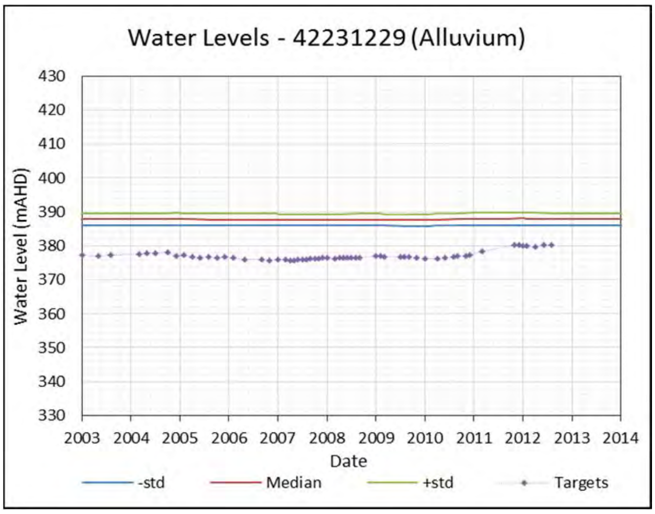
Targets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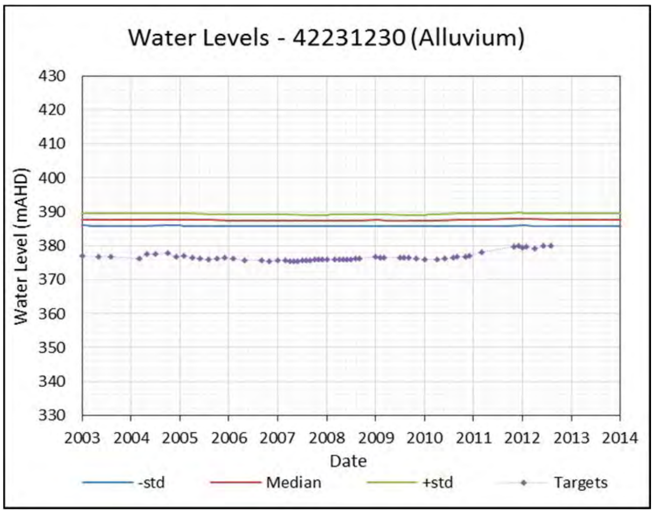
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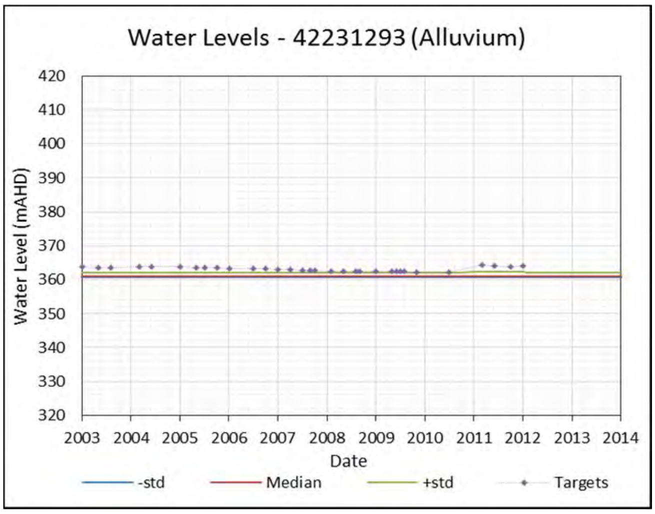
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Water Level (mAHD)
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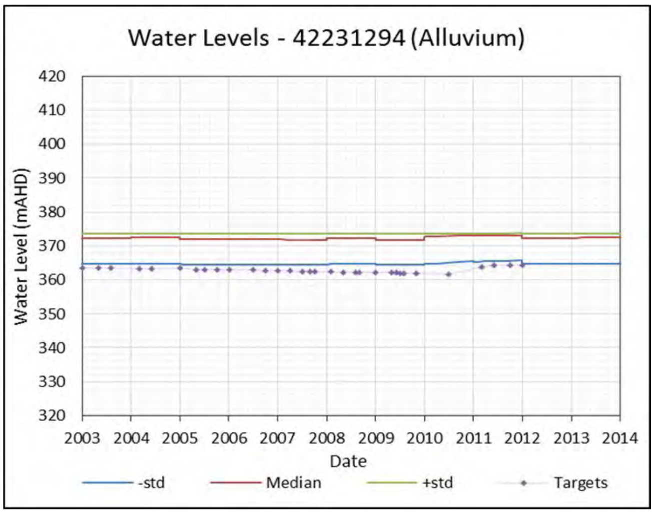
Targets


Water Levels - 42231294 (Alluvium)
Water Level (mAHD)
420
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400
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Date
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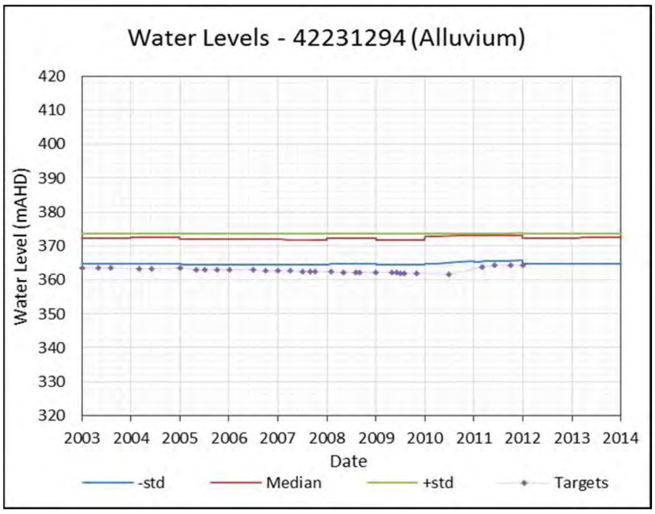
Median
+std
Targets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Water Level (mAHD)
420
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360
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320
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Date
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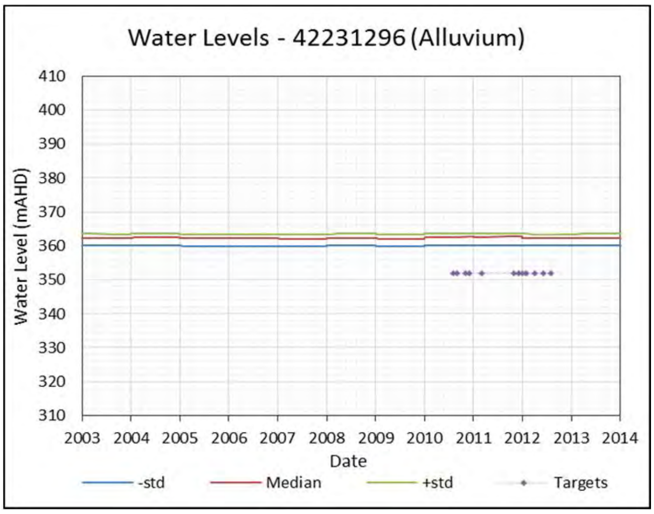
Median
+std
Targets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Water Level (mAHD)
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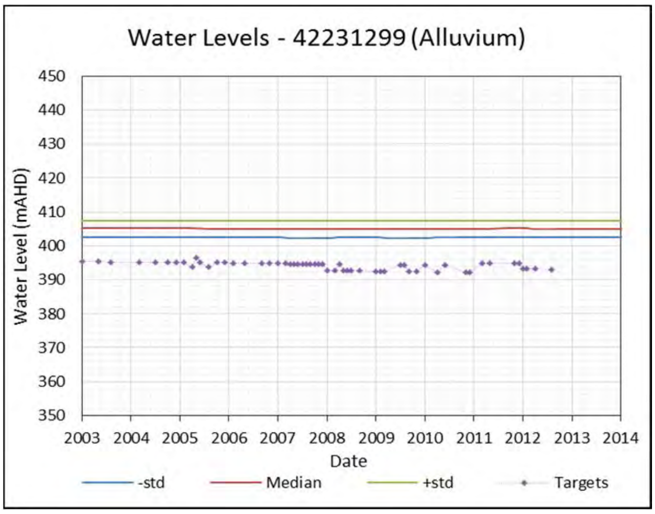
Targets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Water Level (mAHD)
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Date
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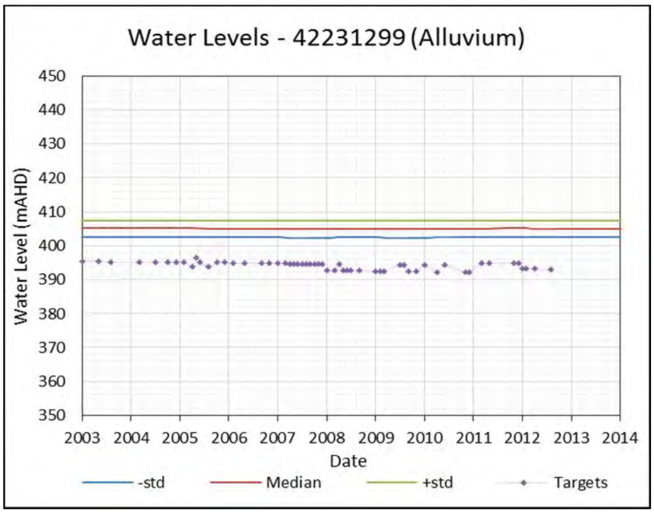
Median
+std
Targets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Water Level (mAHD)
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Median
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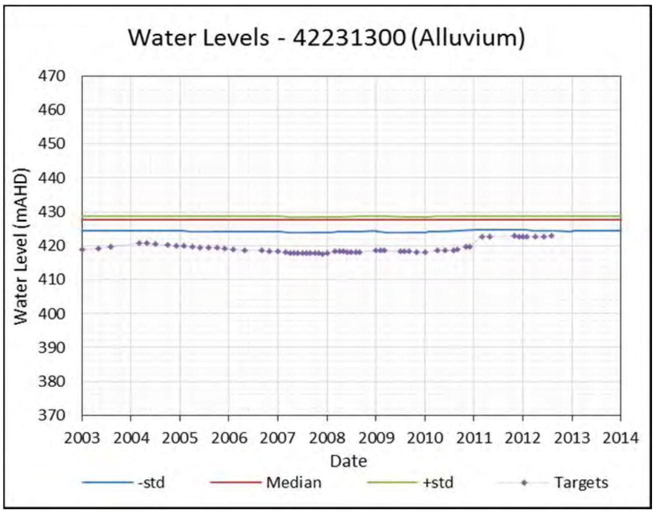
Targets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Water Level (mAHD)
470
460
450
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400
390
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2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
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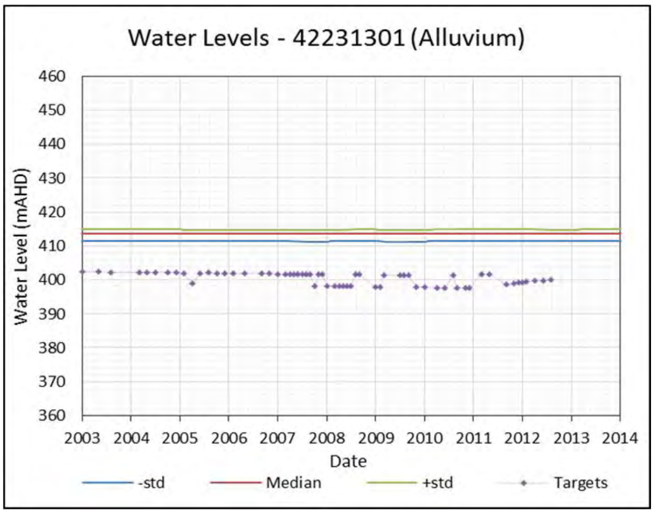
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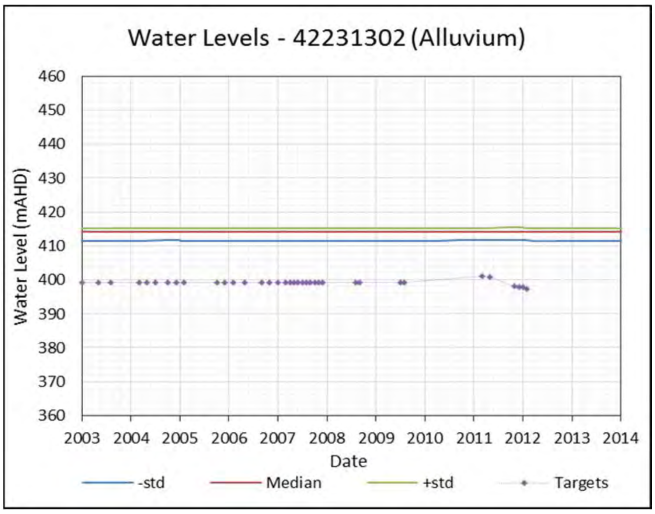
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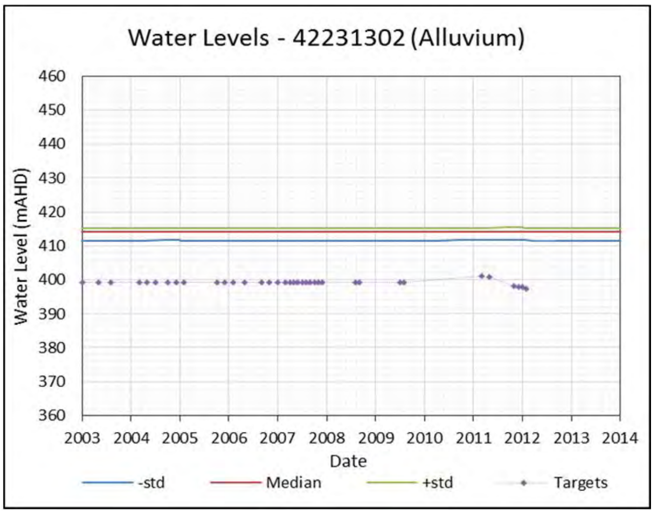
Targets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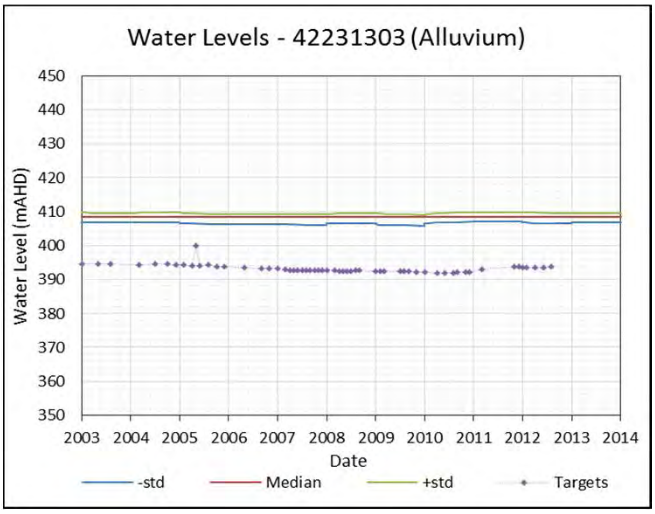
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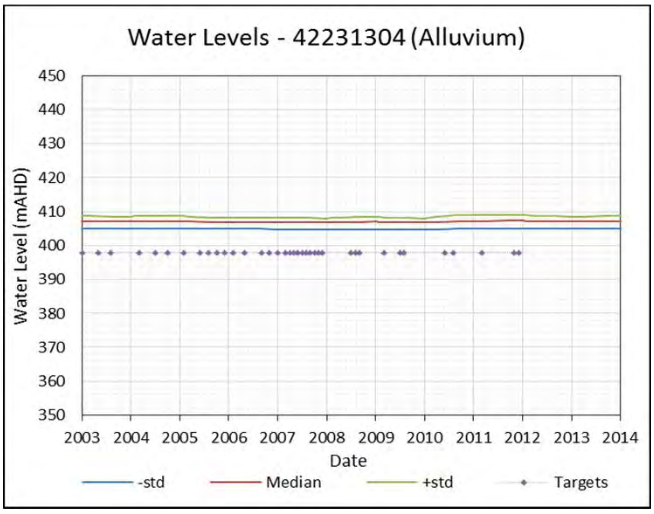
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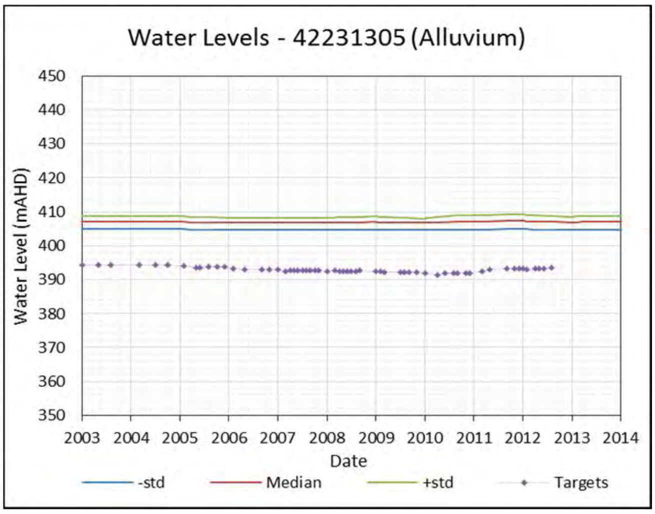
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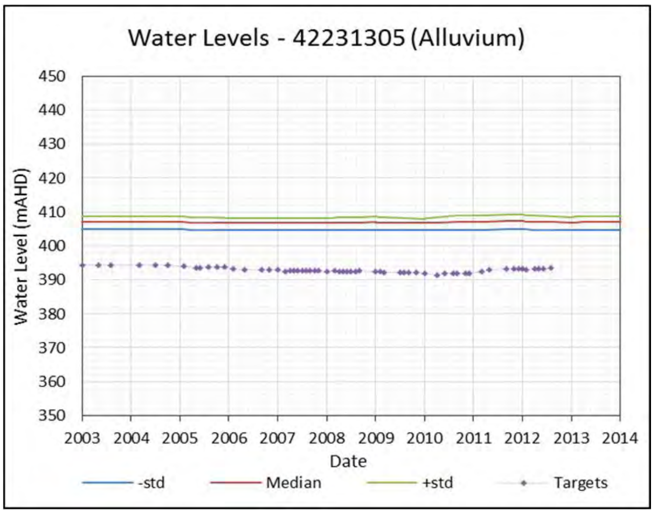
Targets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370
360
350
Water Level (mAHD)
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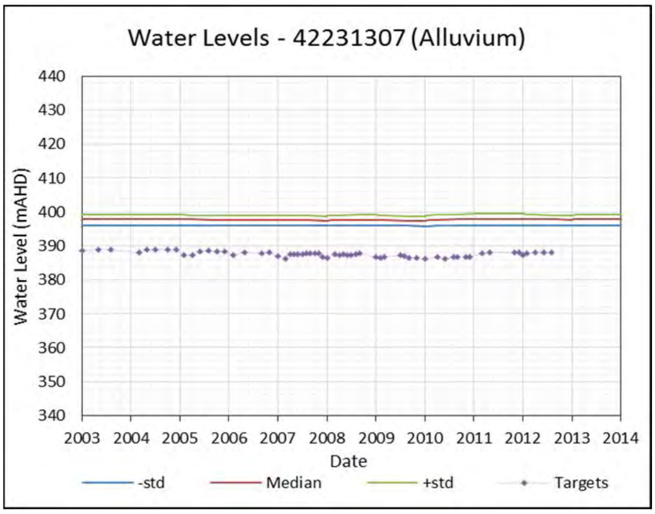
Date
-std
Median
+std
Targets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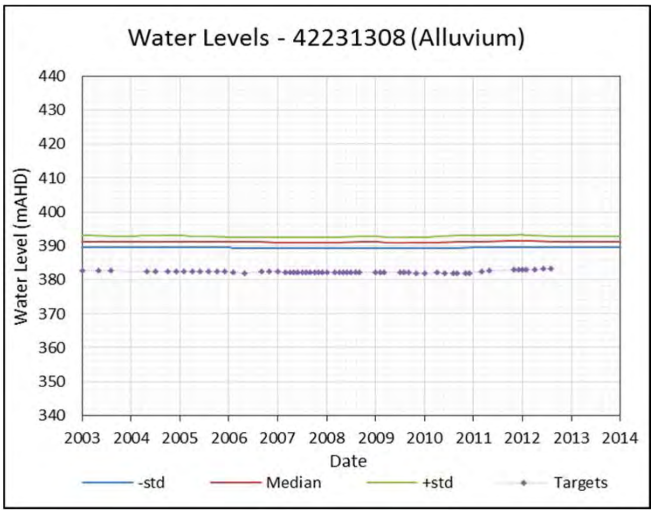
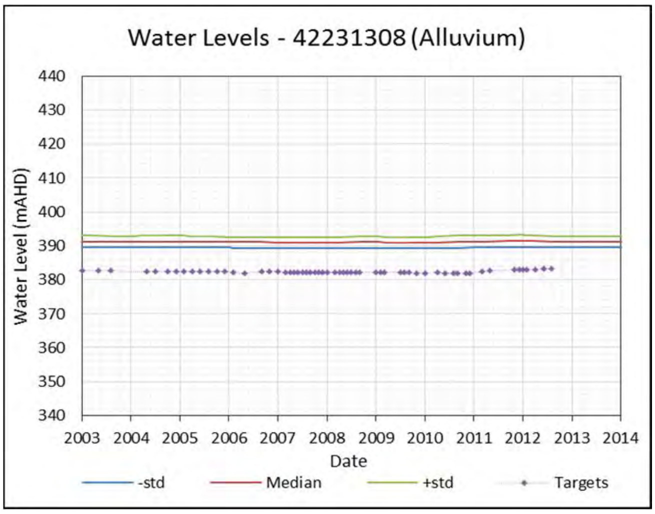
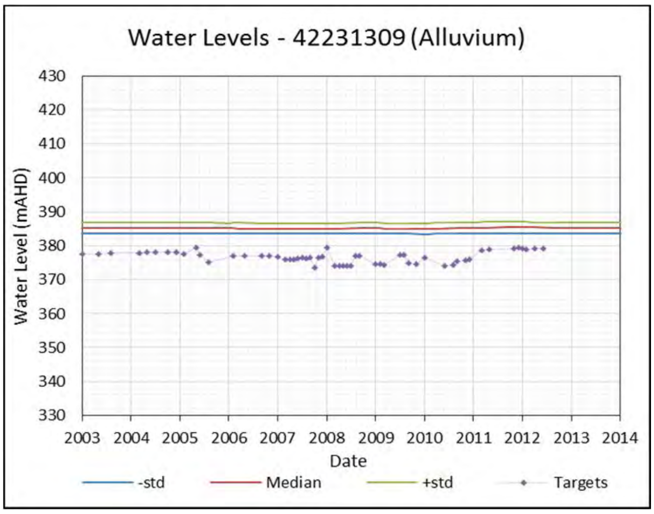
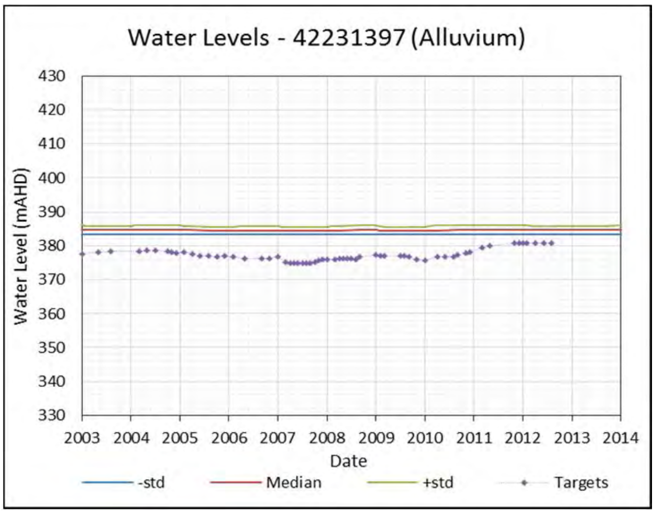
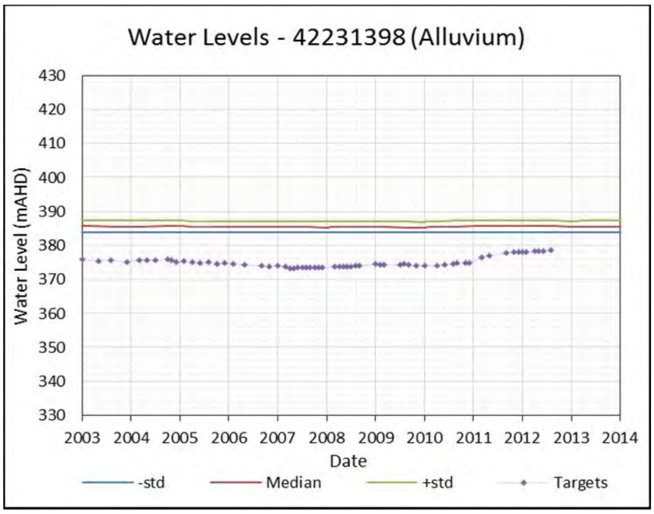
370
360
350
340
Water Level (mAHD)
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

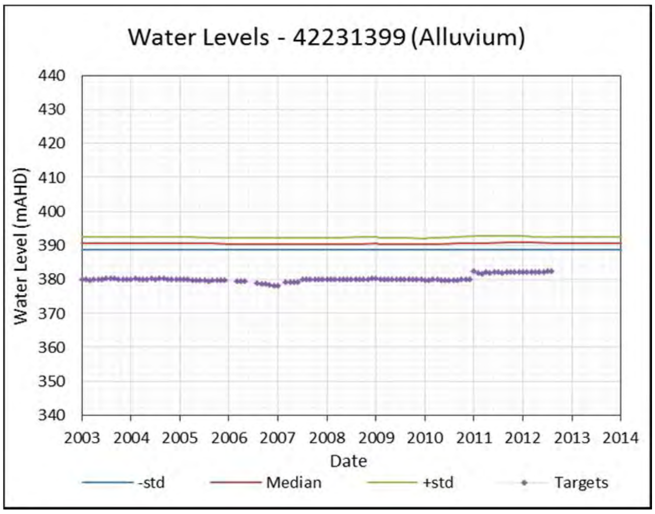

Water Levels - 42231308 (Alluvium)
440
430
420
410
400
390
380
370
360
350
340
Water Level (mAHD)
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

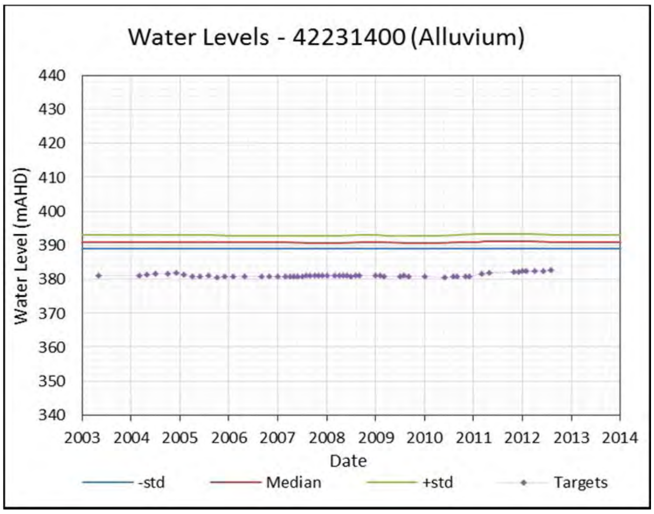

Water Levels - 42231308 (Alluvium)
440
430
420
410
400
390
380
370
360
350
340
Water Level (mAHD)
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

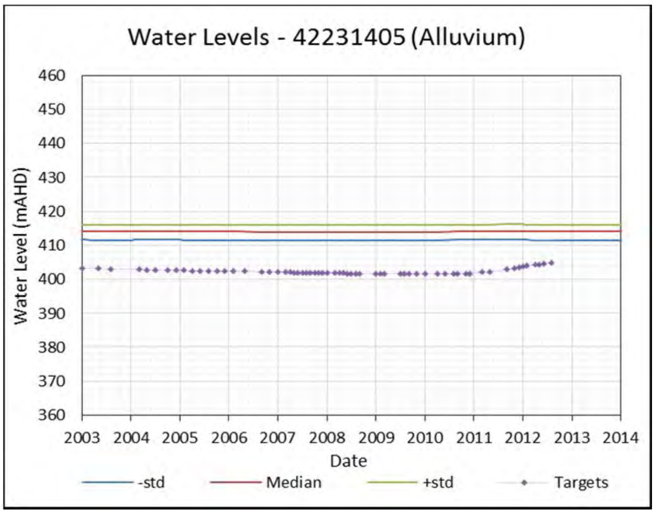

Water Levels - 42231309 (Alluvium)
430
420
410
400
390
380
370
360
350
340
330
Water Level (mAHD)
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

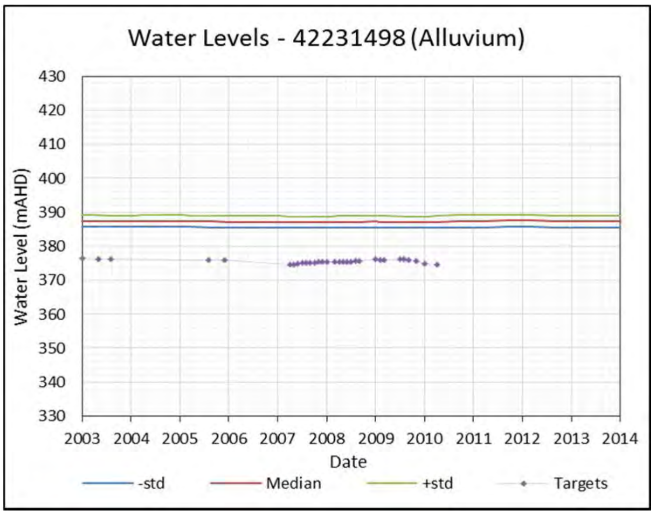

Water Levels - 42231397 (Alluvium)
430
420
410
400
390
380
370
360
350
340
330
Water Level (mAHD)
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets


Water Levels - 42231398 (Alluvium)
Water Level (mAHD)
430
420
410
400
390
380
370
360
350
340
330
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

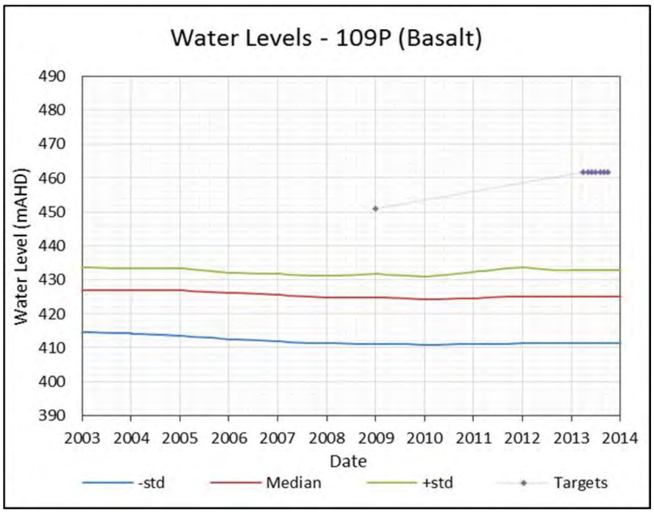

Water Levels - 42231399 (Alluvium)
Water Level (mAHD)
440
430
420
410
400
390
380
370
360
350
340
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

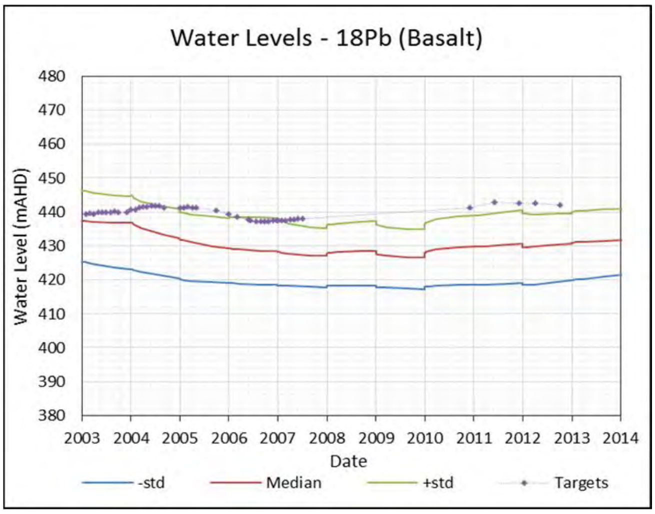

Water Levels - 42231400 (Alluvium)
Water Level (mAHD)
440
430
420
410
400
390
380
370
360
350
340
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

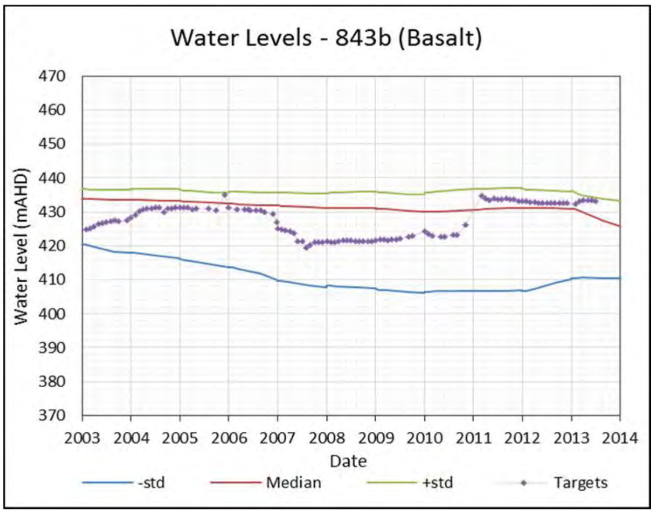

Water Levels - 42231405 (Alluvium)
Water Level (mAHD)
460
450
440
430
420
410
400
390
380
370
360
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

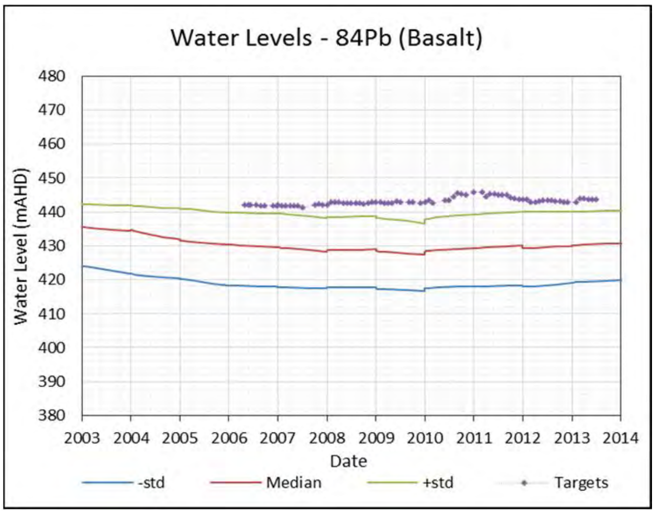

Water Levels - 42231498 (Alluvium)
Water Level (mAHD)
430
420
410
400
390
380
370
360
350
340
330
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

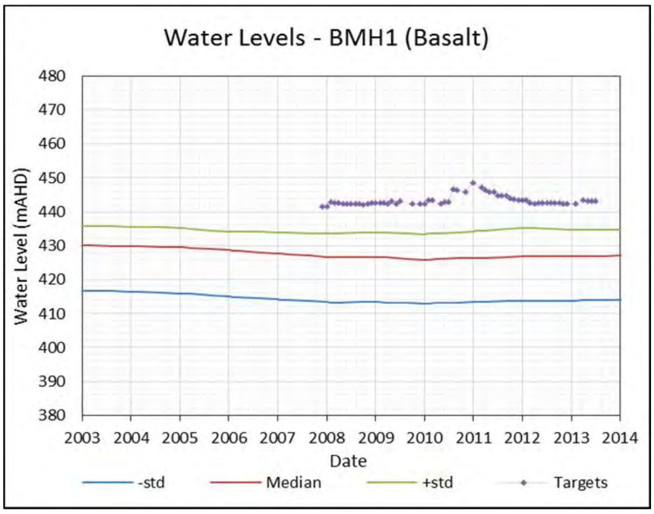
Basalt Bores

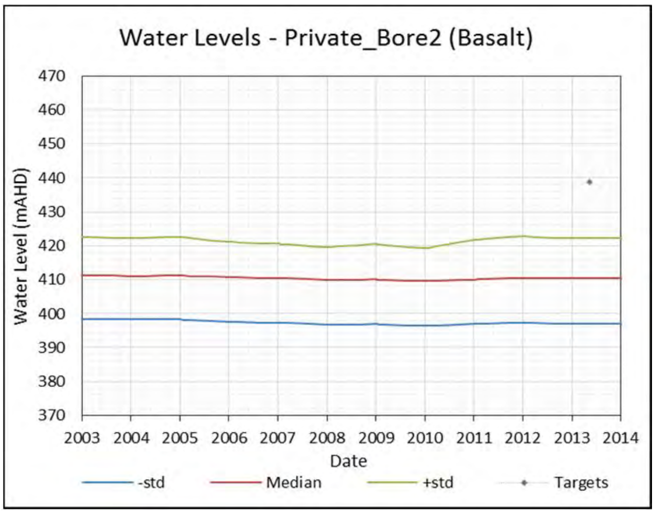

Water Levels - 109P (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

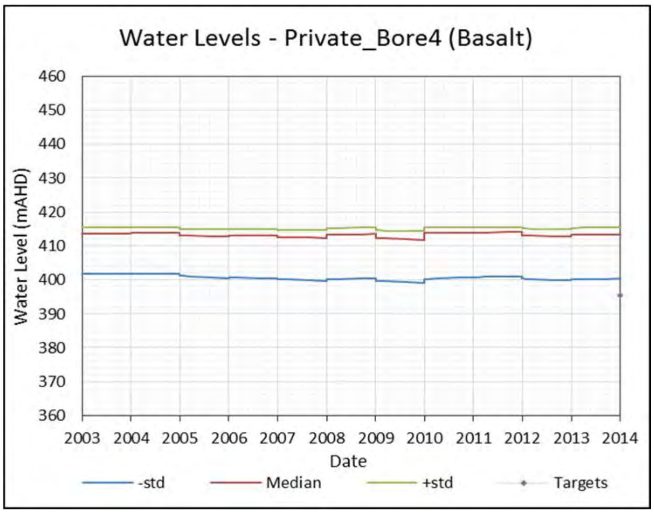

Water Levels - 18Pb (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

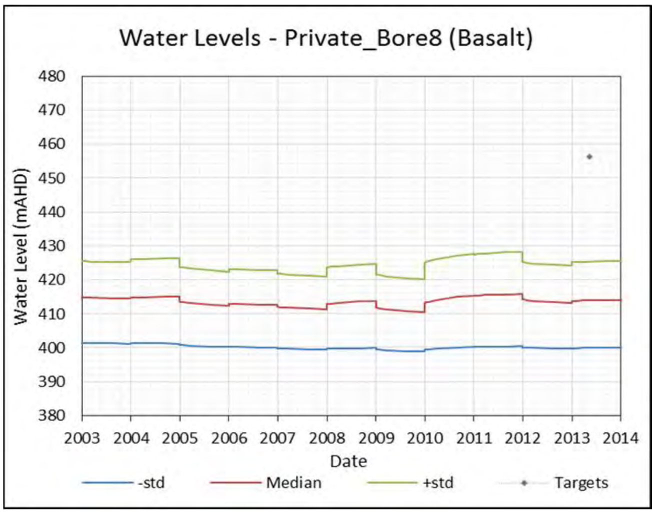

Water Levels - 843b (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

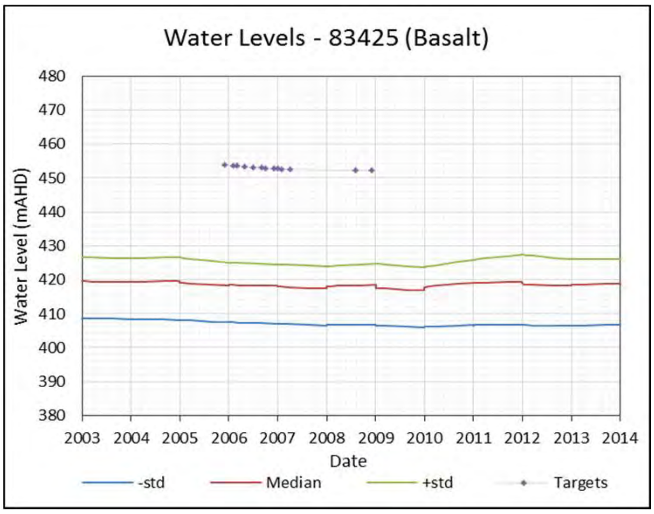

Water Levels - 84Pb (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

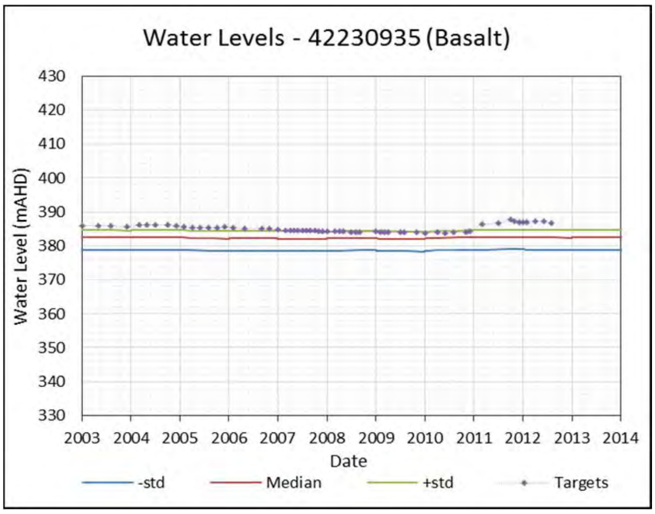

Water Levels - BMH1 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

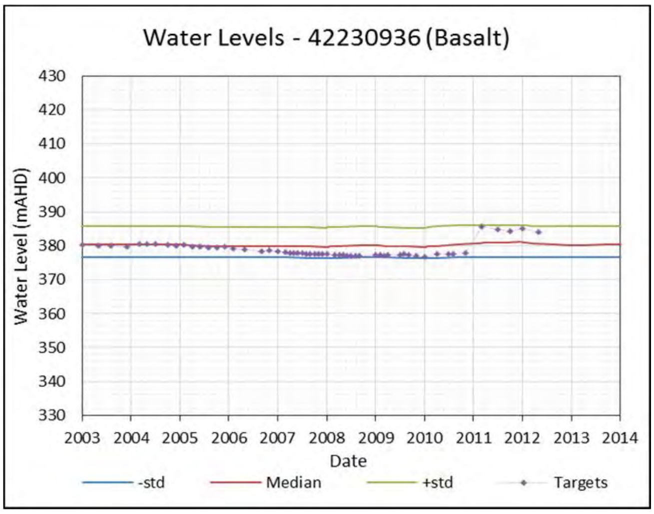

Water Levels - Private_Bore2 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

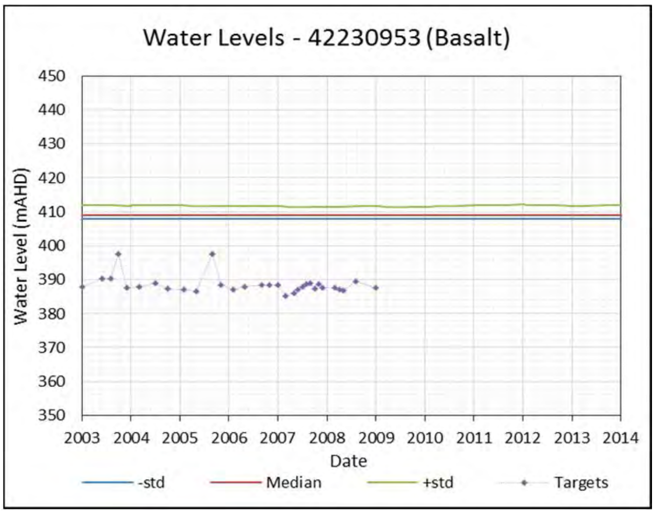

Water Levels - Private_Bore4 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

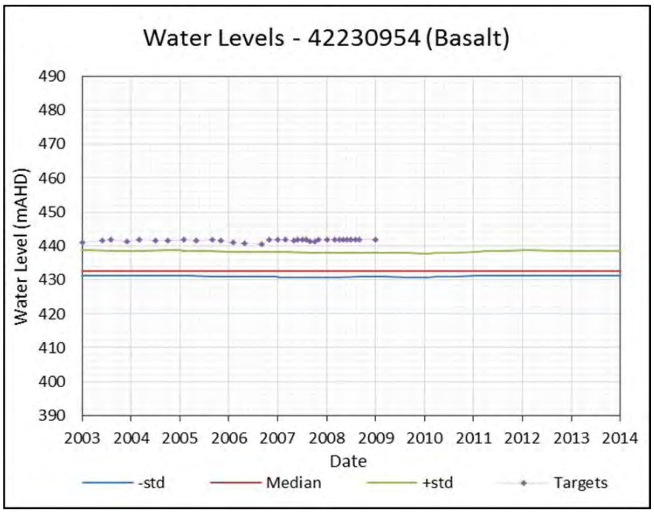

Water Levels - Private_Bore8 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

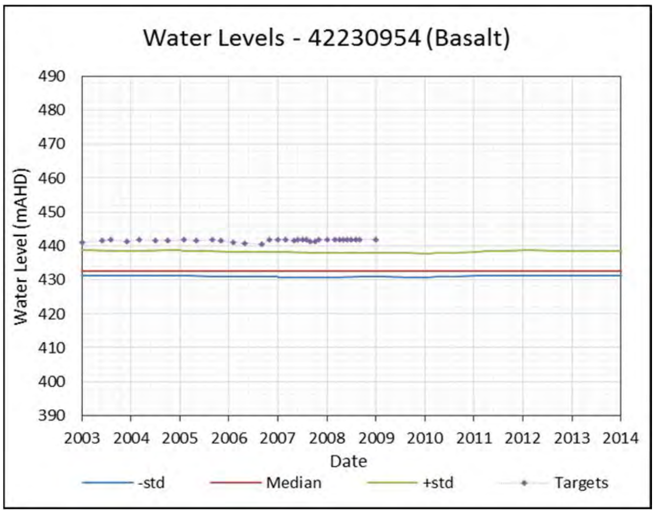

Water Levels - 83425 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

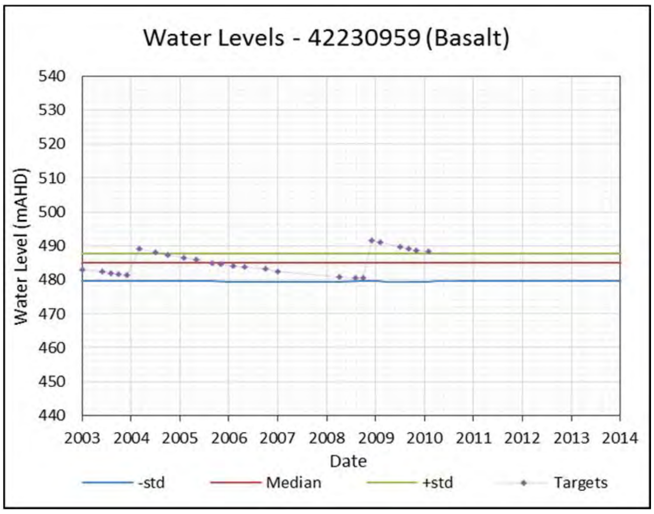

Water Levels - 42230935 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

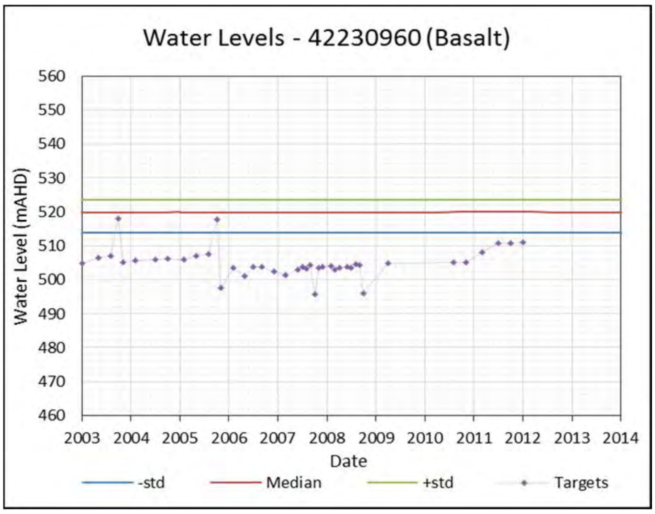

Water Levels - 42230936 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

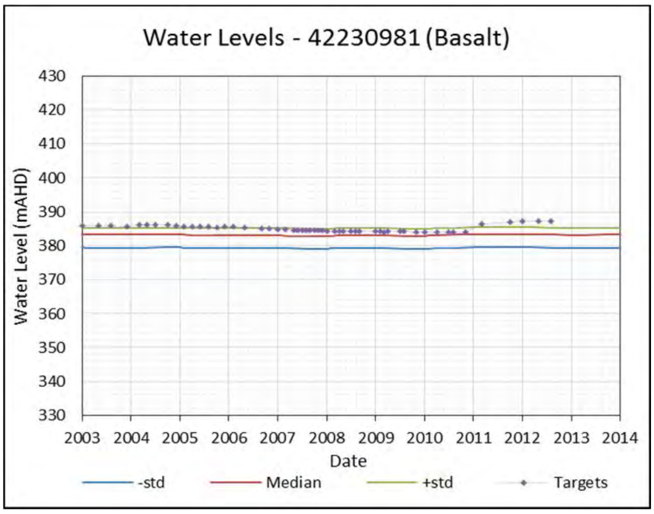

Water Levels - 42230953 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

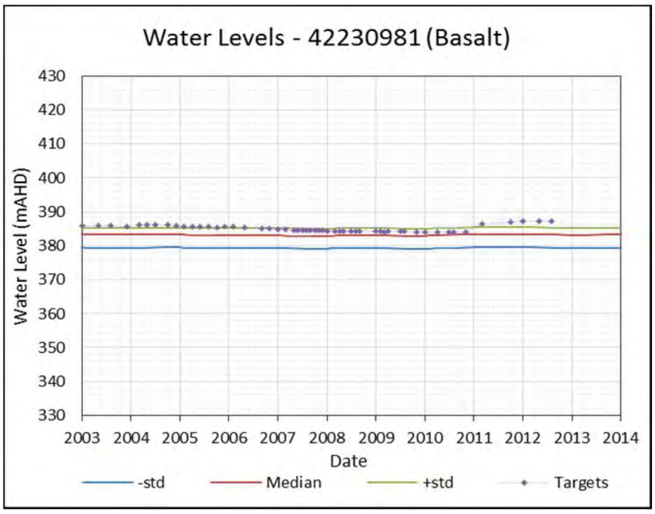

Water Levels - 42230954 (Basalt)
Water Level (mAHD)
490
480
470
460
450
440
430
420
410
400
390
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

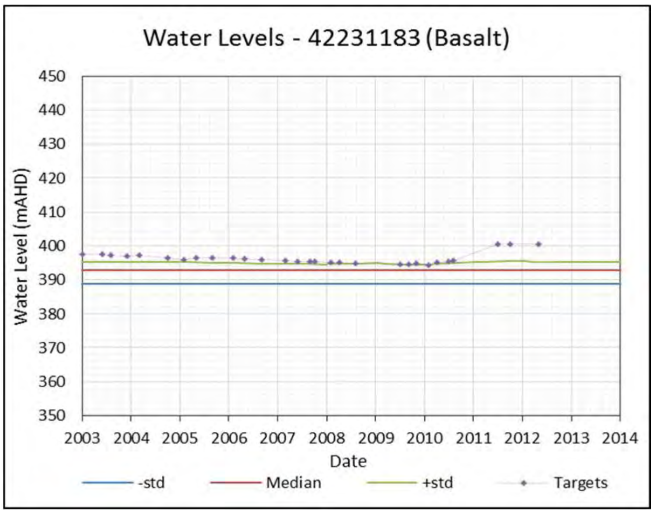

Water Levels - 42230954 (Basalt)
Water Level (mAHD)
490
480
470
460
450
440
430
420
410
400
390
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

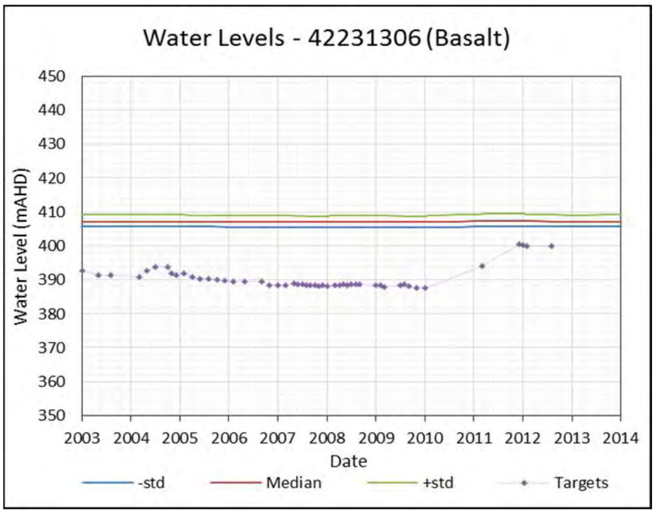

Water Levels - 42230959 (Basalt)
Water Level (mAHD)
540
530
520
510
500
490
480
470
460
450
440
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

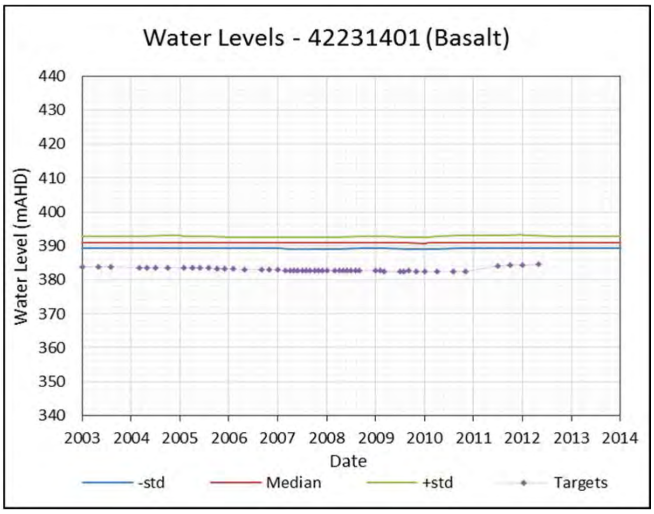

Water Levels - 42230960 (Basalt)
Water Level (mAHD)
560
550
540
530
520
510
500
490
480
470
460
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

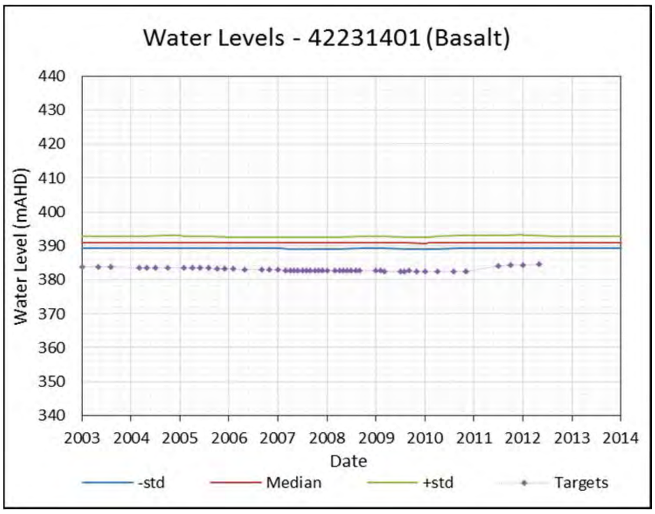

Water Levels - 42230981 (Basalt)
Water Level (mAHD)
430
420
410
400
390
380
370
360
350
340
330
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

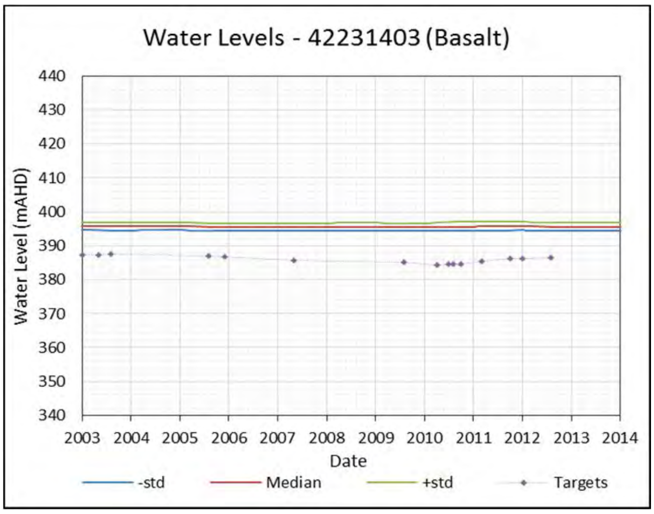

Water Levels - 42230981 (Basalt)
Water Level (mAHD)
430
420
410
400
390
380
370
360
350
340
330
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

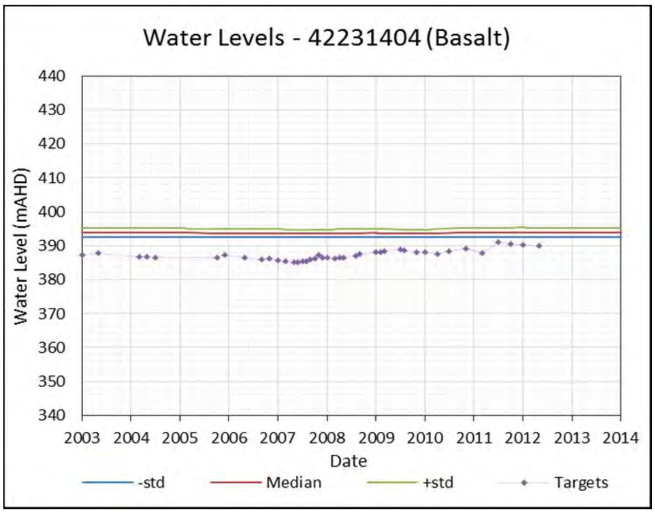

Water Levels - 42231183 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

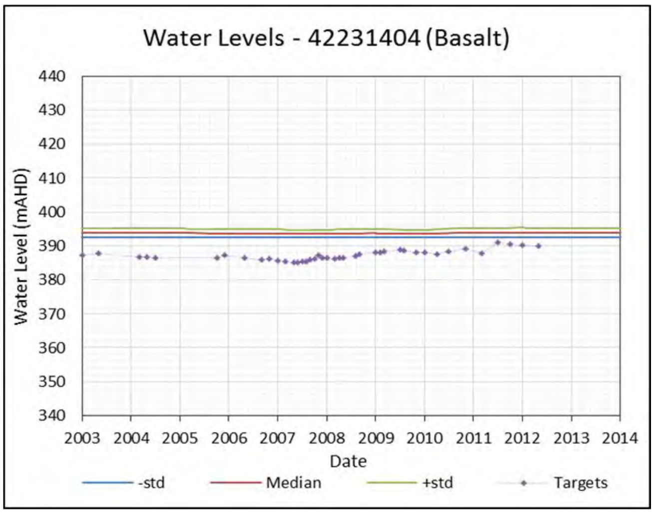

Water Levels - 42231306 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

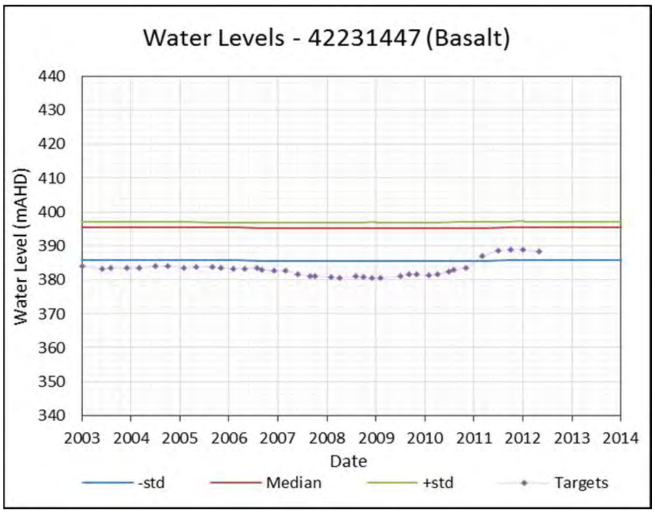

Water Levels - 42231401 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

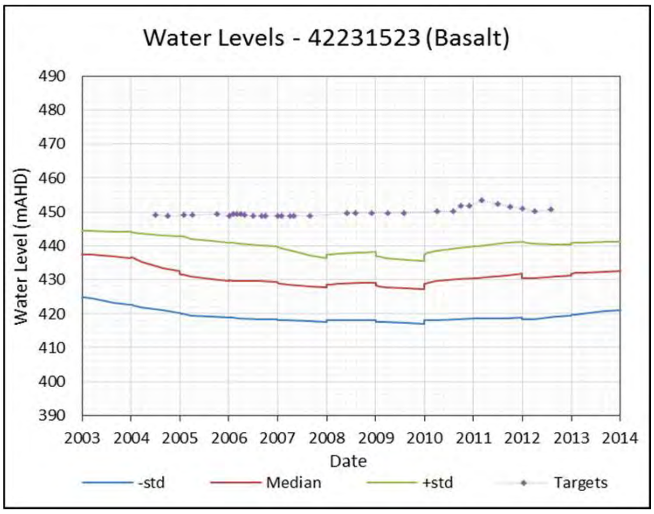

Water Levels - 42231401 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

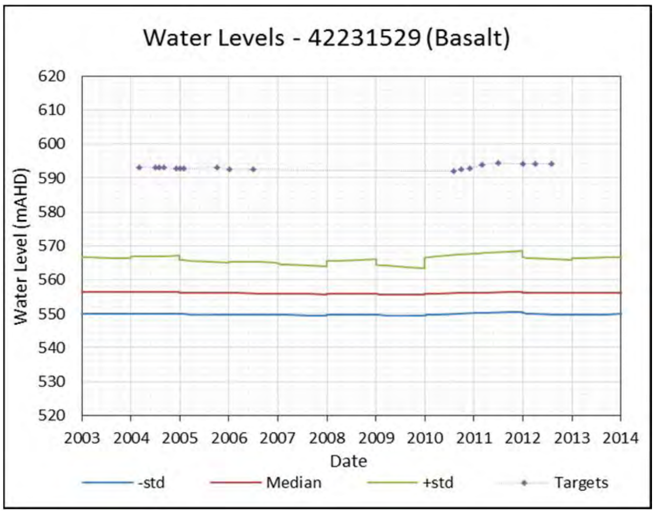

Water Levels - 42231403 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

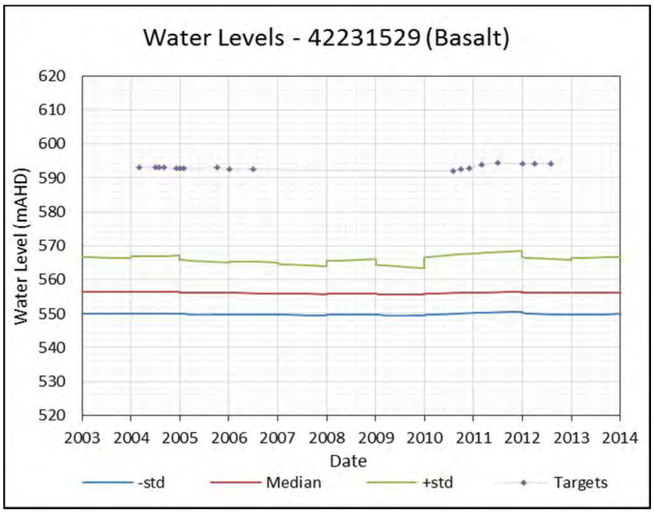

Water Levels - 42231404 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

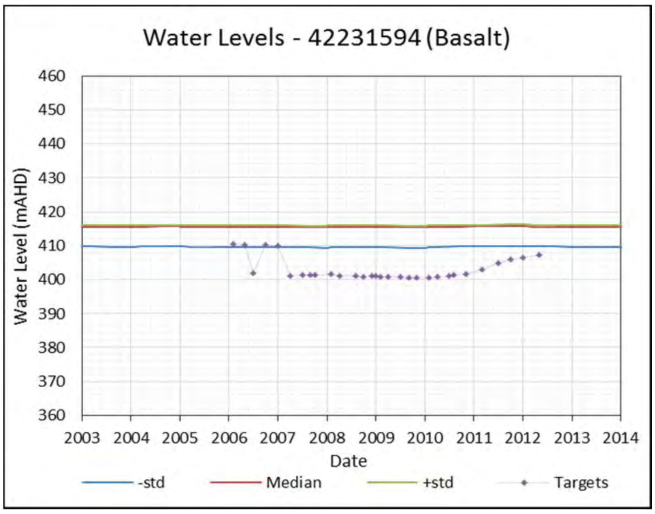

Water Levels - 42231404 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

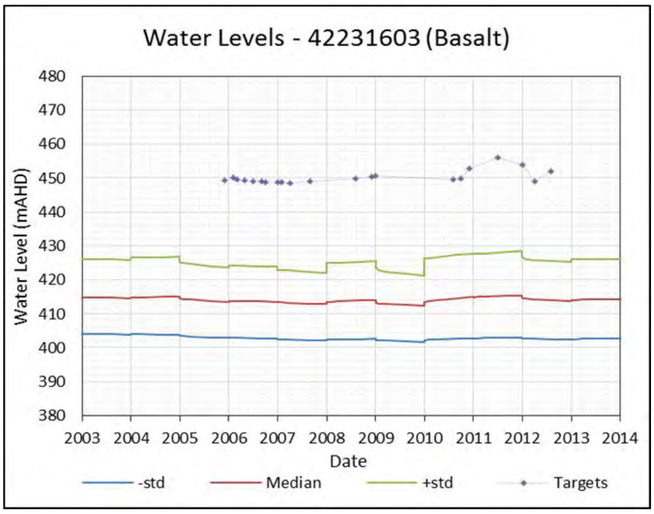

Water Levels - 42231447 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets


Water Levels - 42231523 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

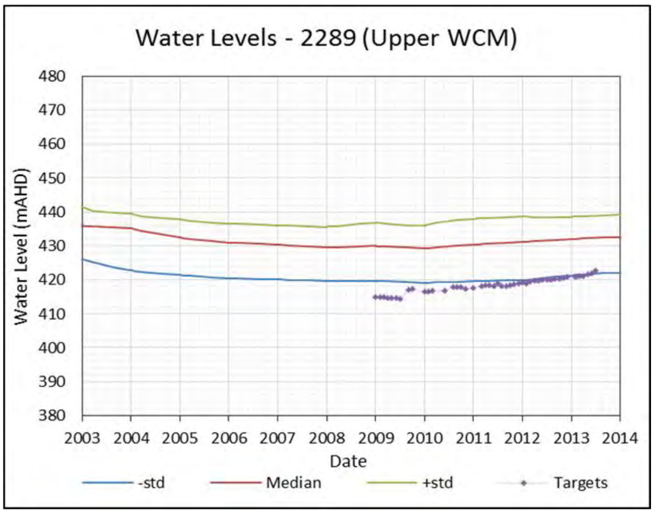

Water Levels - 42231529 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

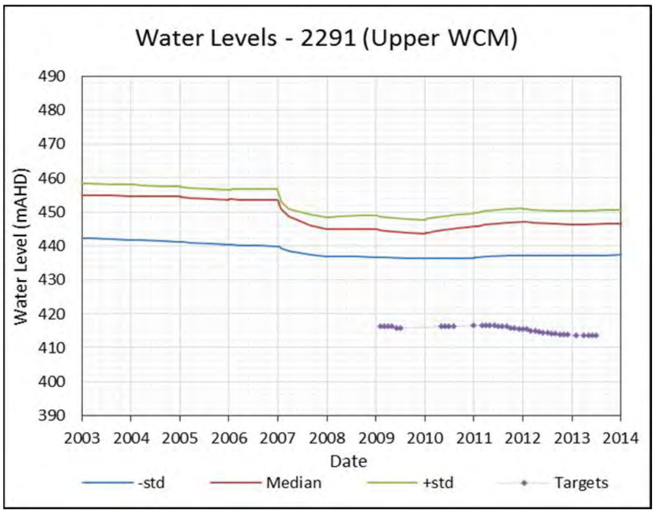

Water Levels - 42231529 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

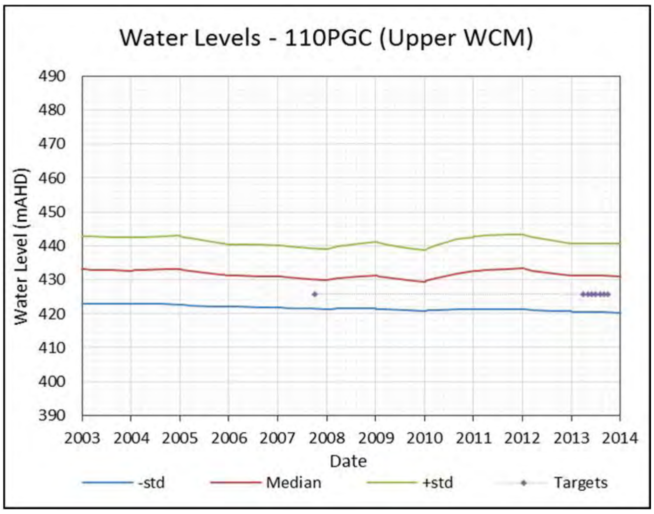

Water Levels - 42231594 (Basalt)
Water Level (mAHD)
Date
-std
Median
+std
Targets

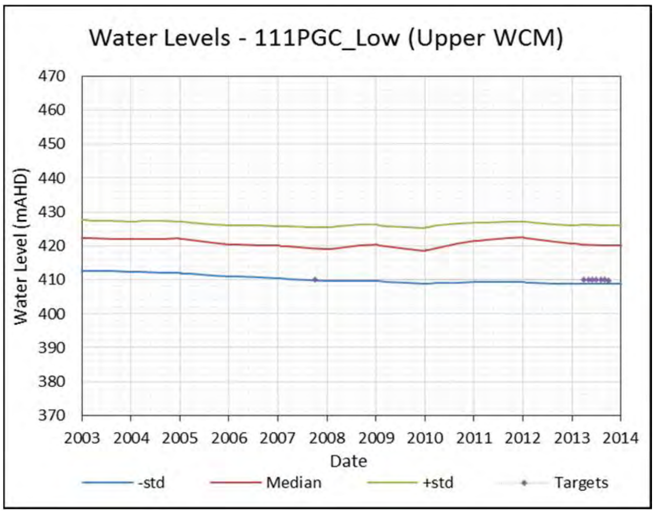

Water Levels - 42231603 (Basalt)
Water Level (mAHD)
480
470
460
450
440
430
420
410
400
390
380
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

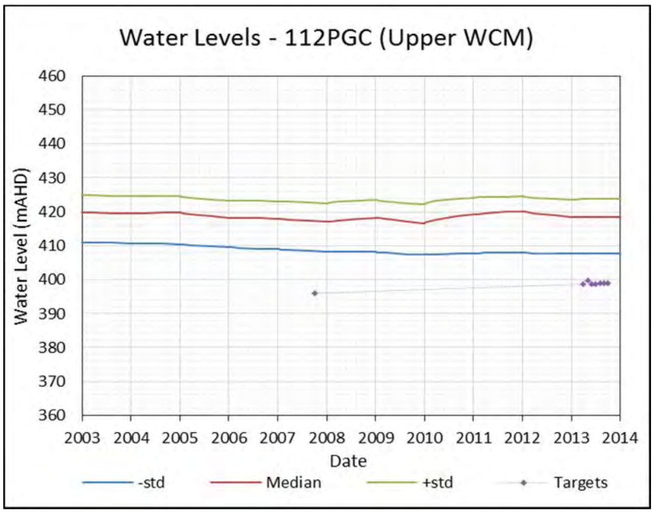
Upper Walloon Coal Measures Bores

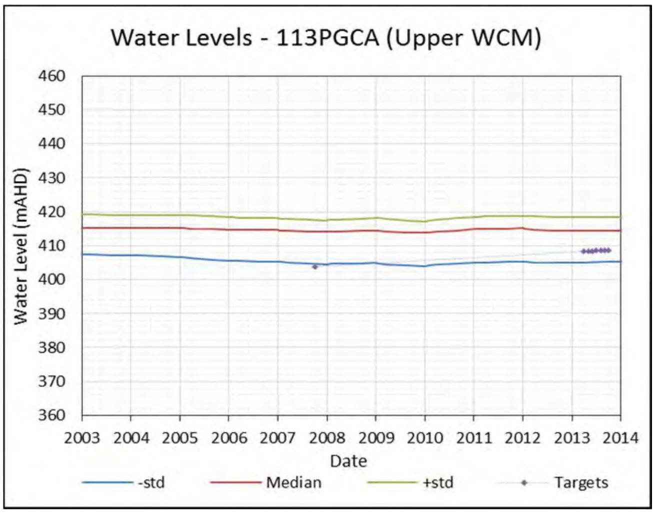

Water Levels - 2289 (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

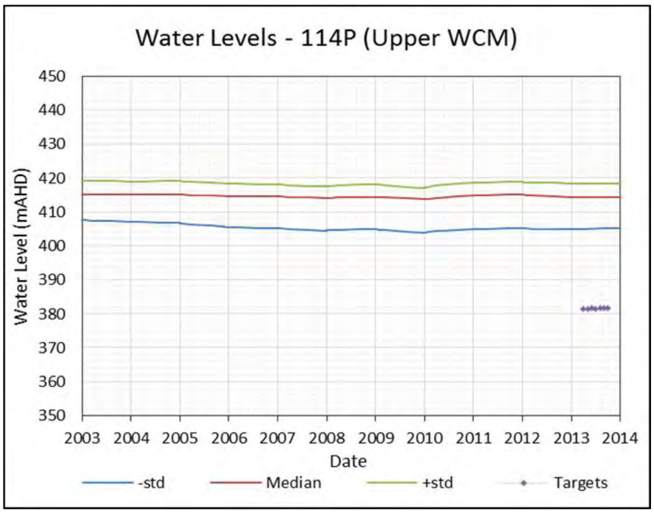

Water Levels - 2291 (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

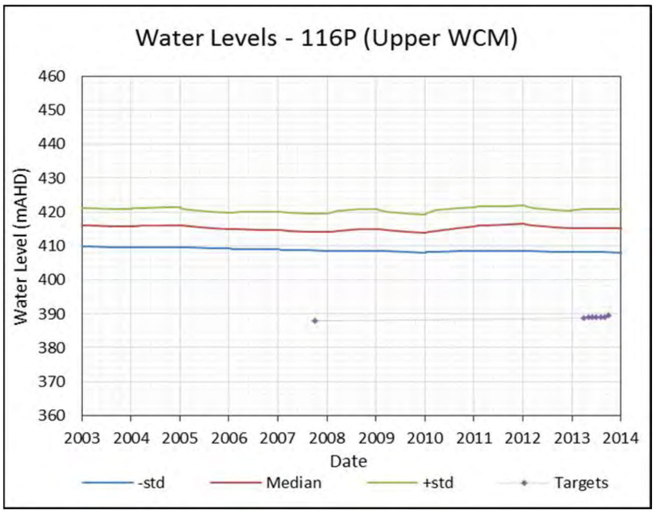

Water Levels - 110PGC (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

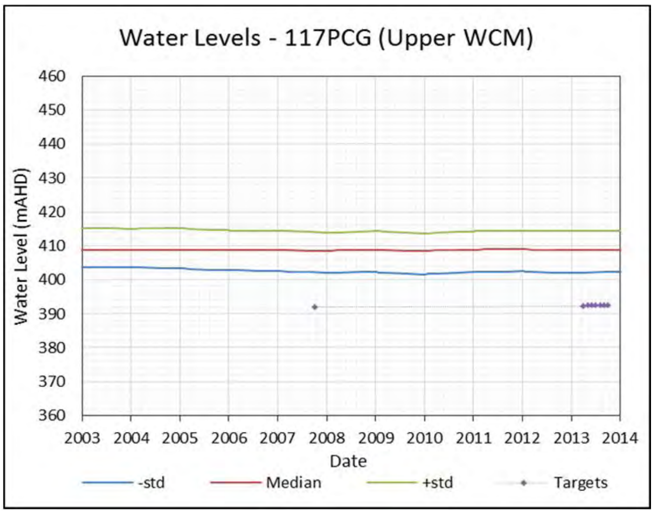

Water Levels - 111PGC_Low (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

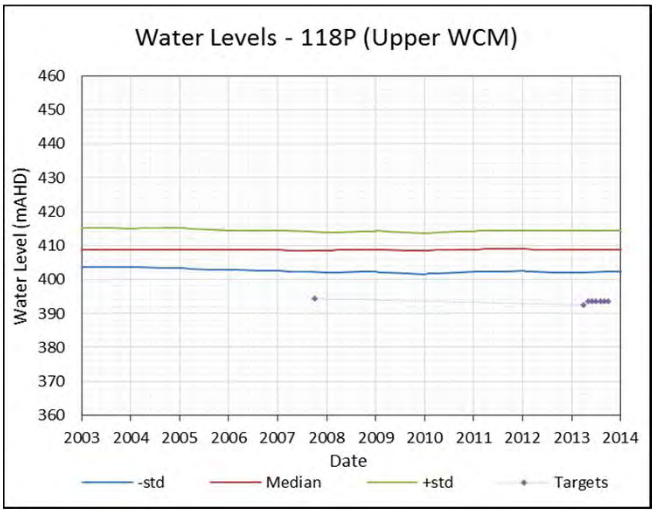

Water Levels - 112PGC (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

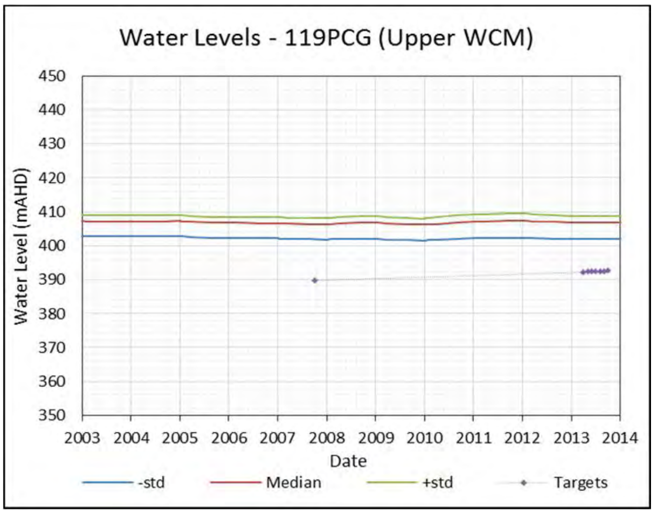

Water Levels - 113PGCA (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

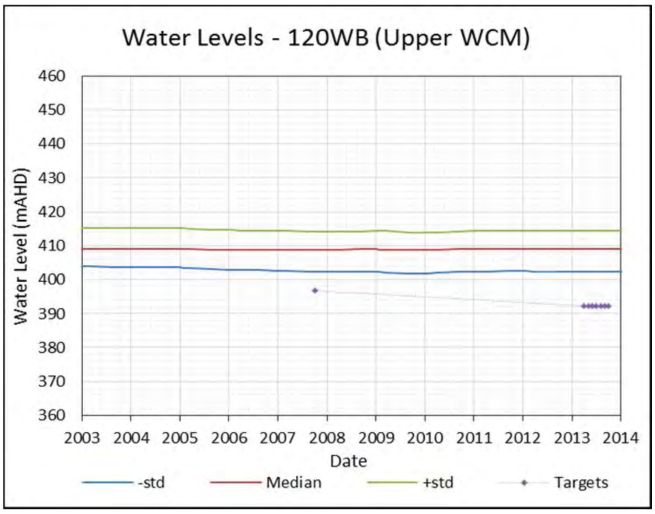

Water Levels - 114P (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

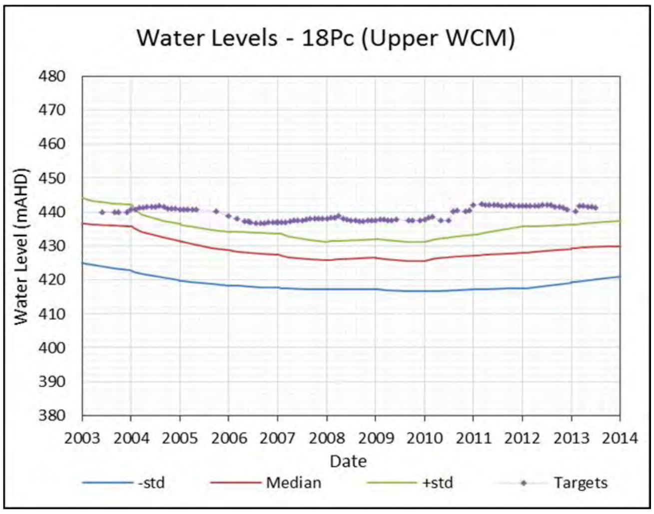

Water Levels - 116P (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

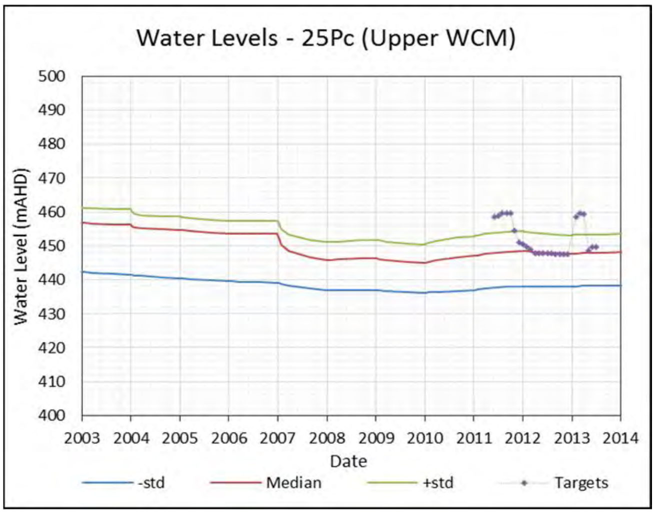

Water Levels - 117PCG (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

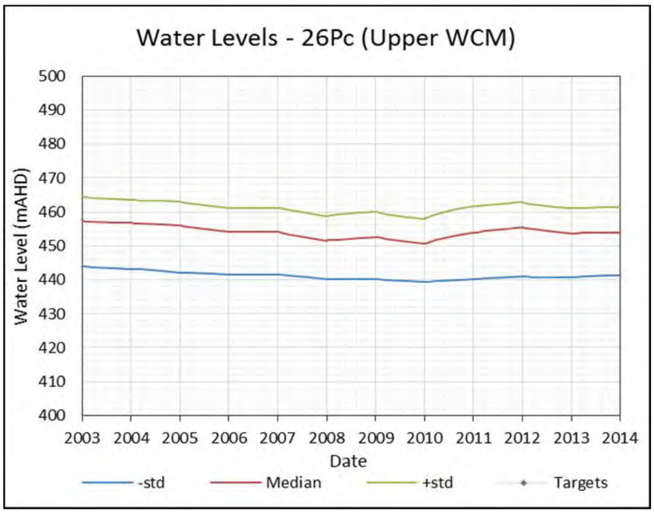

Water Levels - 118P (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

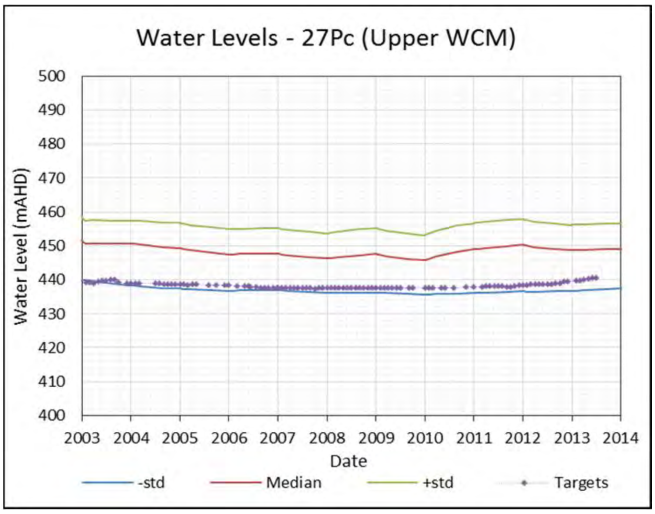

Water Levels - 119PCG (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

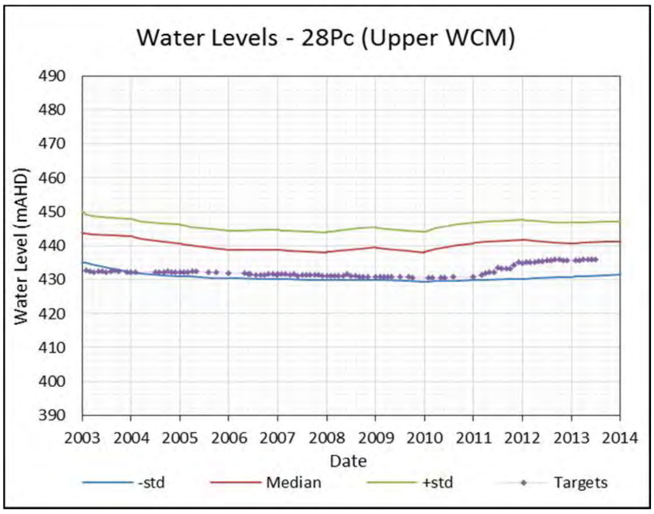

Water Levels - 120WB (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

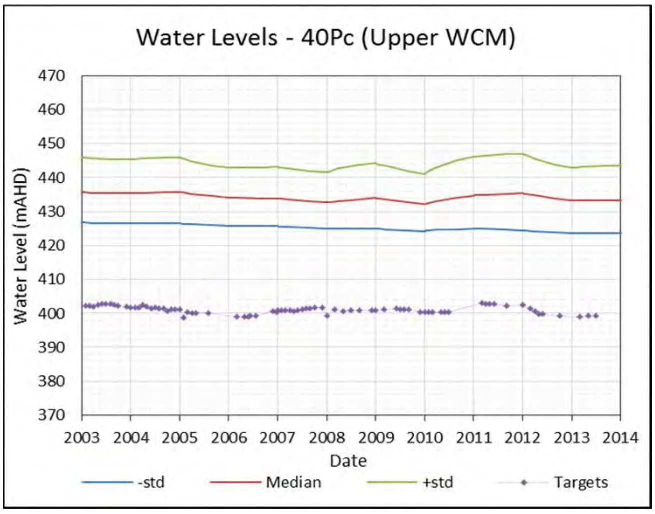

Water Levels - 18Pc (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

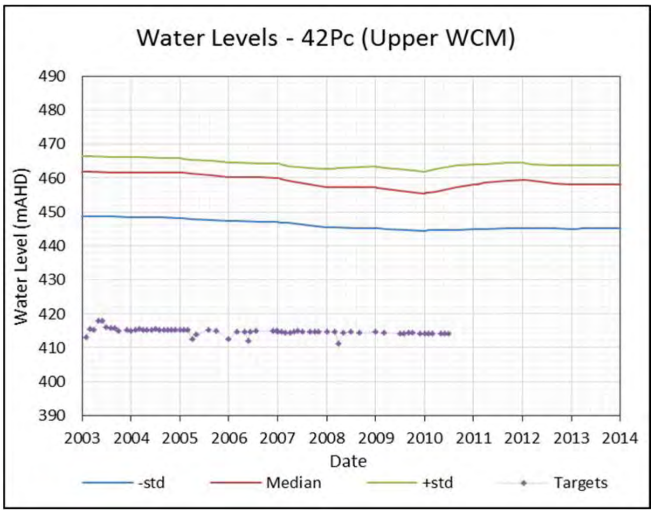

Water Levels - 25Pc (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

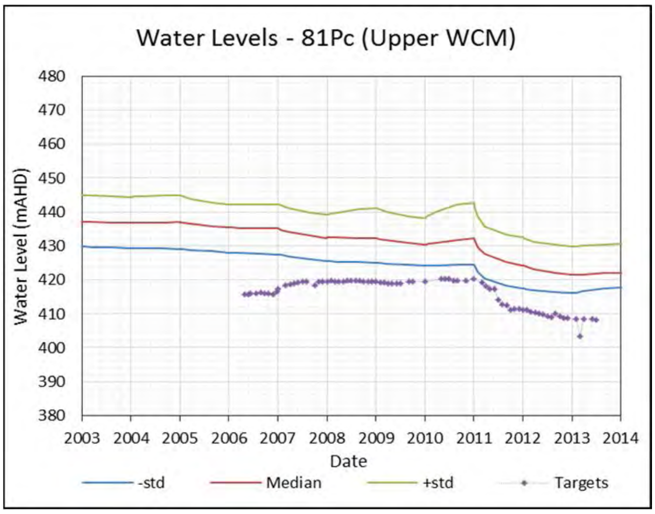

Water Levels - 26Pc (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

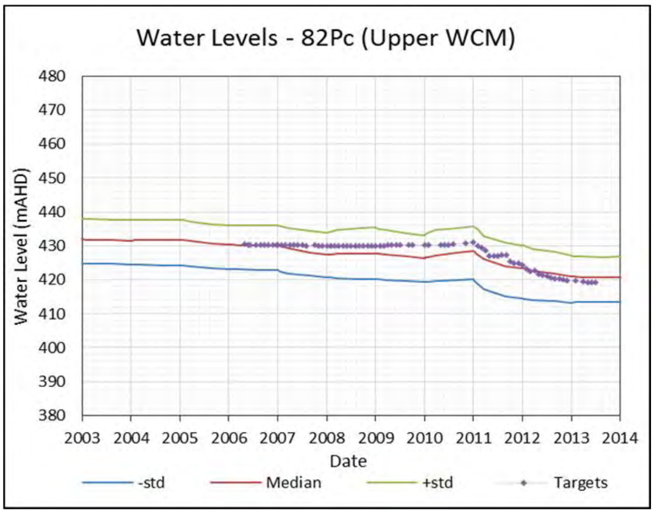

Water Levels - 27Pc (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

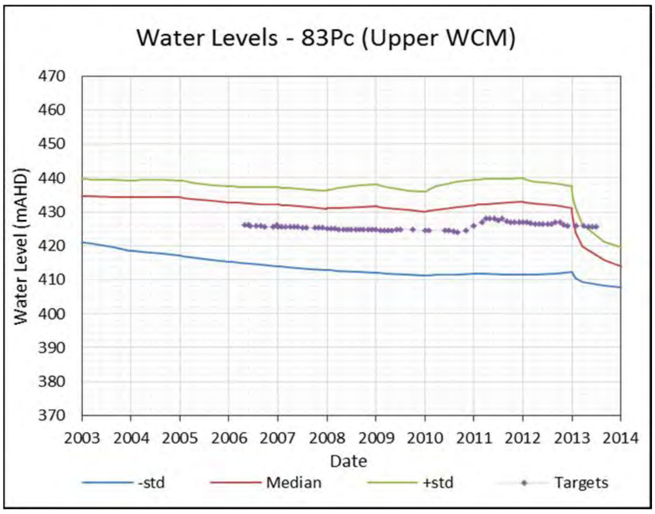

Water Levels - 28Pc (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

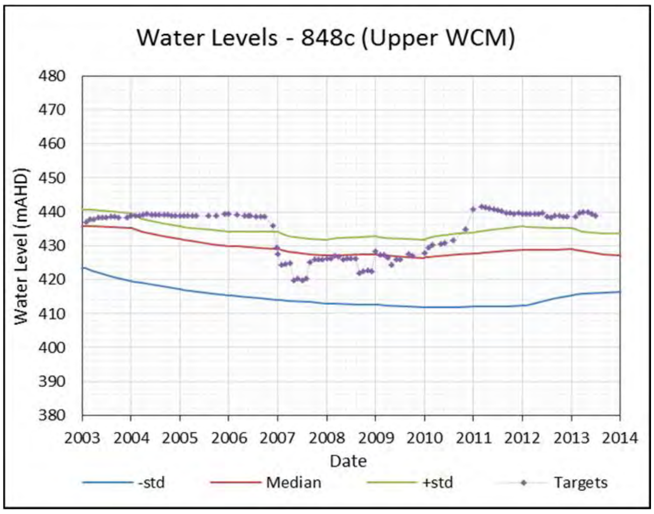

Water Levels - 40Pc (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

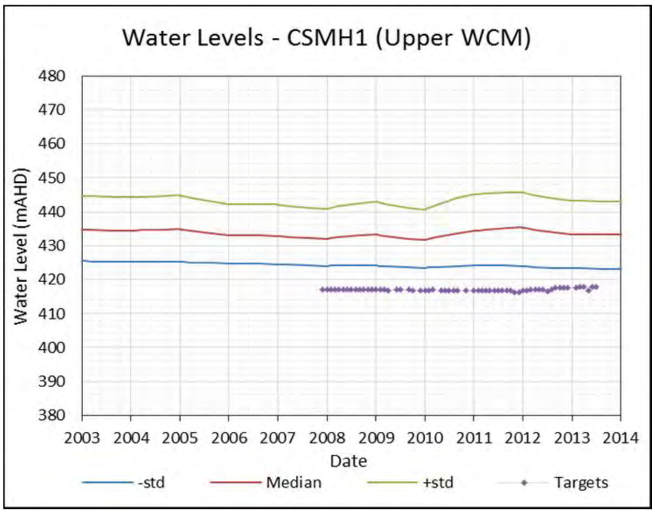

Water Levels - 42Pc (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

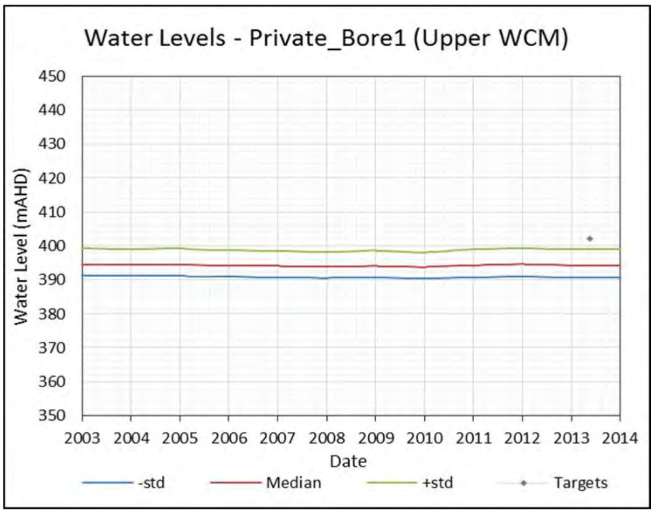

Water Levels - 81Pc (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

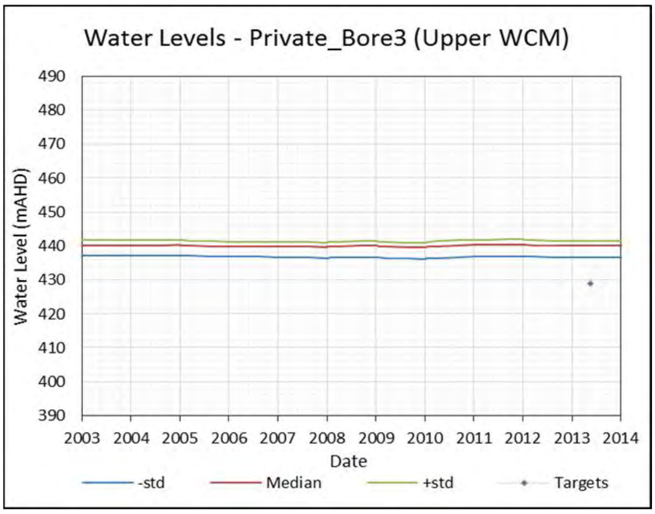

Water Levels - 82Pc (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

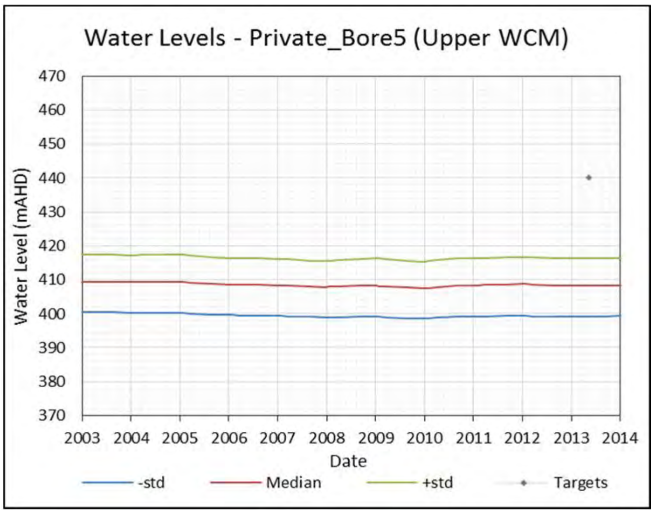

Water Levels - 83Pc (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

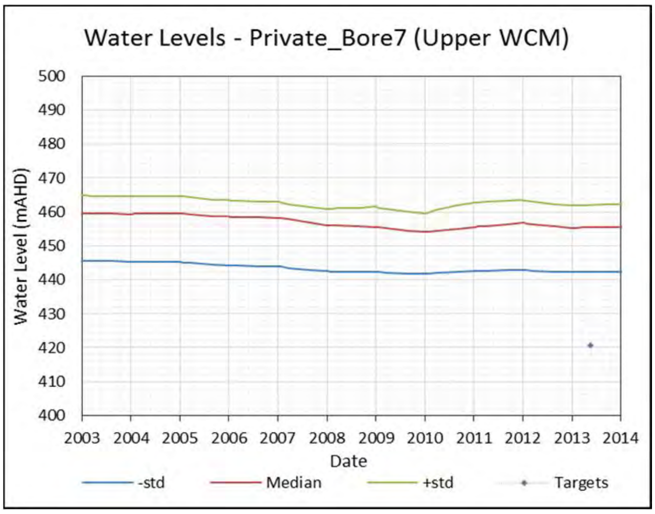

Water Levels - 848c (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

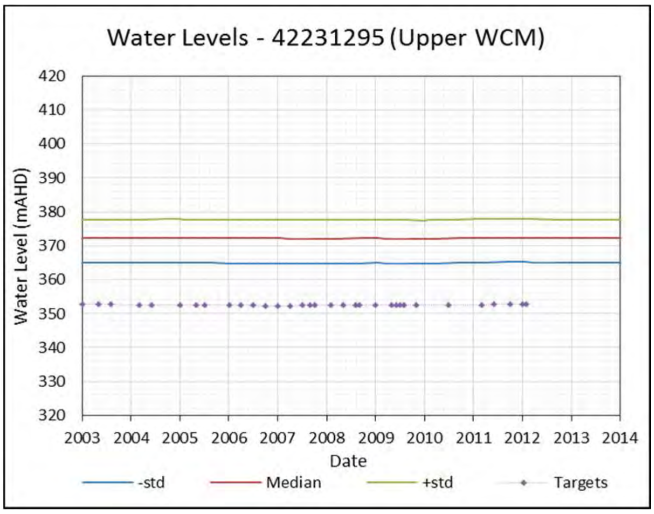

Water Levels - CSMH1 (Upper WCM)
Water Level (mAHD)
Date
-std
Median
+std
Targets

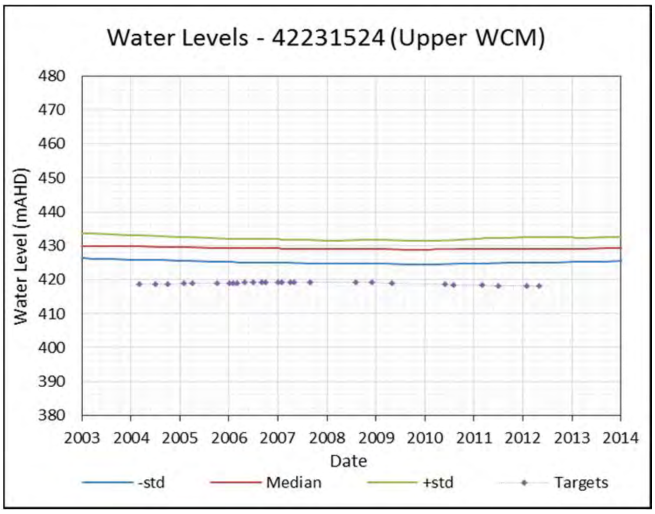

Water Levels - Private_Bore1 (Upper WCM)
Water Level (mAHD)
450
440
430
420
410
400
390
380
370
360
350
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets


Water Levels - Private_Bore3 (Upper WCM)
Water Level (mAHD)
490
480
470
460
450
440
430
420
410
400
390
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

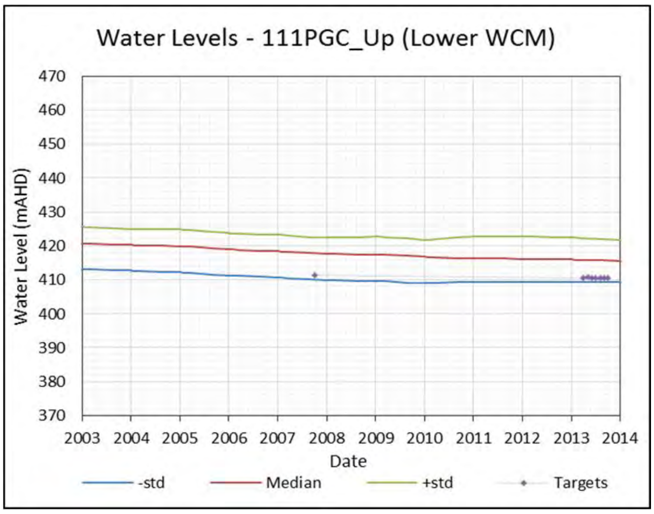

Water Levels - Private_Bore5 (Upper WCM)
Water Level (mAHD)
470
460
450
440
430
420
410
400
390
380
370
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

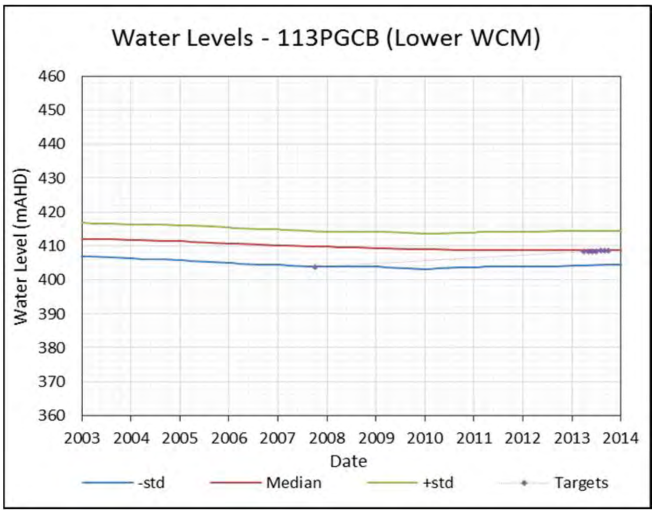

Water Levels - Private_Bore7 (Upper WCM)
Water Level (mAHD)
500
490
480
470
460
450
440
430
420
410
400
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets


Water Levels - 42231295 (Upper WCM)
Water Level (mAHD)
420
410
400
390
380
370
360
350
340
330
320
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

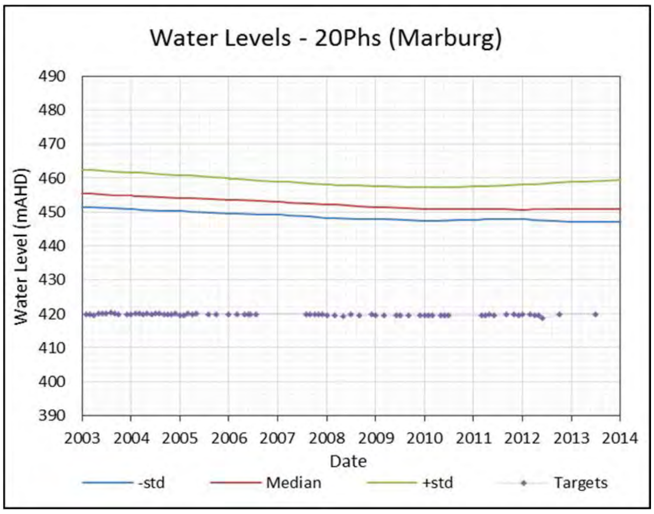

Water Levels - 42231524 (Upper WCM)
Water Level (mAHD)
480
470
460
450
440
430
420
410
400
390
380
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

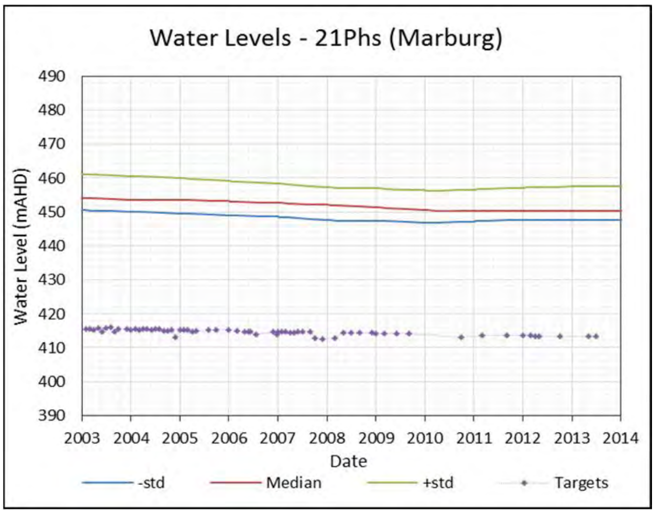
Lower Walloon Coal Measures Bores

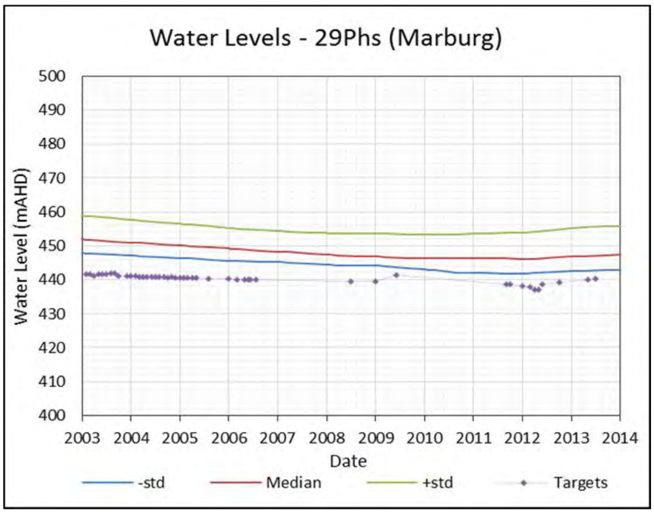

Water Levels - 111PGC_Up (Lower WCM)
Water Level (mAHD)
470
460
450
440
430
420
410
400
390
380
370
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

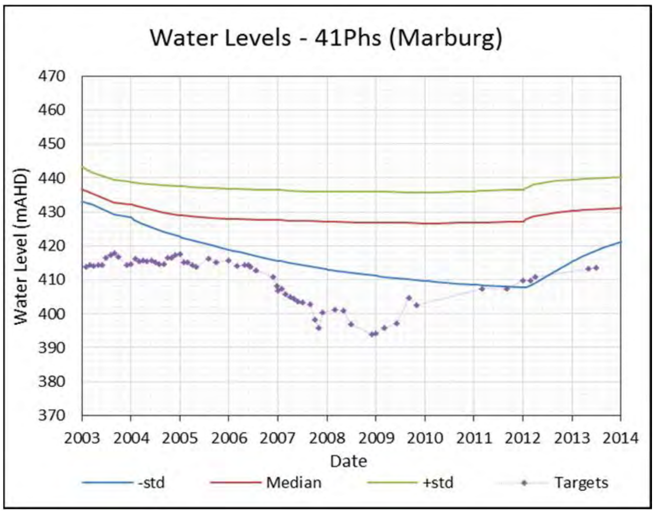

Water Levels - 113PGCB (Lower WCM)
Water Level (mAHD)
460
450
440
430
420
410
400
390
380
370
360
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

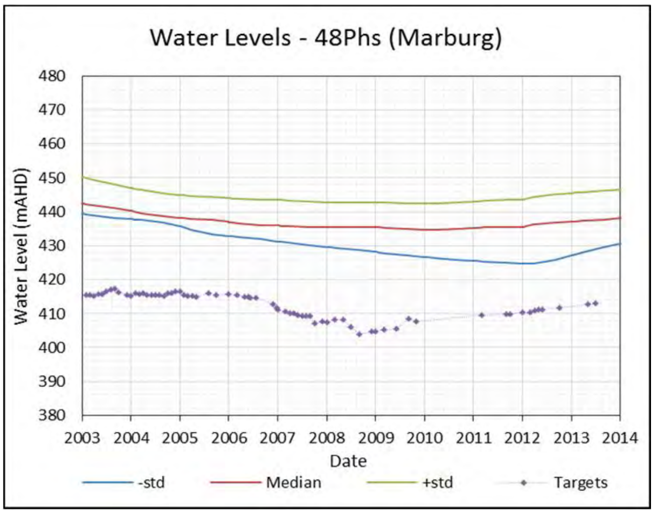
Marburg Sandstone Bores

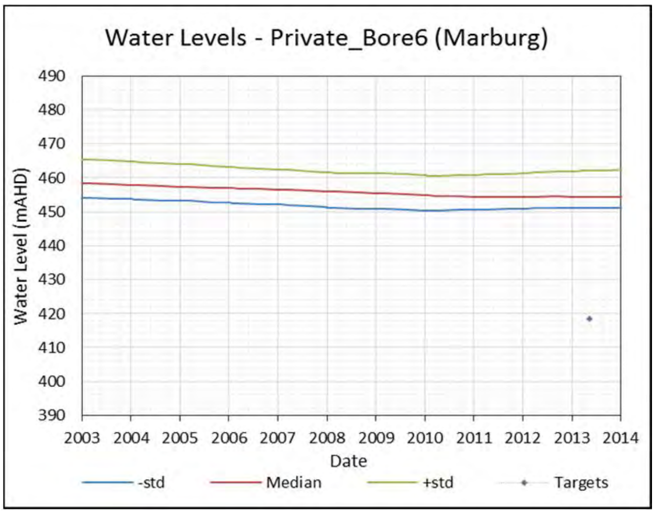

Water Levels - 20Phs (Marburg)
Water Level (mAHD)
490
480
470
460
450
440
430
420
410
400
390
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

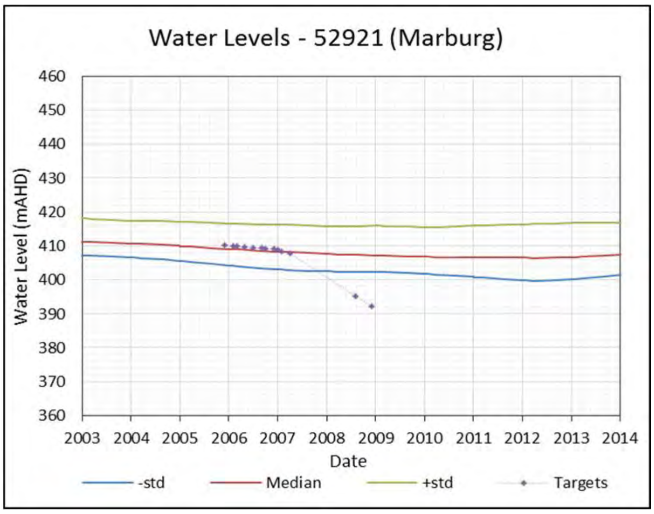

Water Levels - 21Phs (Marburg)
Water Level (mAHD)
490
480
470
460
450
440
430
420
410
400
390
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

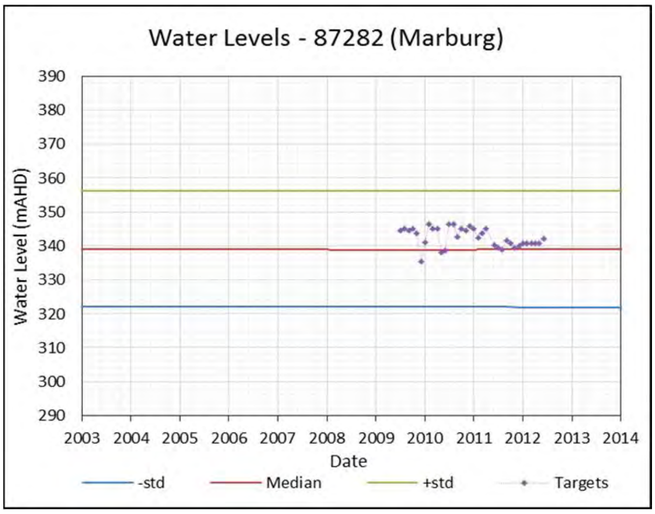

Water Levels - 29Phs (Marburg)
Water Level (mAHD)
500
490
480
470
460
450
440
430
420
410
400
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

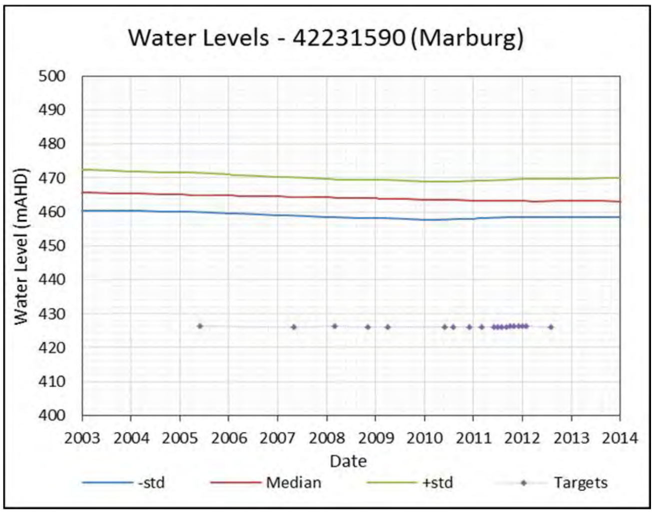

Water Levels - 41Phs (Marburg)
Water Level (mAHD)
470
460
450
440
430
420
410
400
390
380
370
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets


Water Levels - 48Phs (Marburg)
Water Level (mAHD)
480
470
460
450
440
430
420
410
400
390
380
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets

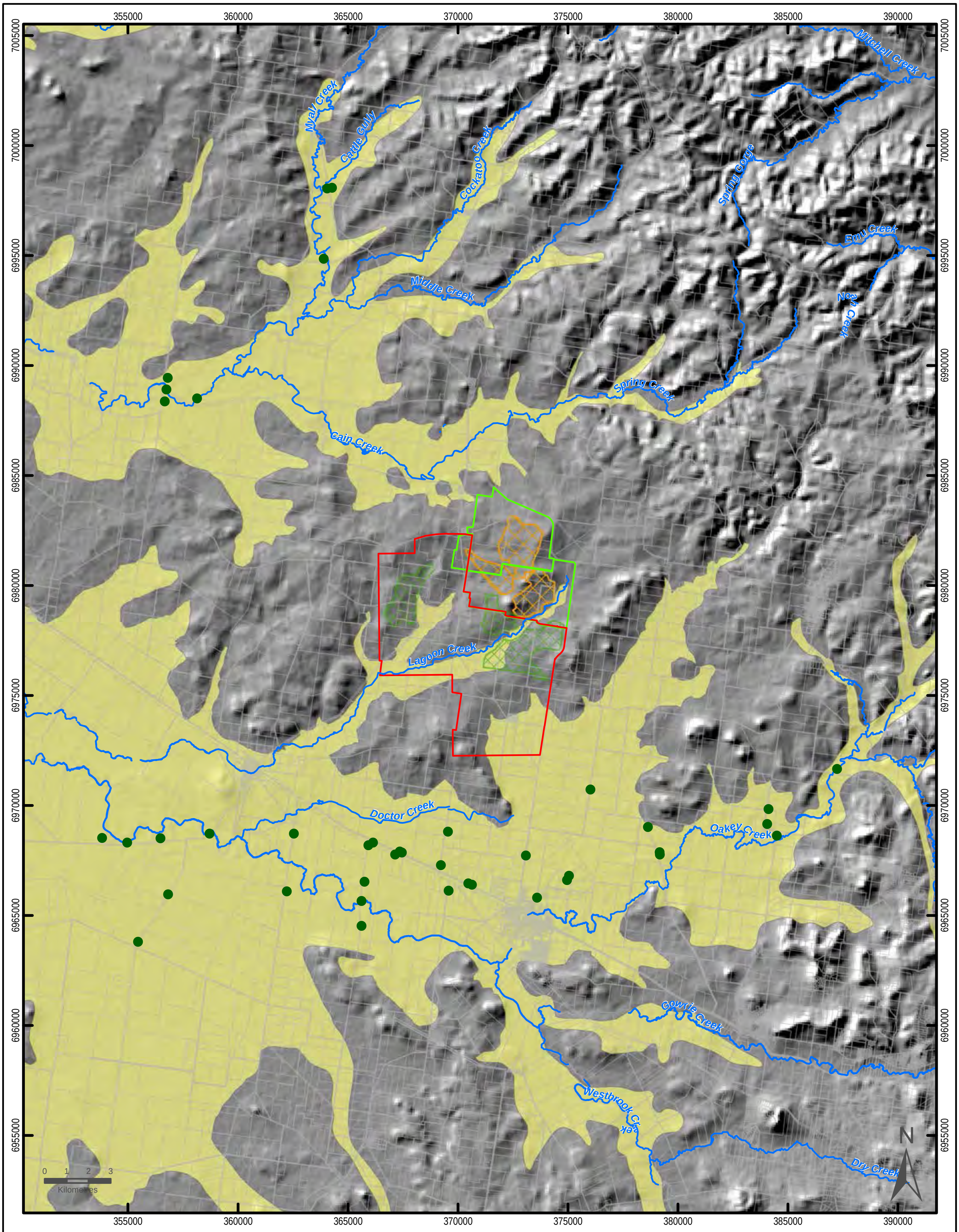

Water Levels - Private_Bore6 (Marburg)
Water Level (mAHD)
490
480
470
460
450
440
430
420
410
400
390
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Date
-std
Median
+std
Targets


Water Levels - 52921 (Marburg)
Water Level (mAHD)
Date
-std
Median
+std
Targets


Water Levels - 87282 (Marburg)
Water Level (mAHD)
Date
-std
Median
+std
Targets


Water Levels - 42231590 (Marburg)
Water Level (mAHD)
Date
-std
Median
+std
Targets

Appendix A.2 Calibration Maps



LEGEND

Alluvium Calibration Points (Bores)
Best Model Calibration Result

- < 5% SRMS
- 5 - 10% SRMS
- 10 - 25% SRMS
- 25 - 50% SRMS

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Alluvium (Qa)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

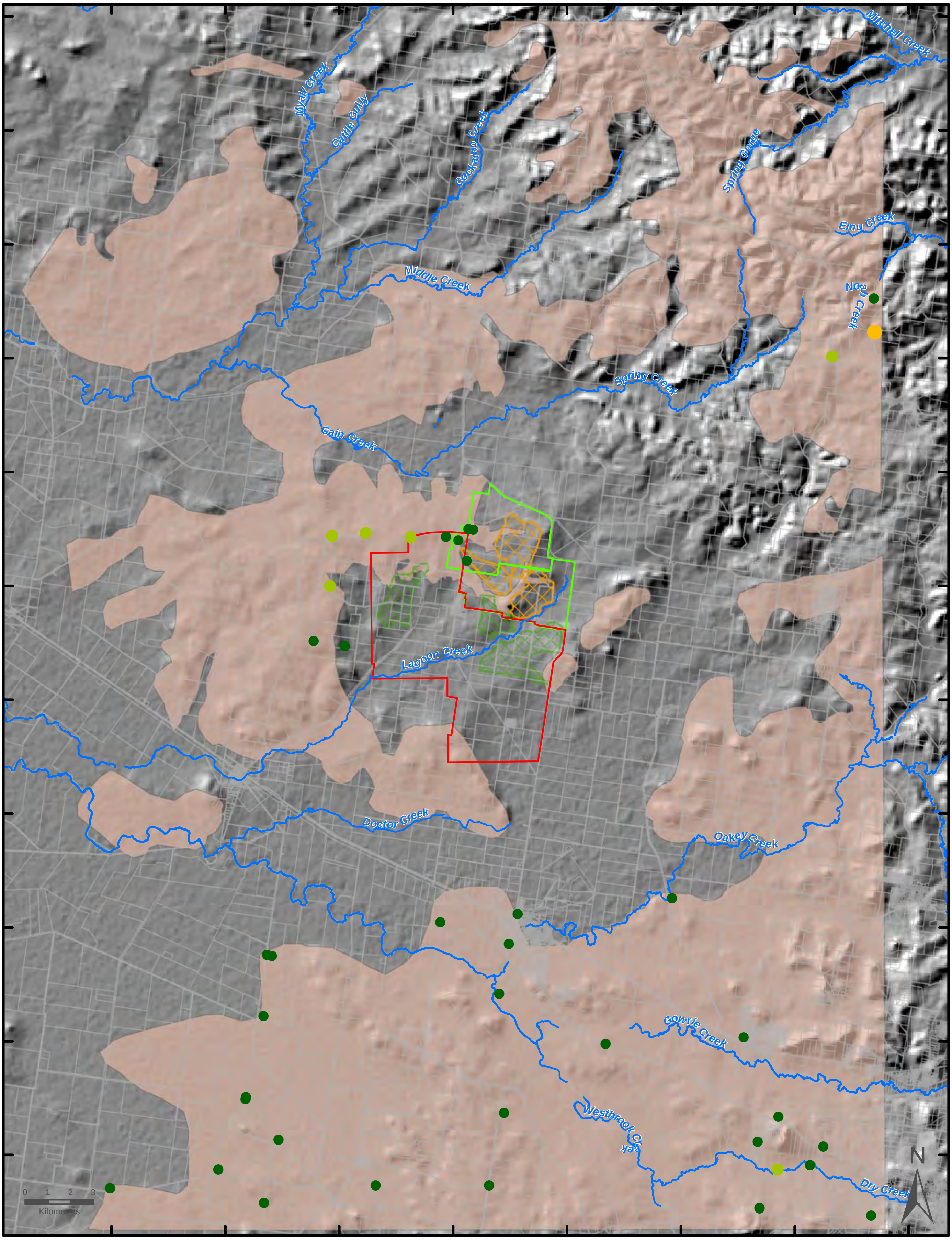
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure A2.1
Alluvium Calibration Map

Scale 1:228,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum140813_NewHope_Groundwater_FigureA2.1_CalibrationAlluvium.mxd

Produced: 28/08/2014



LEGEND

Basalt Calibration Points (Bores)
Best Model Calibration Result

- < 5% SRMS
- 5 - 10% SRMS
- 10 - 25% SRMS
- 25 - 50% SRMS

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Tertiary Basalt (Tm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

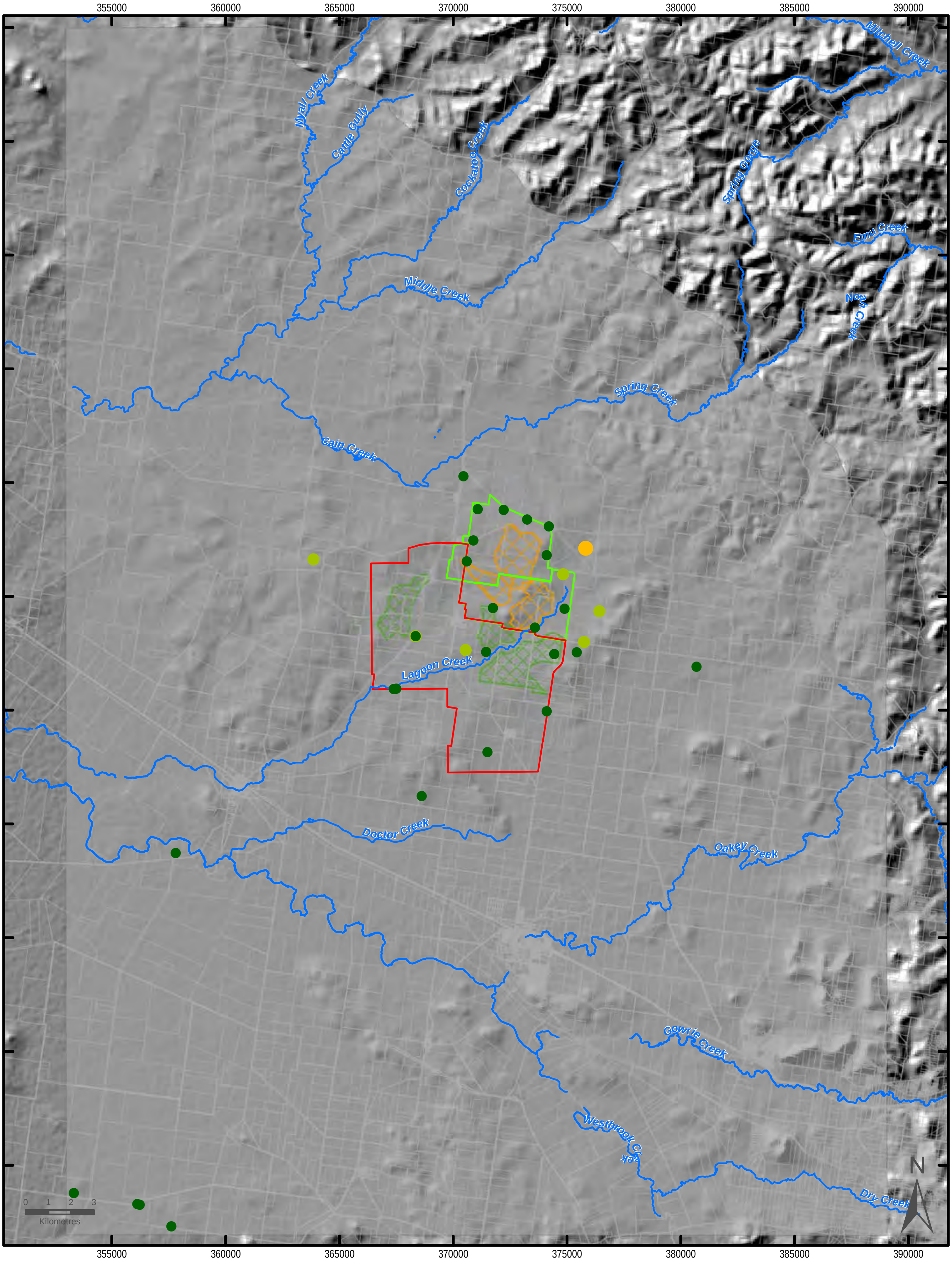
Figure A2.2 Tertiary Basalt Calibration Map

Scale 1:228,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum140813_NewHope_Groundwater_FigureA2.2_CalibrationBasalt.mxd

Produced: 29/08/2014



LEGEND

Upper WCM Calibration Points (Bores)
Best Model Calibration Result
- < 5% SRMS
- 5 - 10% SRMS
- 10 - 25% SRMS
- 25 - 50% SRMS

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents
- Walloon Subgroup (Jw)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

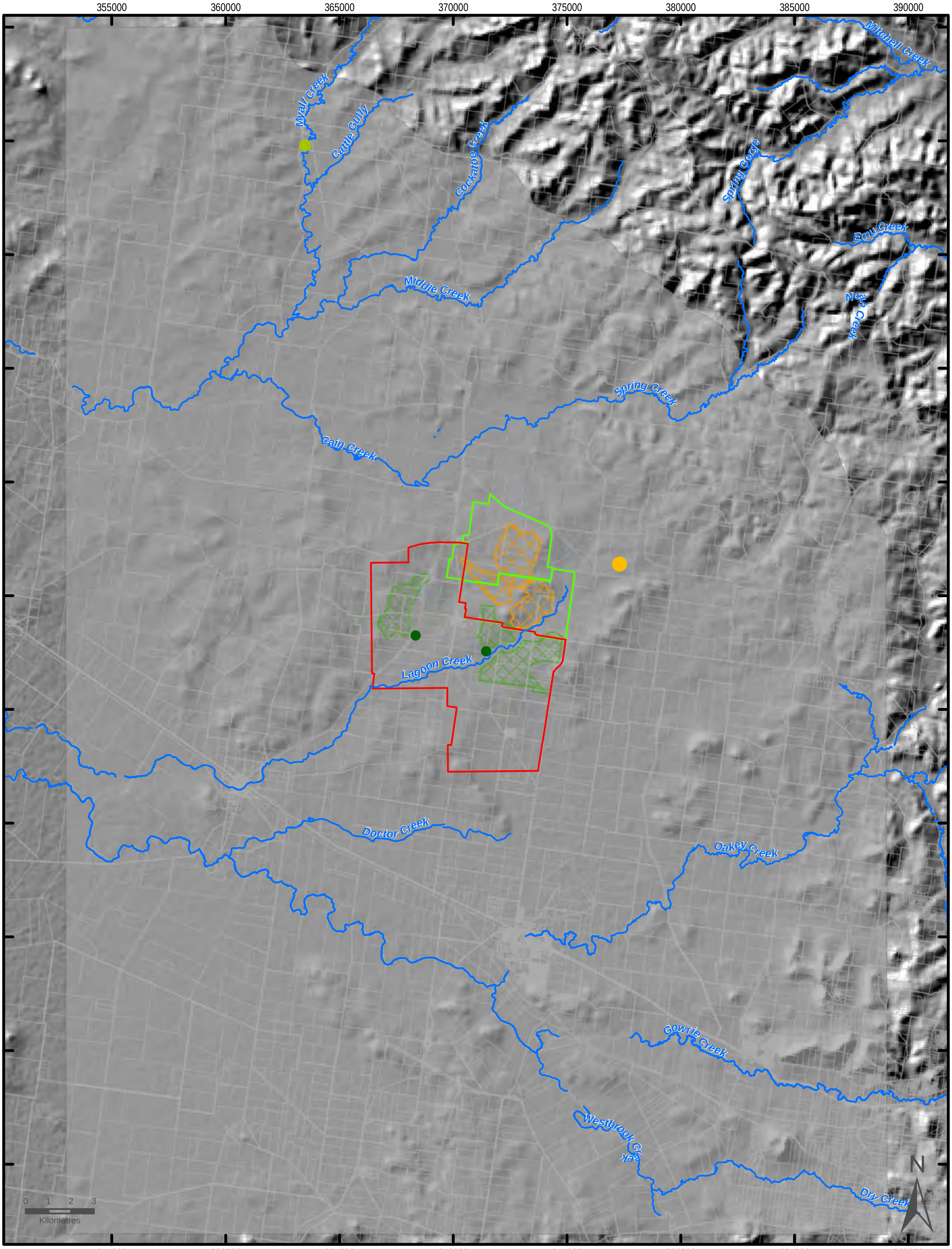
NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure A2.3
Upper Walloon Coal Measures
Calibration Map

Scale 1:228,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140813_NewHope_Groundwater_FigureA2.3_CalibrationUpperWCM.mxd

Produced: 28/08/2014



LEGEND

Lower WCM Calibration Points (Bores)
Best Model Calibration Result

- < 5% SRMS
- 5 - 10% SRMS
- 10 - 25% SRMS
- 25 - 50% SRMS

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Modelled Formation Extents

- Walloon Subgroup (Jw)

NEW HOPE GROUP

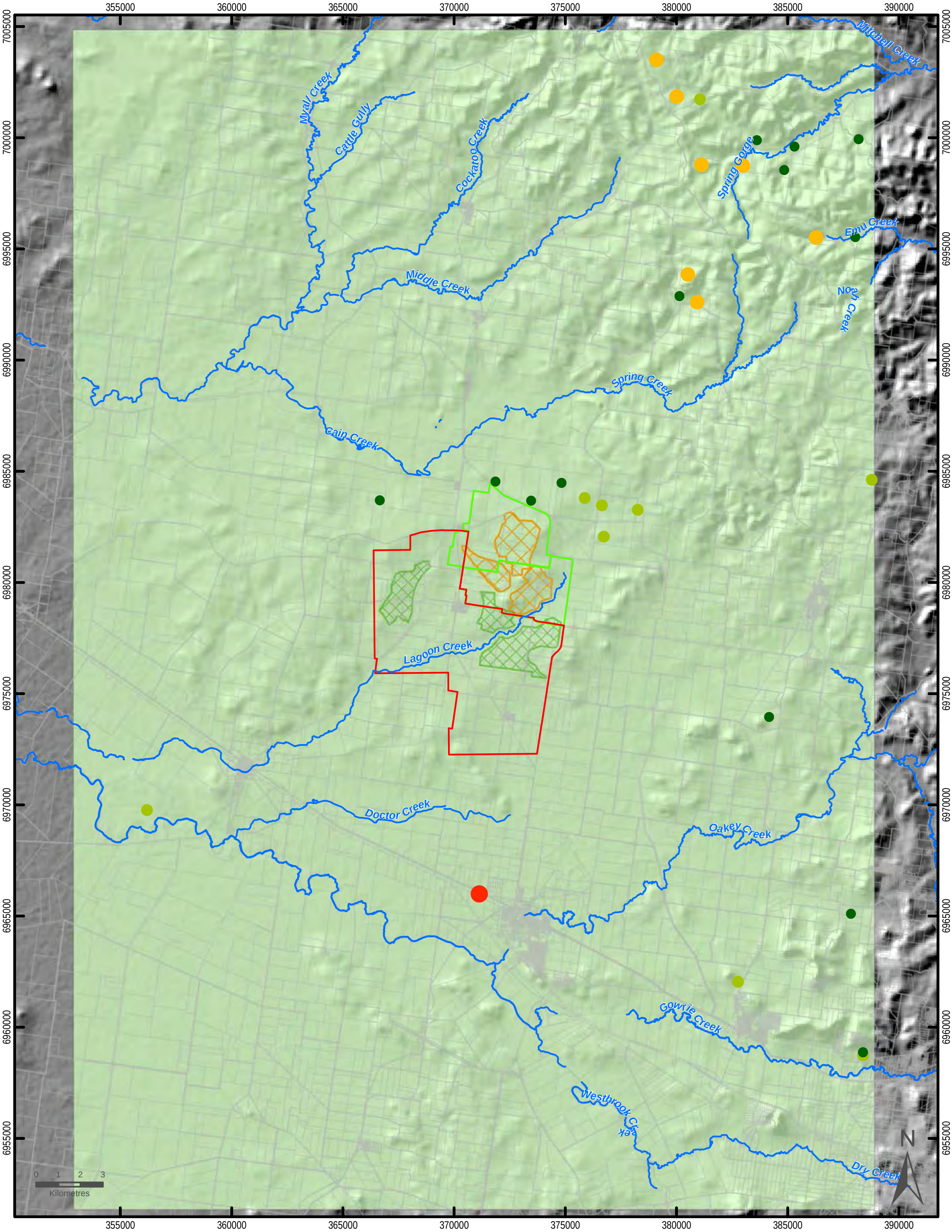
SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure A2.4 Lower Walloon Coal Measures Calibration Map

Scale 1:228,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum140813_NewHope_Groundwater_FigureA2.4_CalibrationLowerWCM.mxd
Produced: 28/08/2014



LEGEND

Marburg Sst Calibration Points (Bores)

Best Model Calibration Result

- < 5% SRMS
- 5 - 10% SRMS
- 10 - 25% SRMS
- 25 - 50% SRMS

Watercourse

New Aland Coal Mine-Stage 3

New Acland Coal Mine

Cadastre

Stage 3 Pit Areas

Existing Permission

Modelled Formation Extents

Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

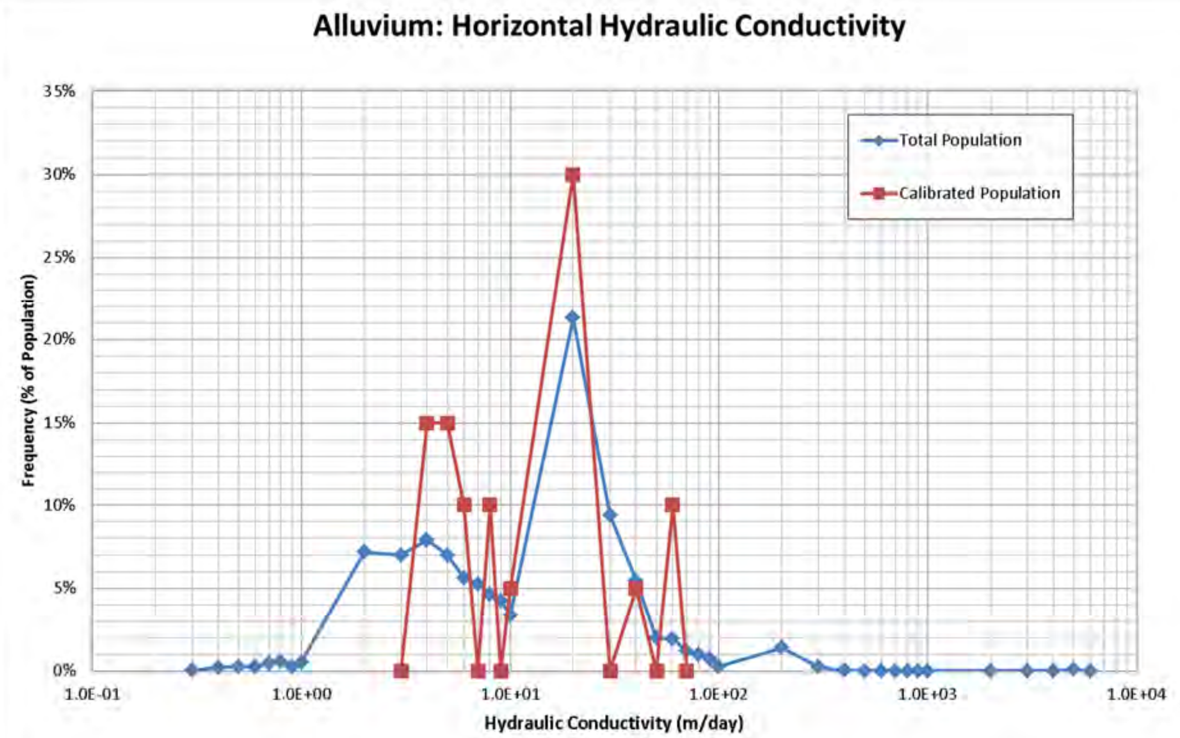
Figure A2.5
Marburg Sandstone Calibration Map

Scale 1:228,000 on A4

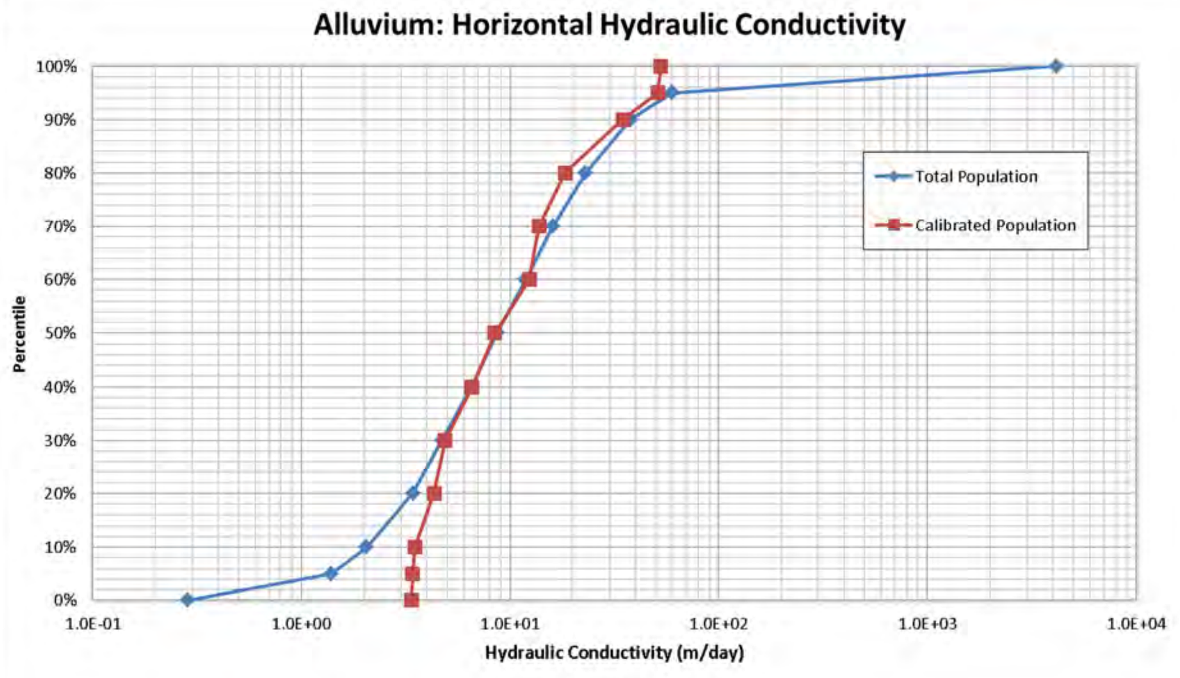
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

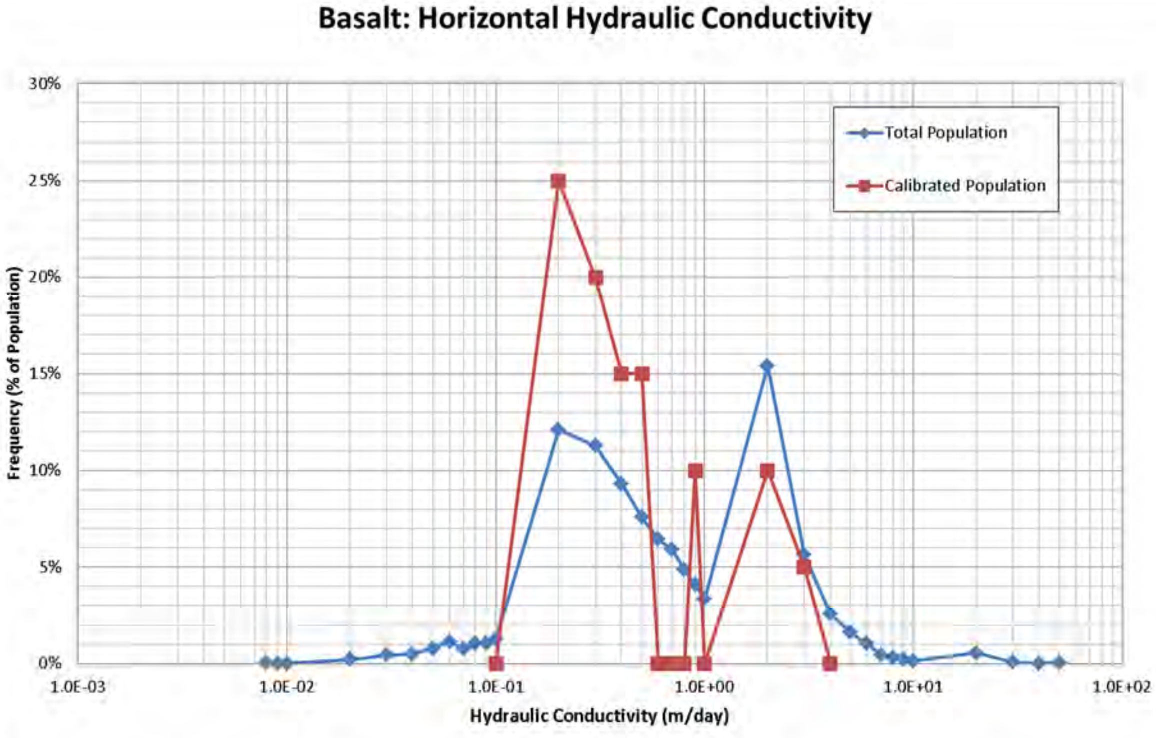
Produced: 28/08/2014 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\03_AEIS\06_GroundwaterResources\ModellingAddendum\140813_NewHope_Groundwater_FigureA2.5_CalibrationMarburg.mxd

Appendix B. Calibration Parameter Sensitivity Plots

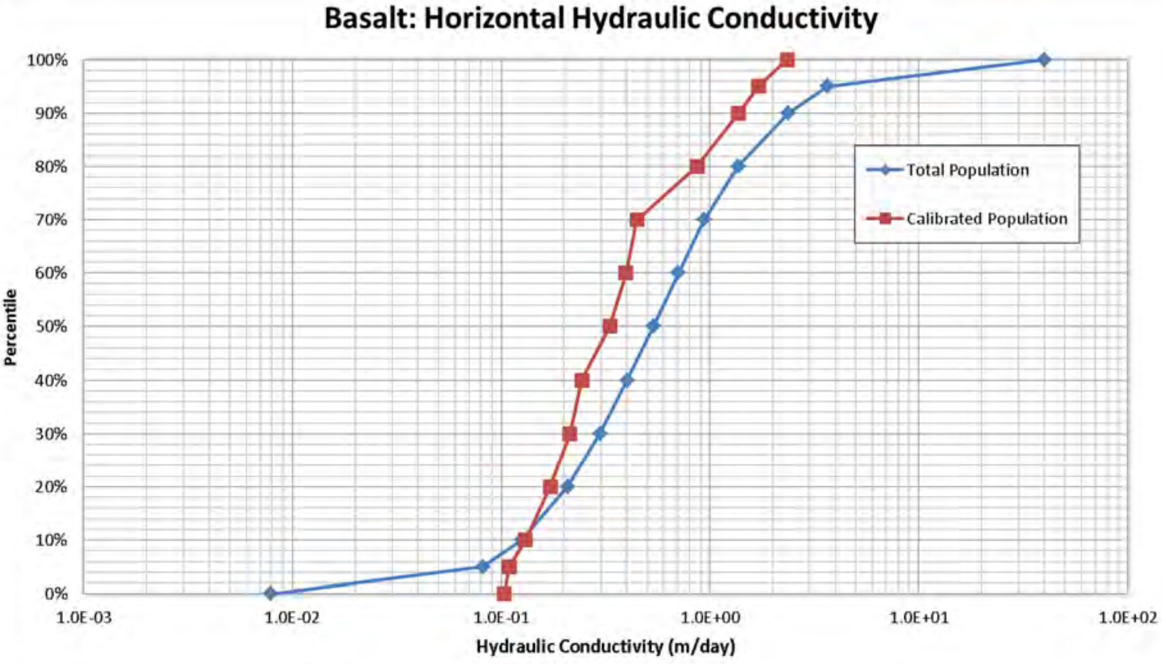


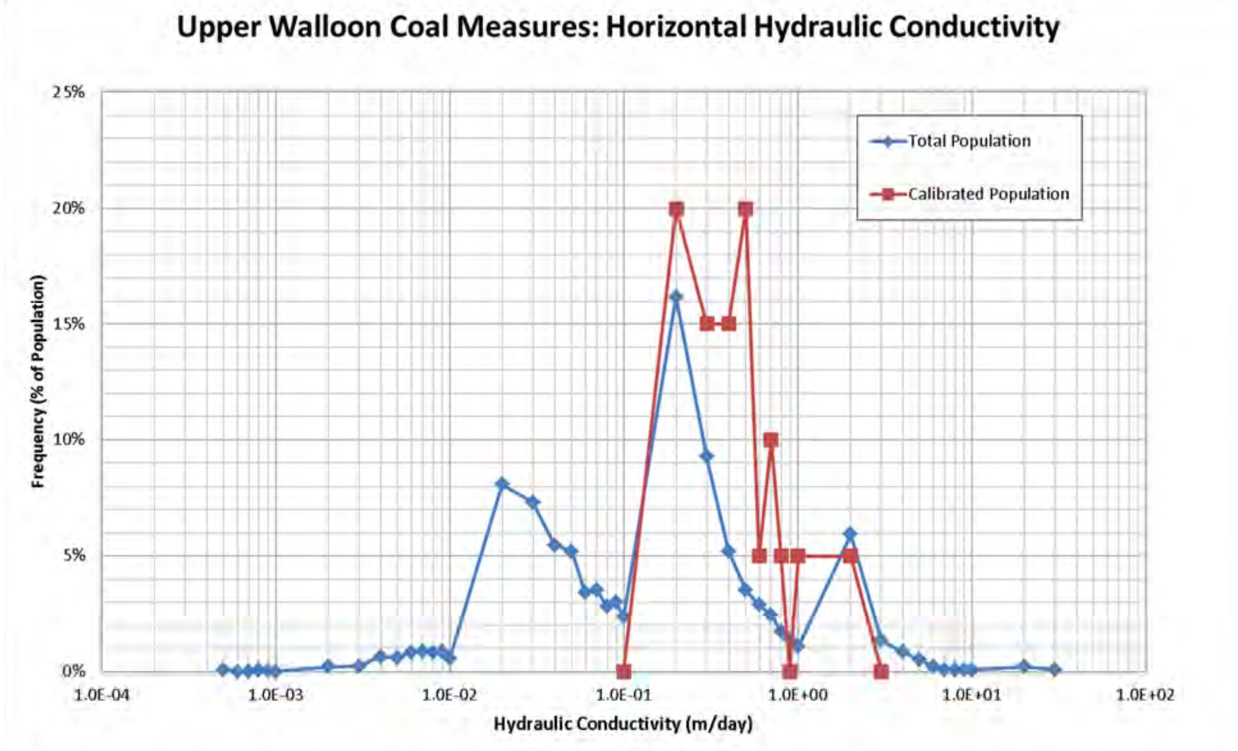
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.



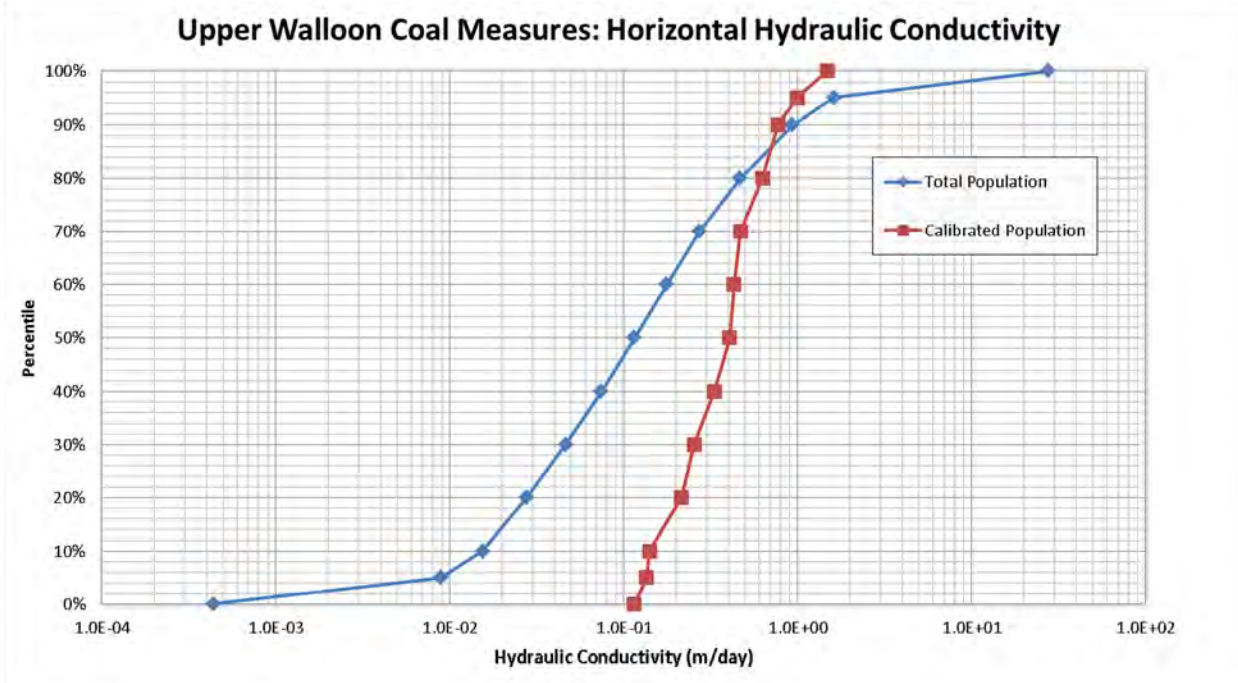


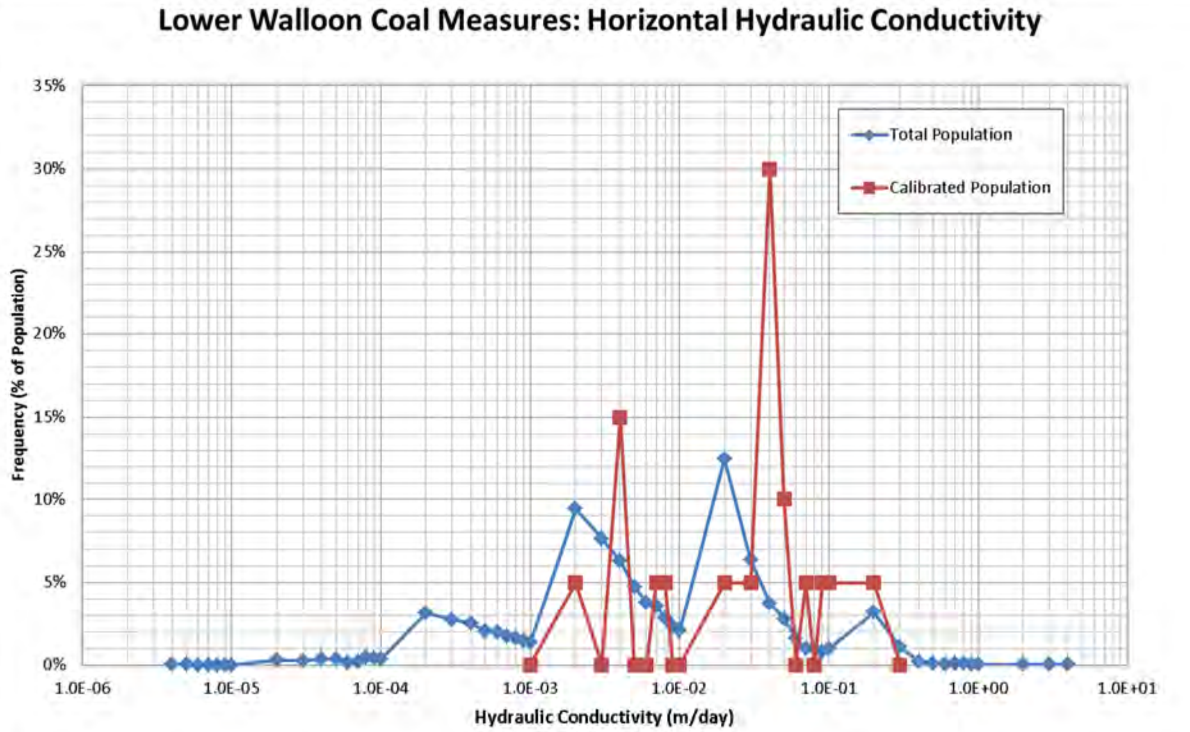
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.



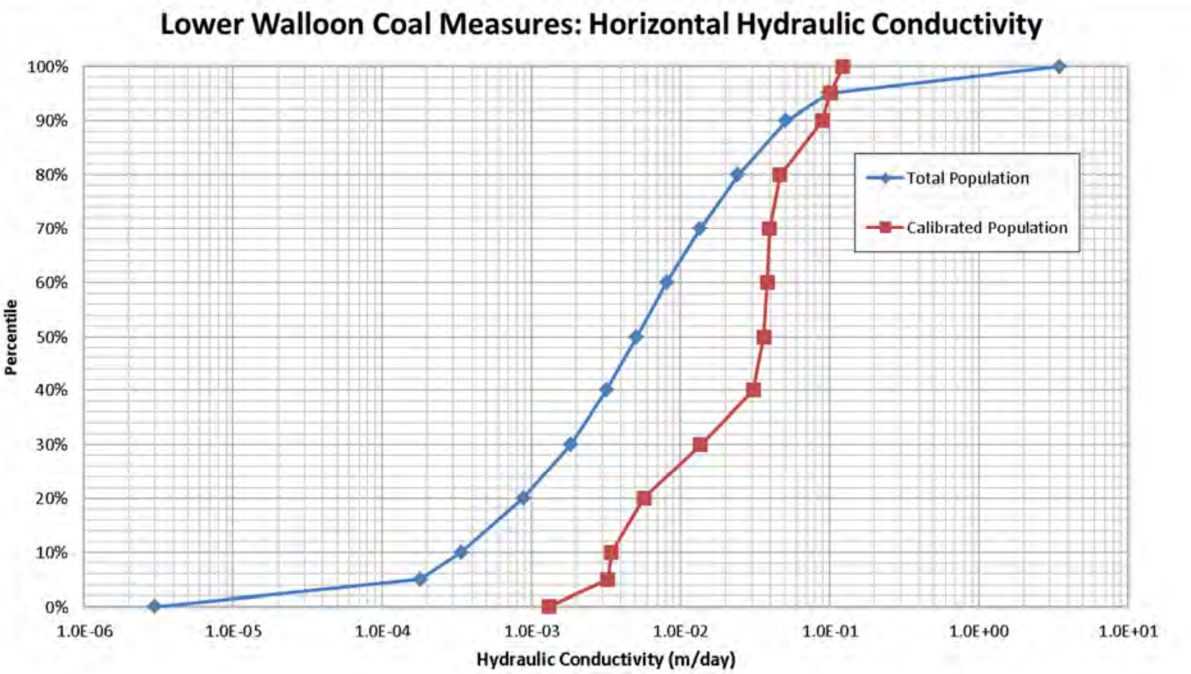


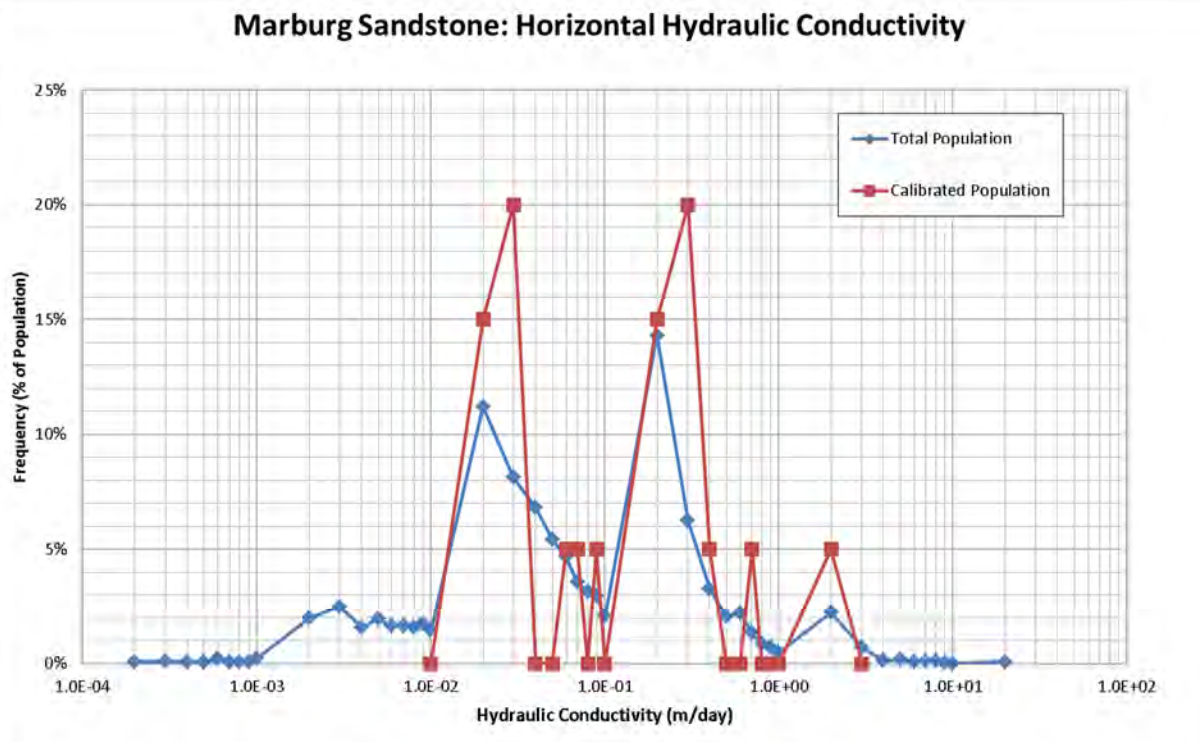
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.



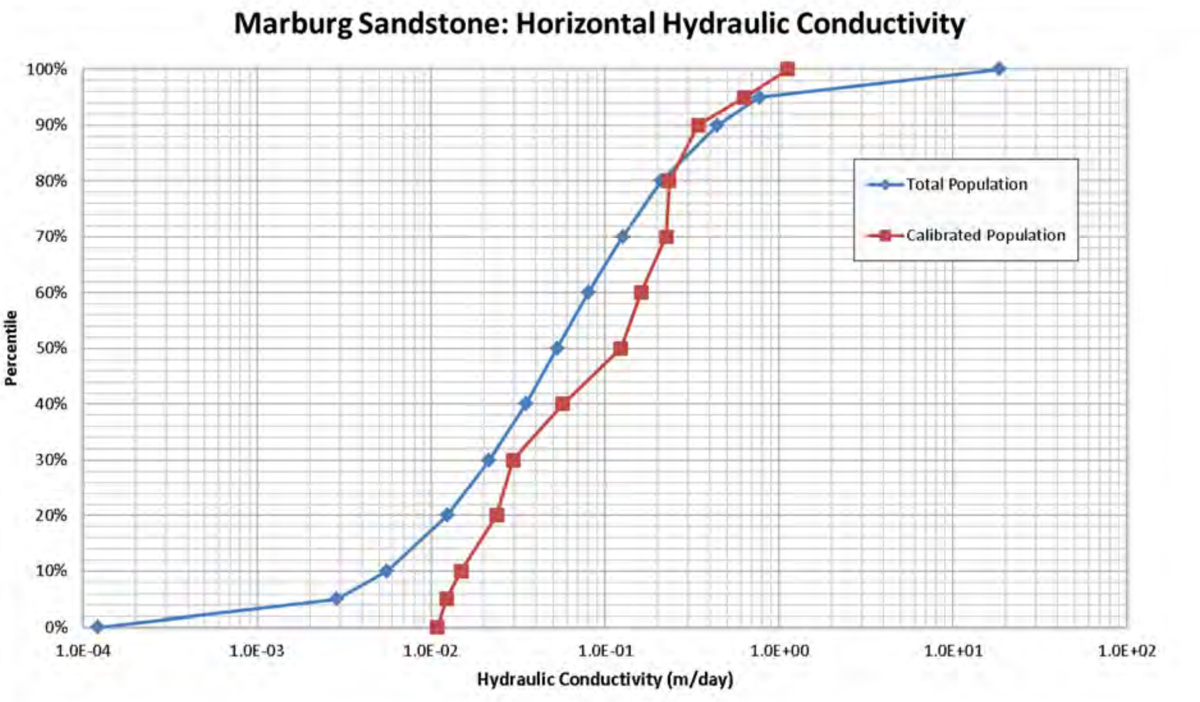


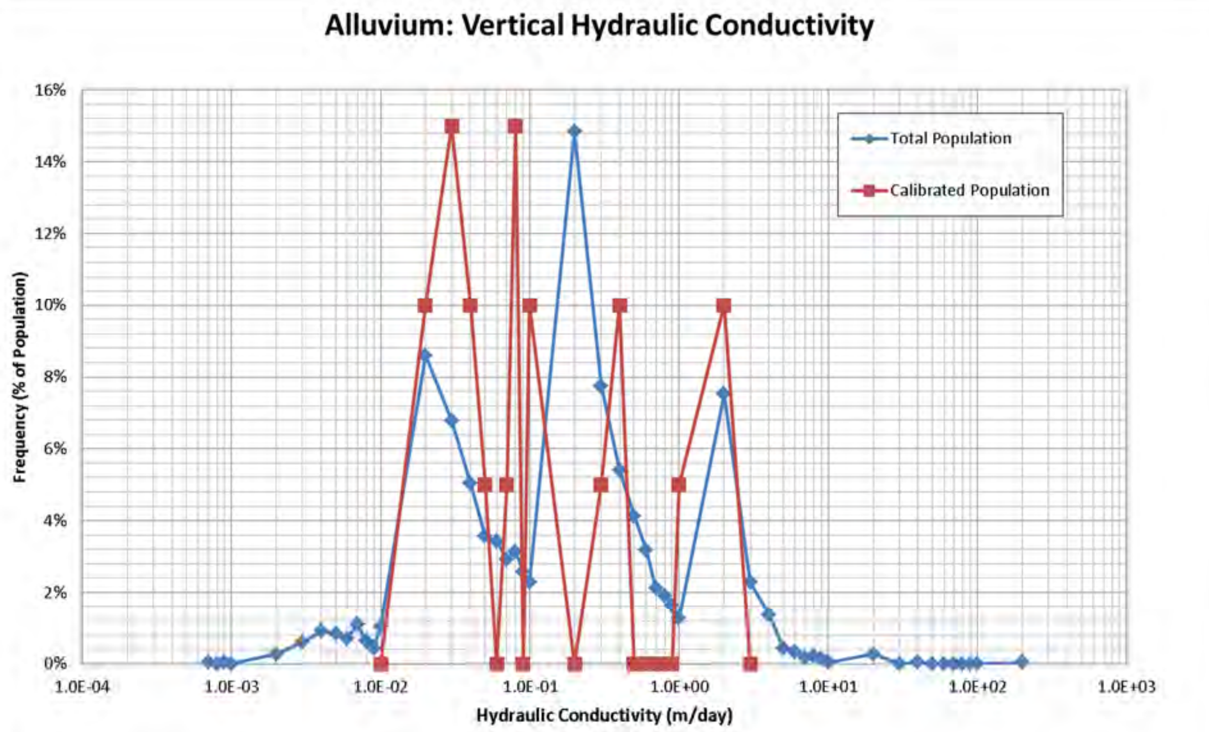
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.





Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.





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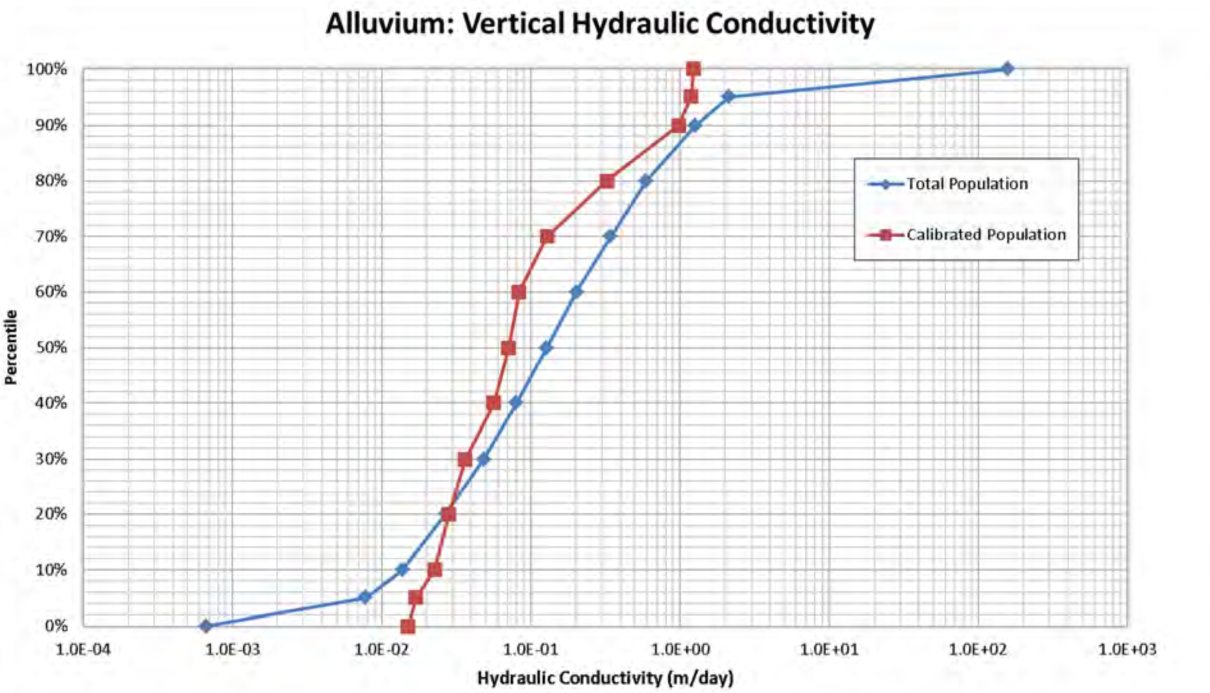
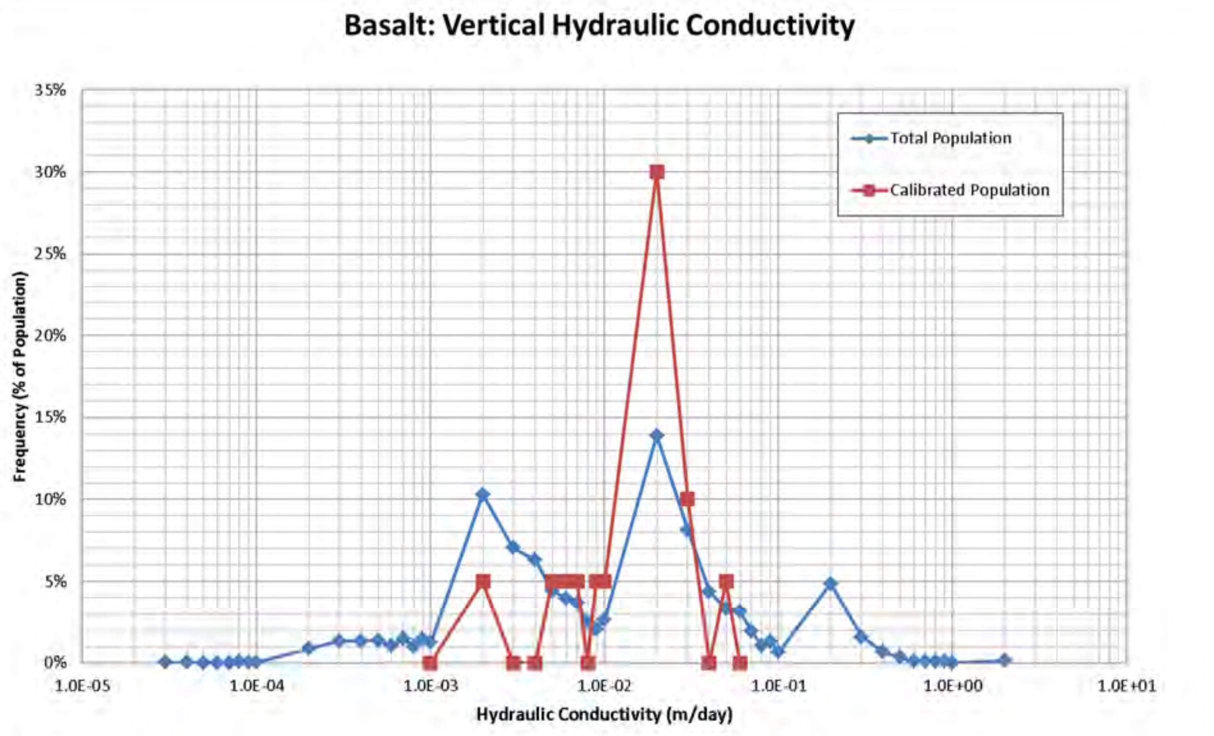
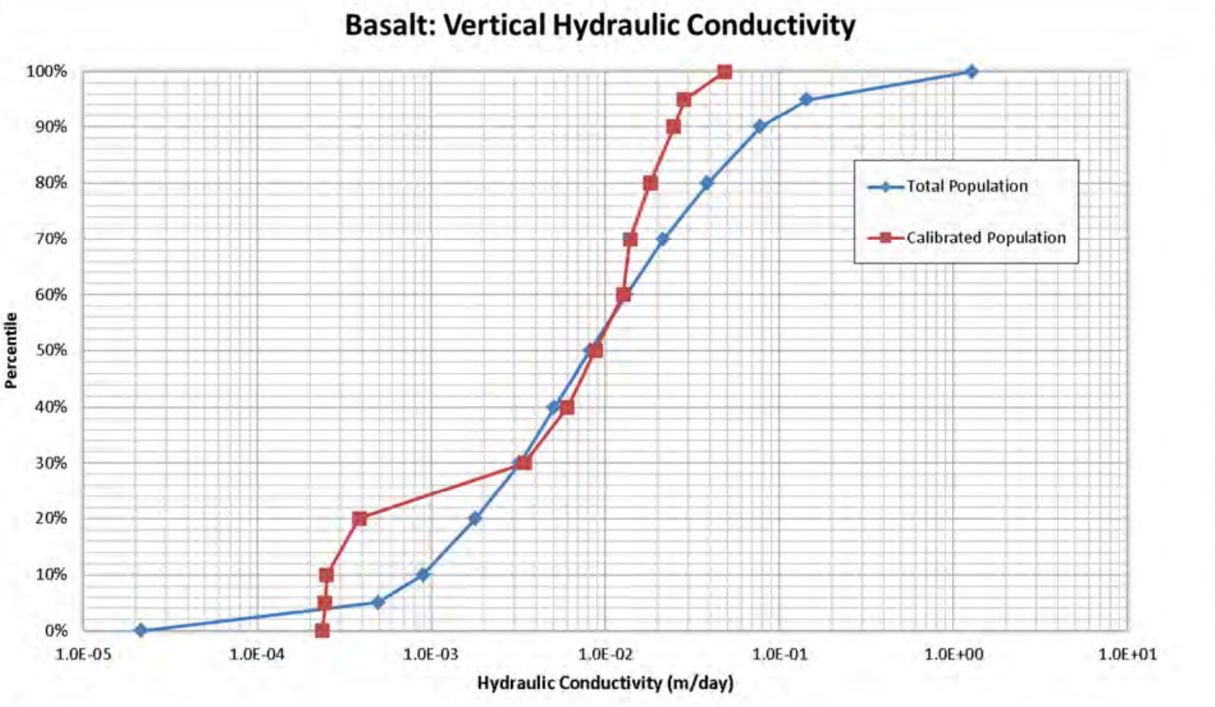
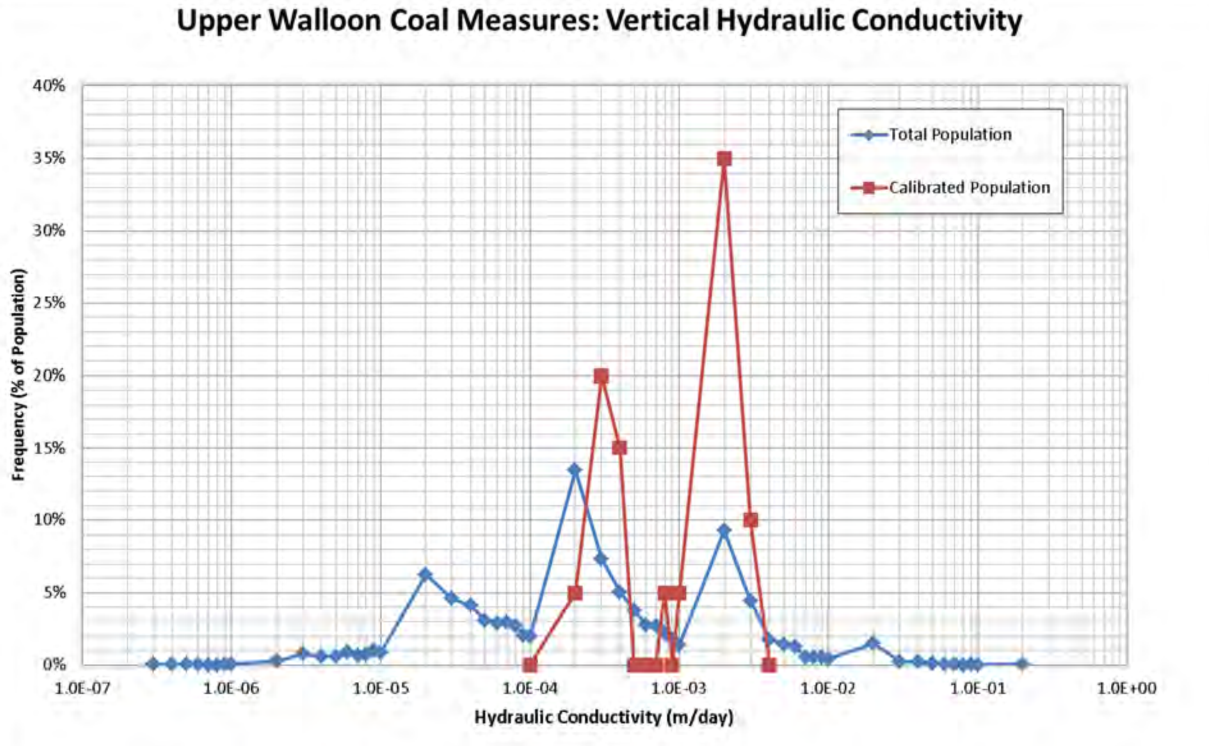


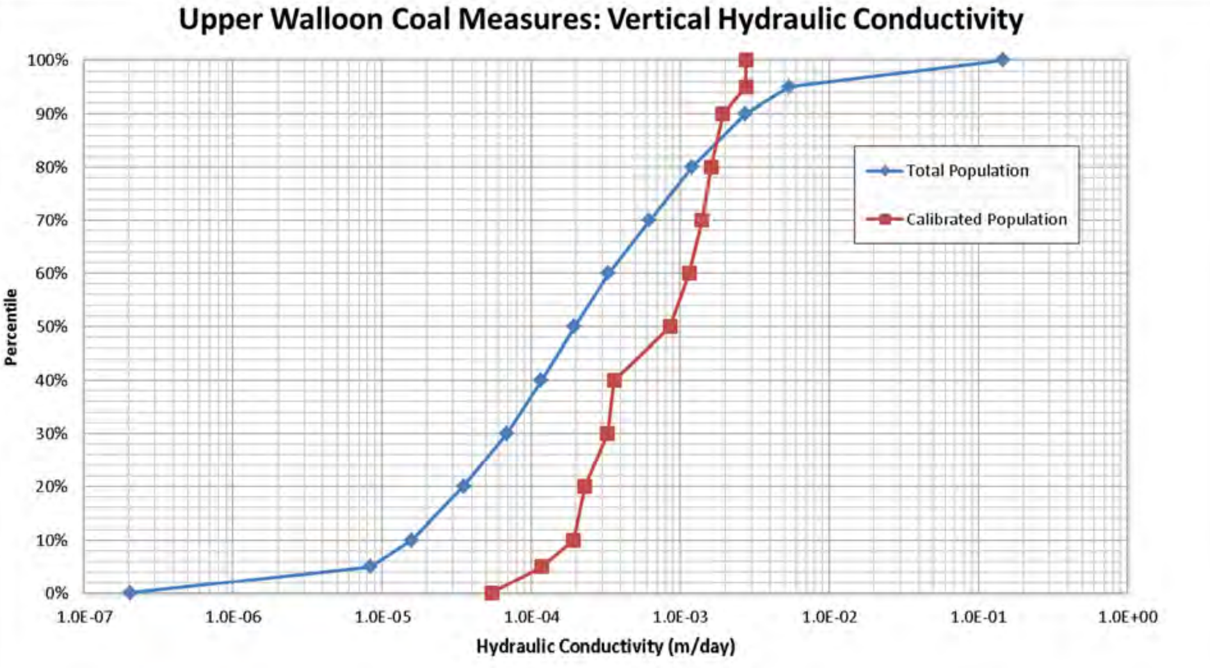


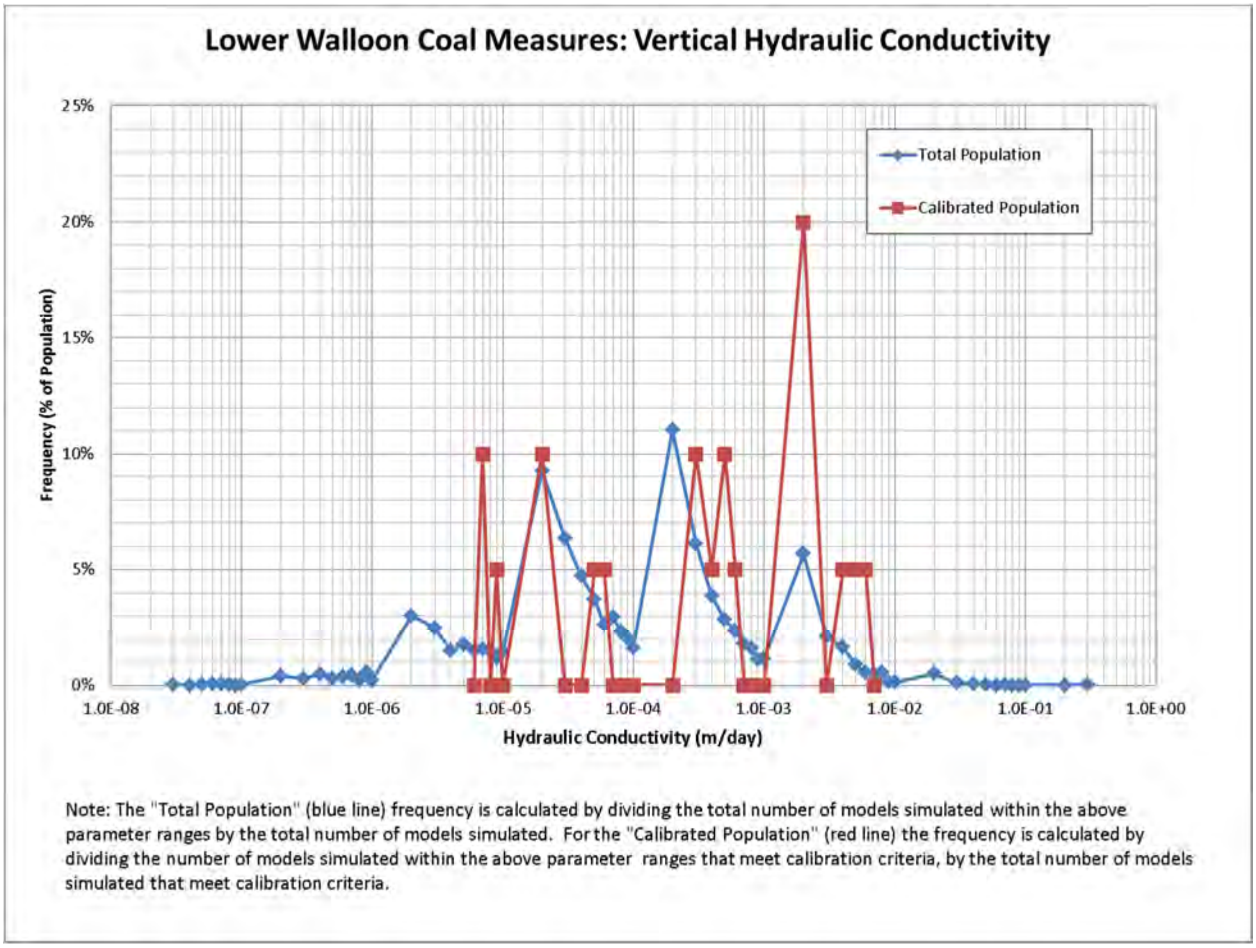
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.

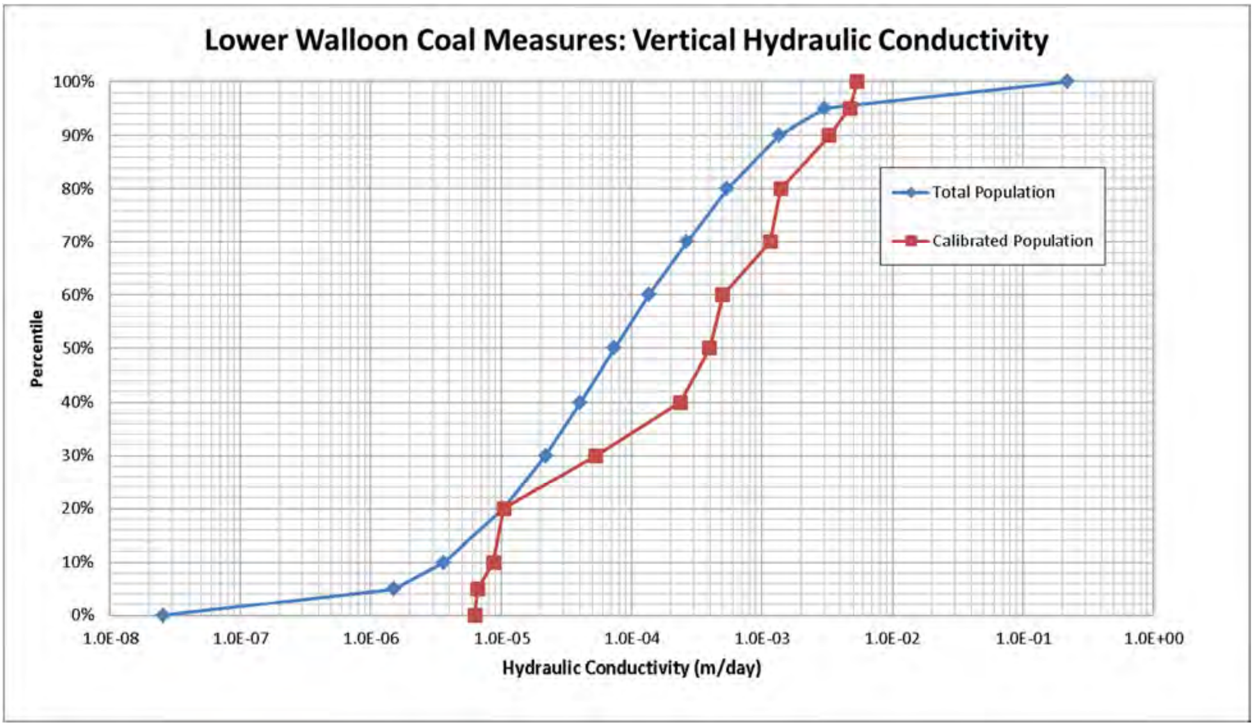


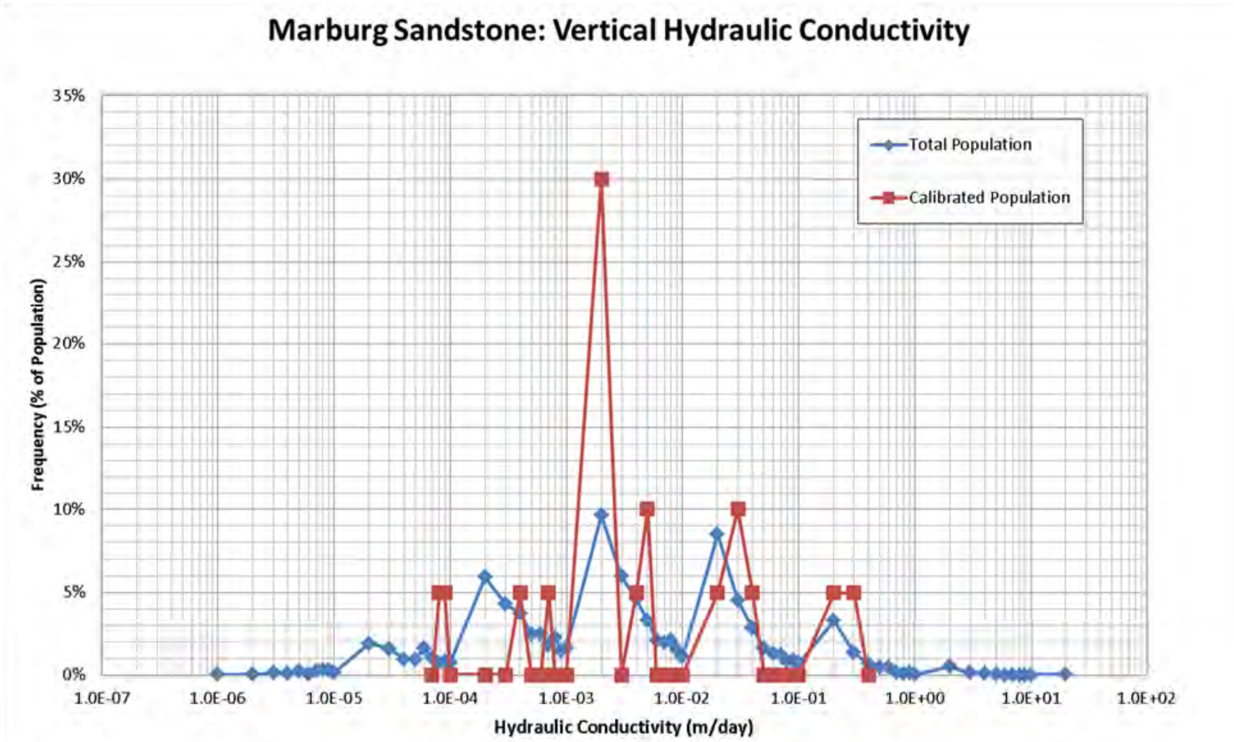


Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.

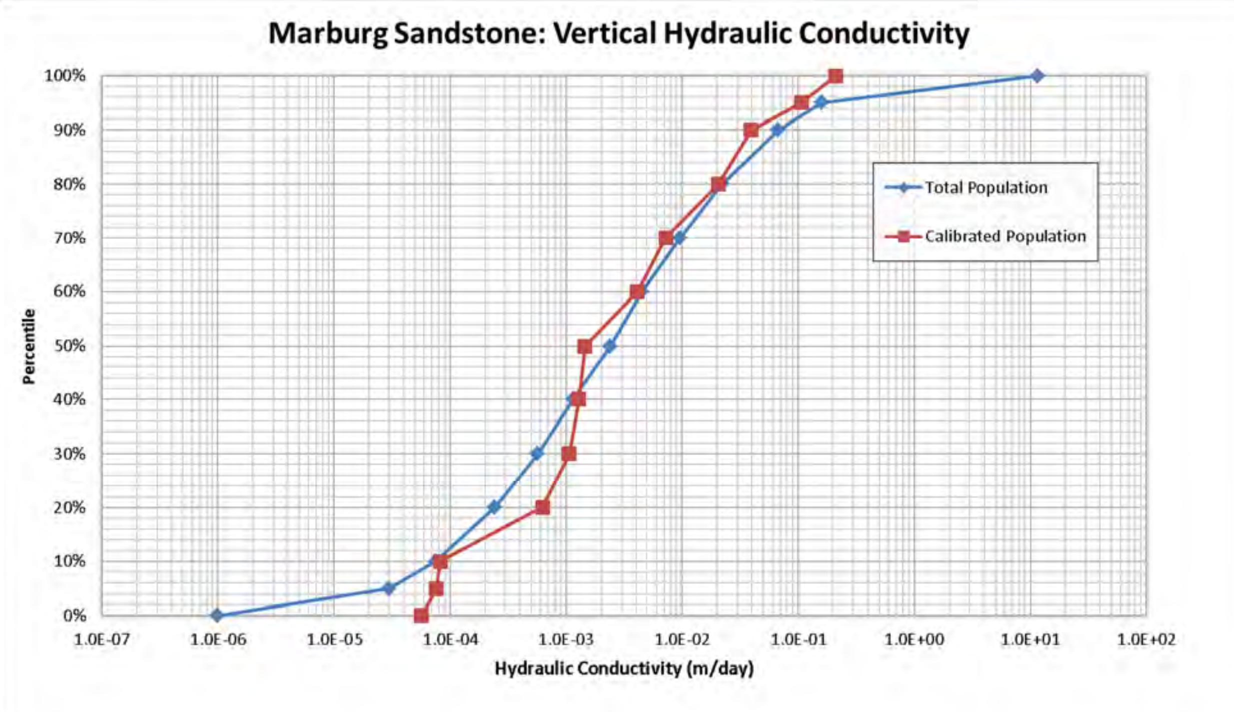


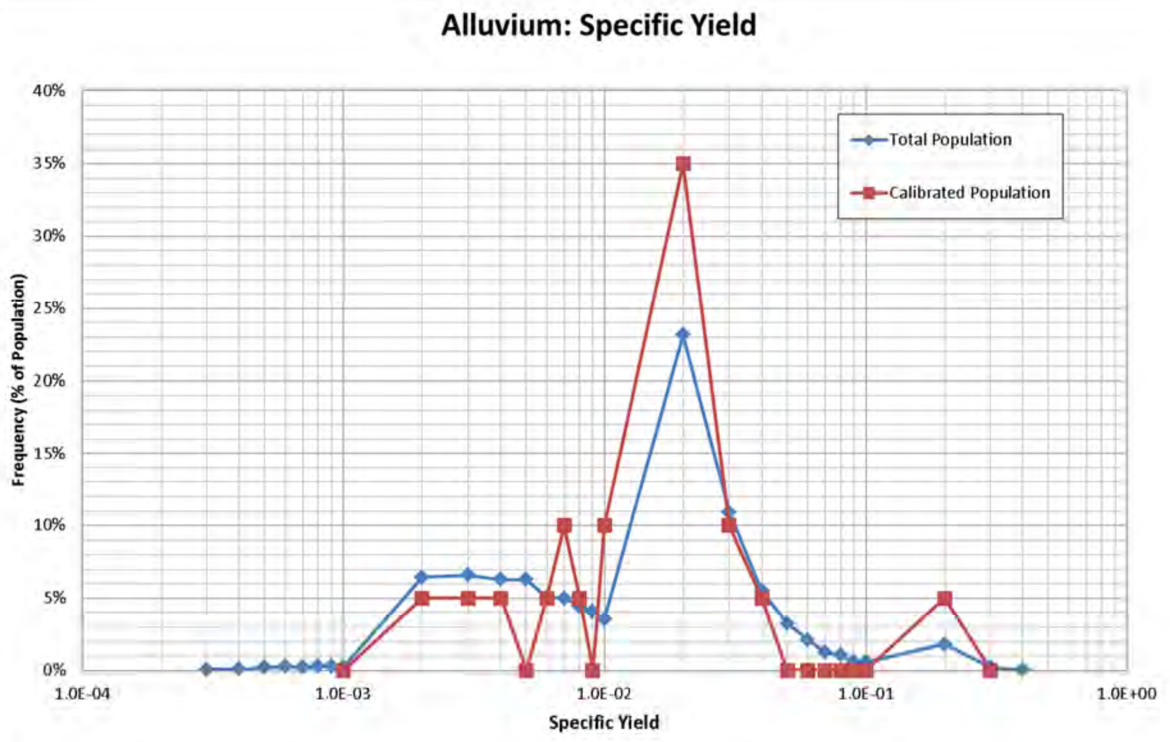

Lower Walloon Coal Measures: Vertical Hydraulic Conductivity
Total Population
Calibrated Population
Frequency (% of Population)
25%
20%
15%
10%
5%
0%
1.0E-08
1.0E-07
1.0E-06
1.0E-05
1.0E-04
1.0E-03
1.0E-02
1.0E-01
1.0E+00
Hydraulic Conductivity (m/day)
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.


Lower Walloon Coal Measures: Vertical Hydraulic Conductivity
Total Population
Calibrated Population
Percentile
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1.0E-08
1.0E-07
1.0E-06
1.0E-05
1.0E-04
1.0E-03
1.0E-02
1.0E-01
1.0E+00
Hydraulic Conductivity (m/day)

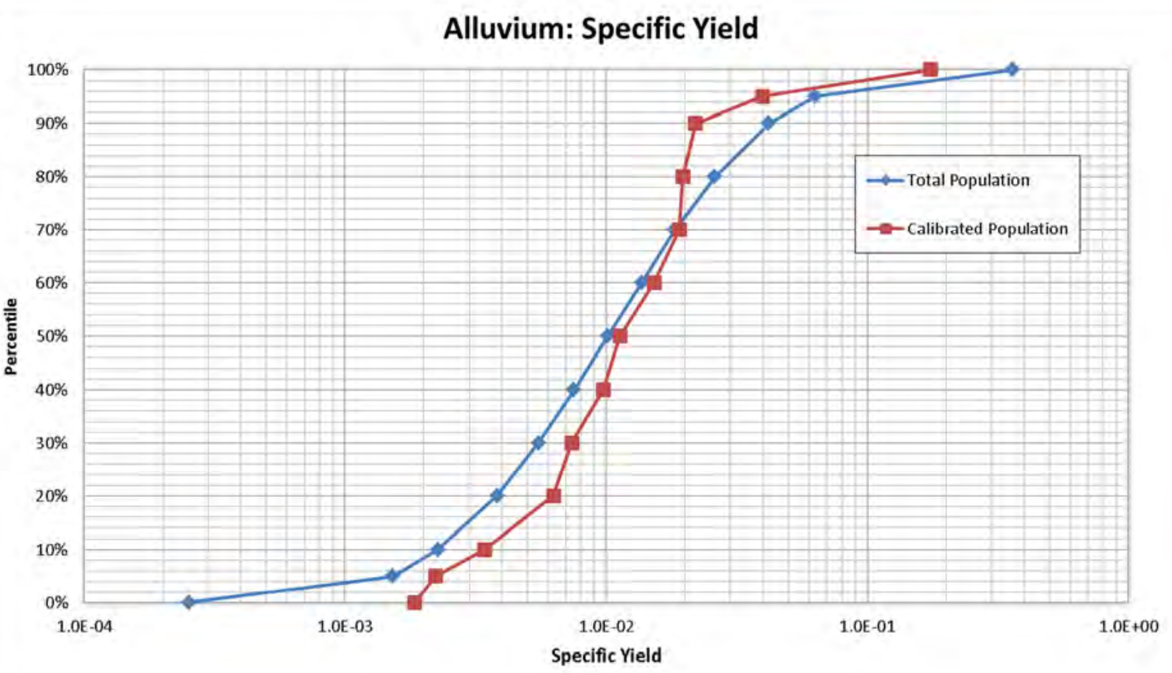


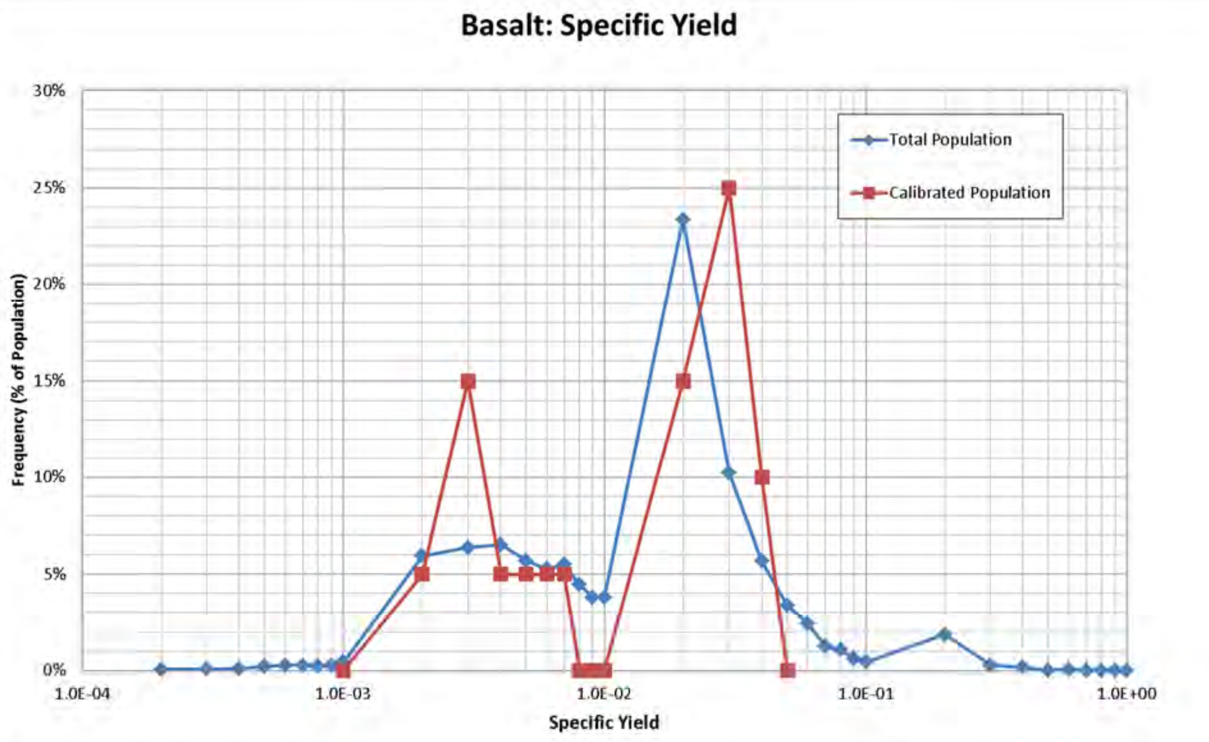
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.



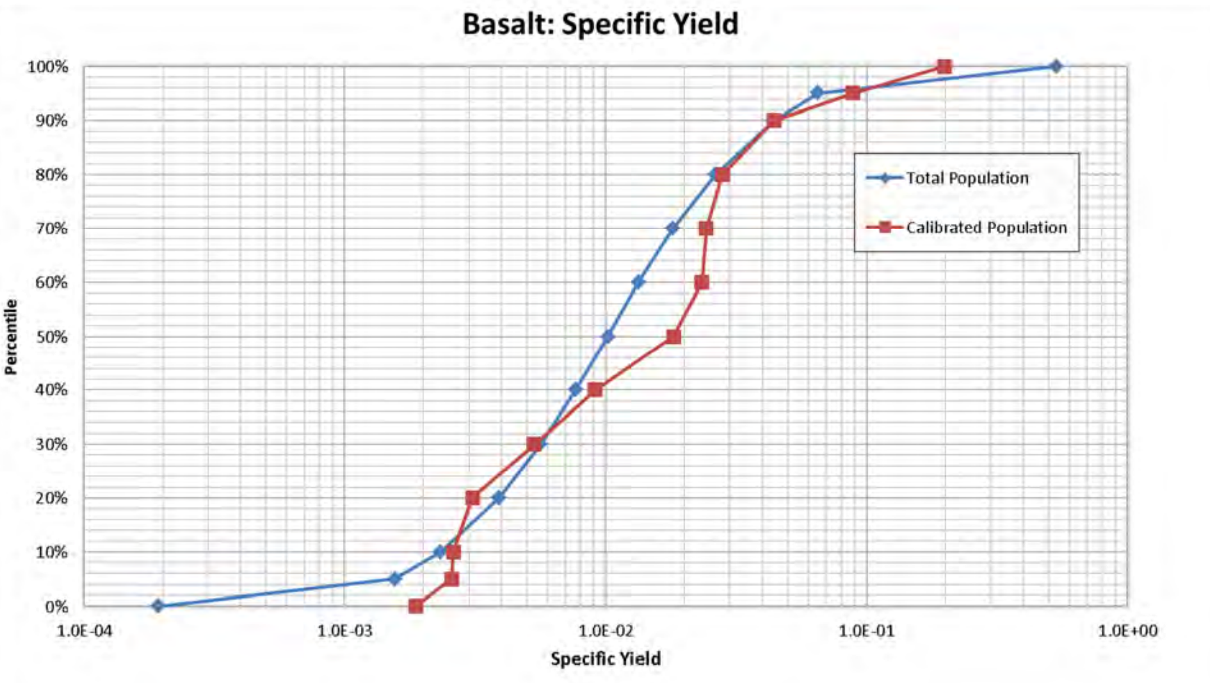


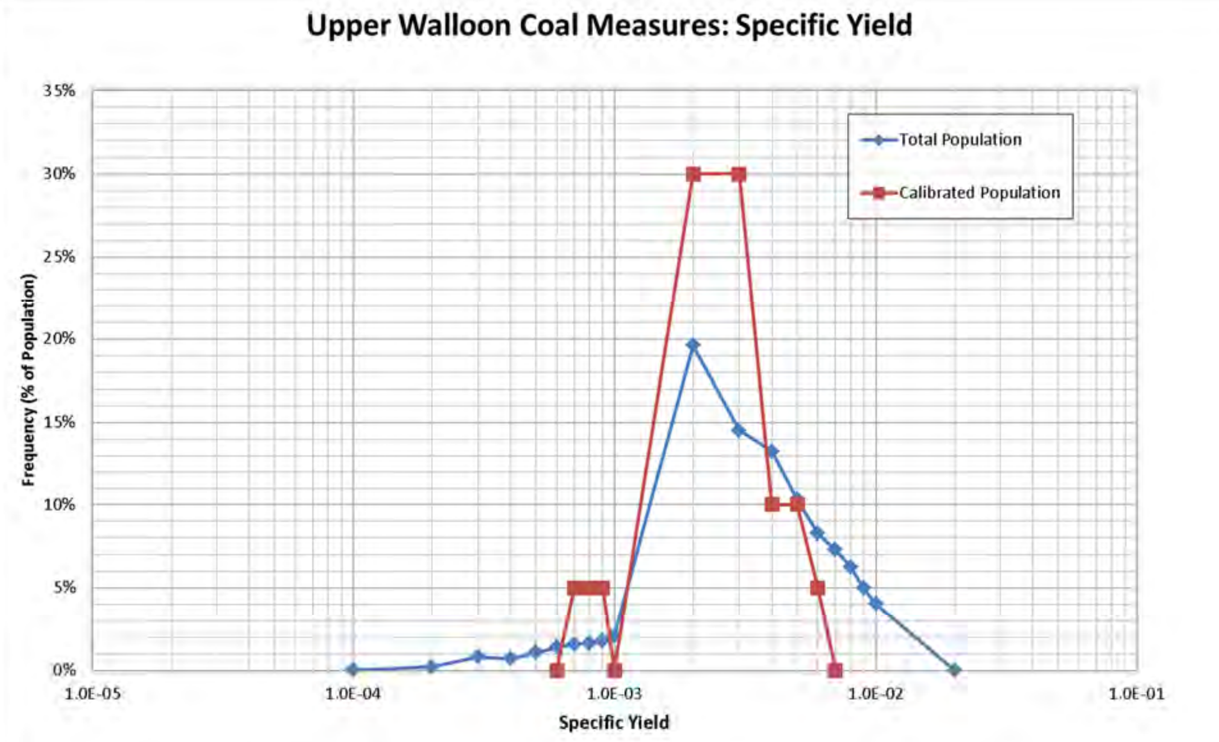
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.



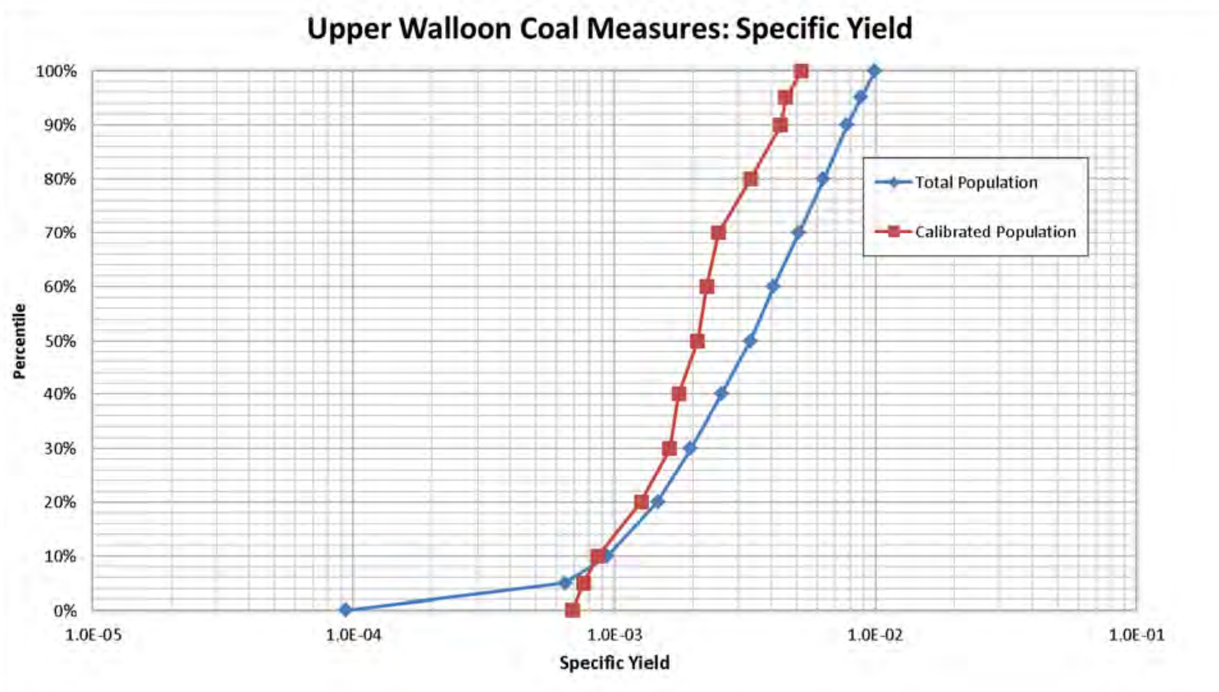


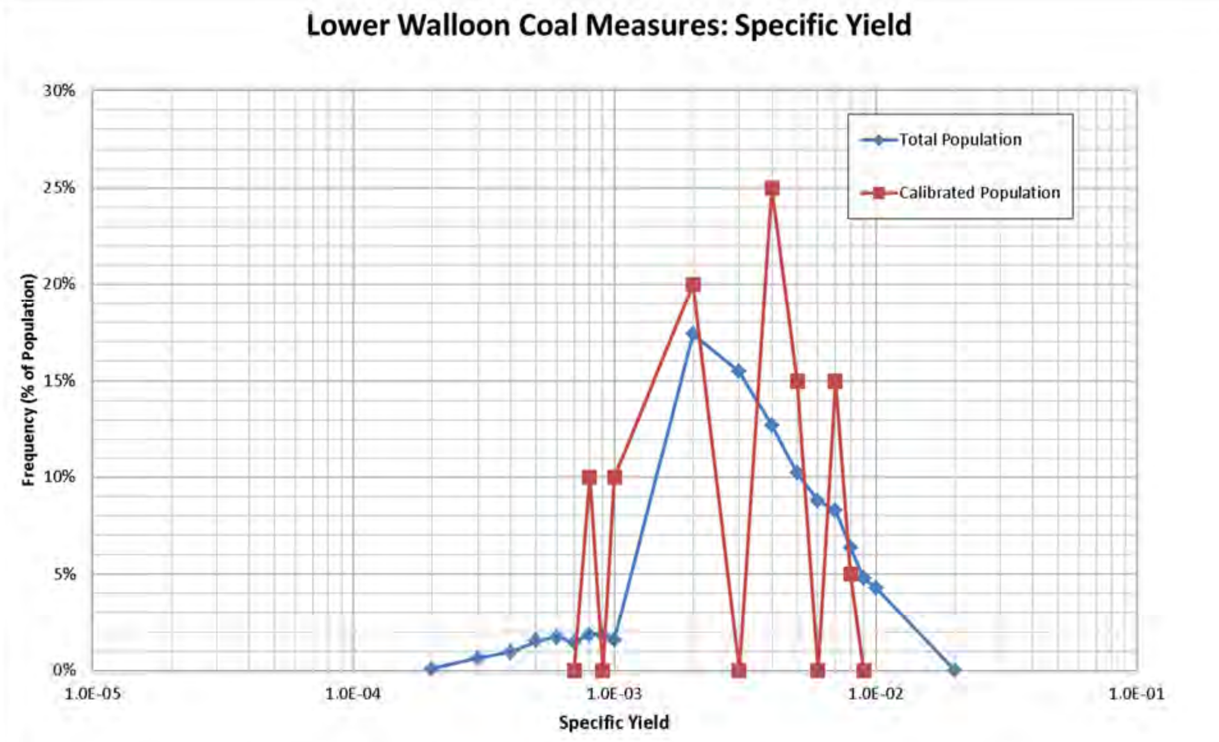
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.



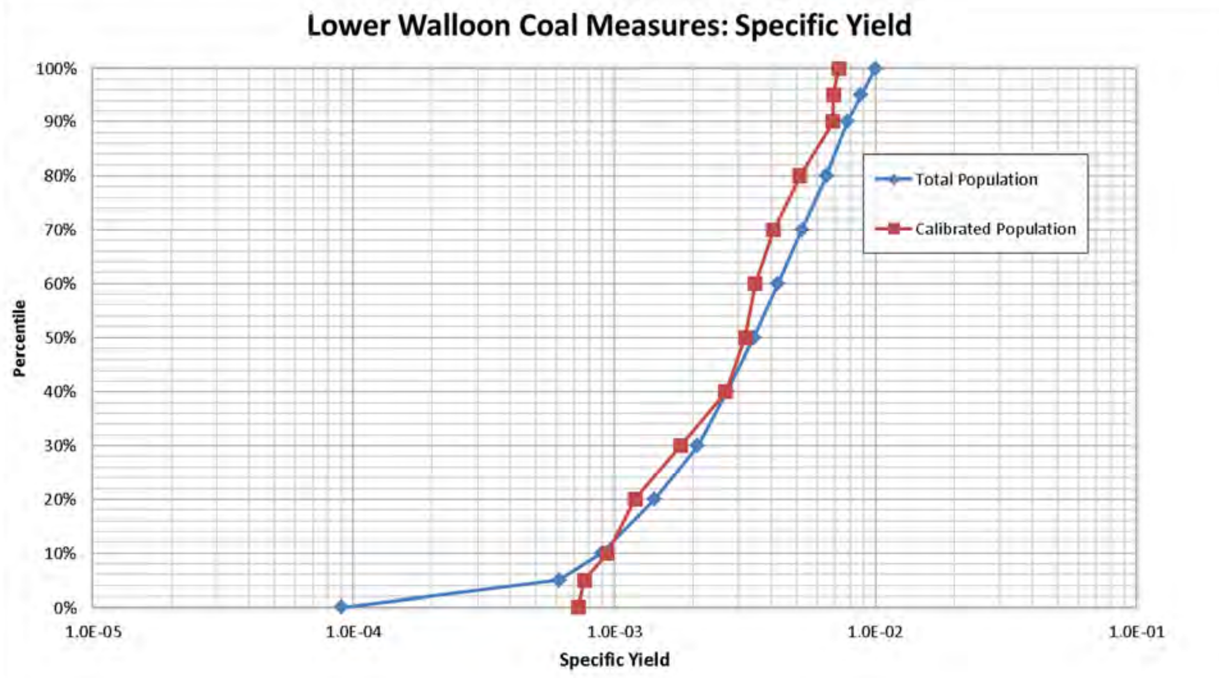


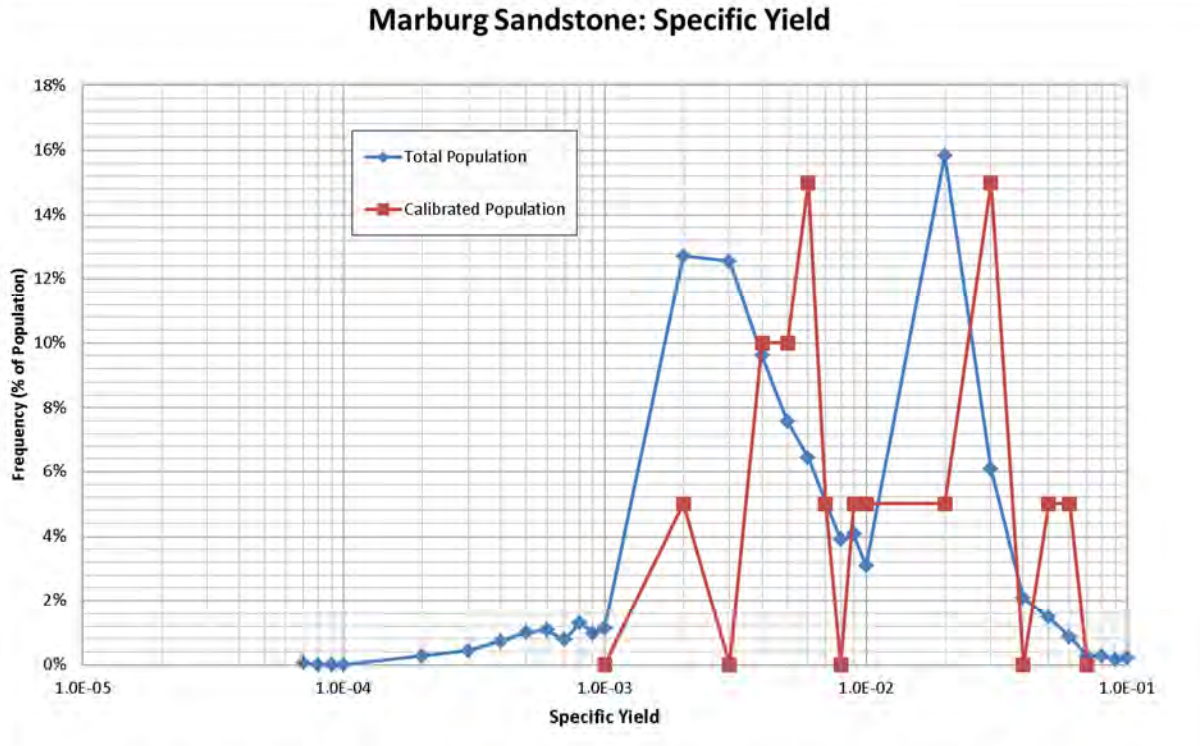
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.



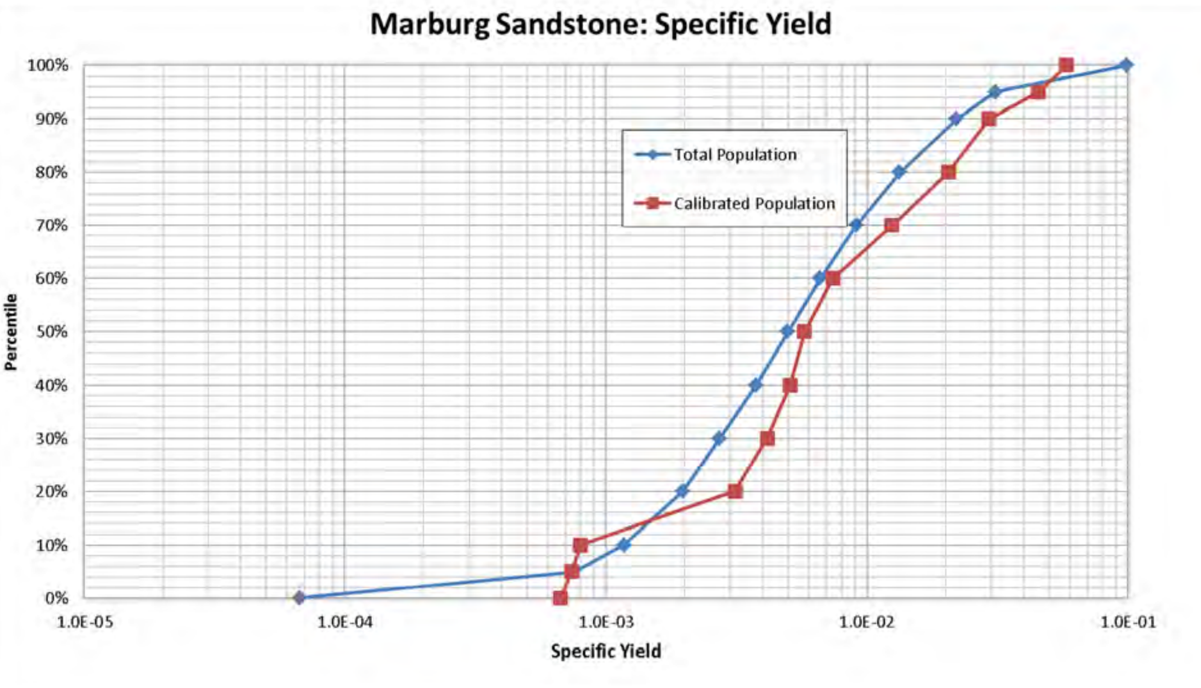


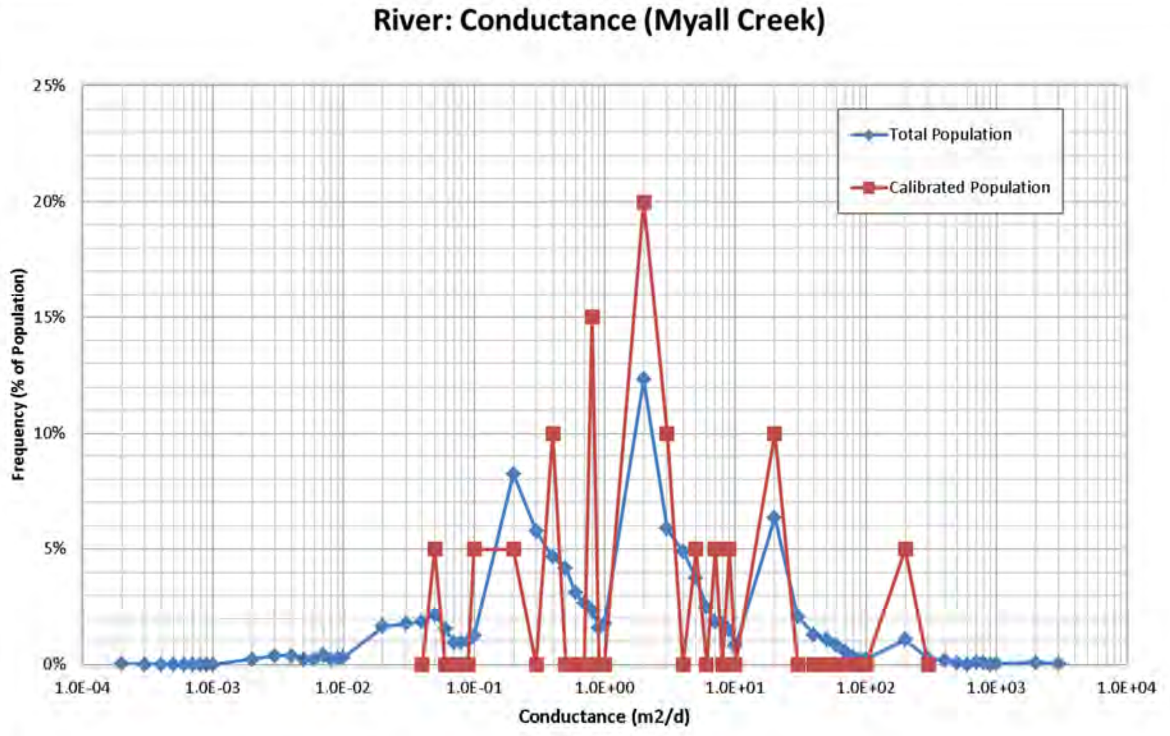
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.



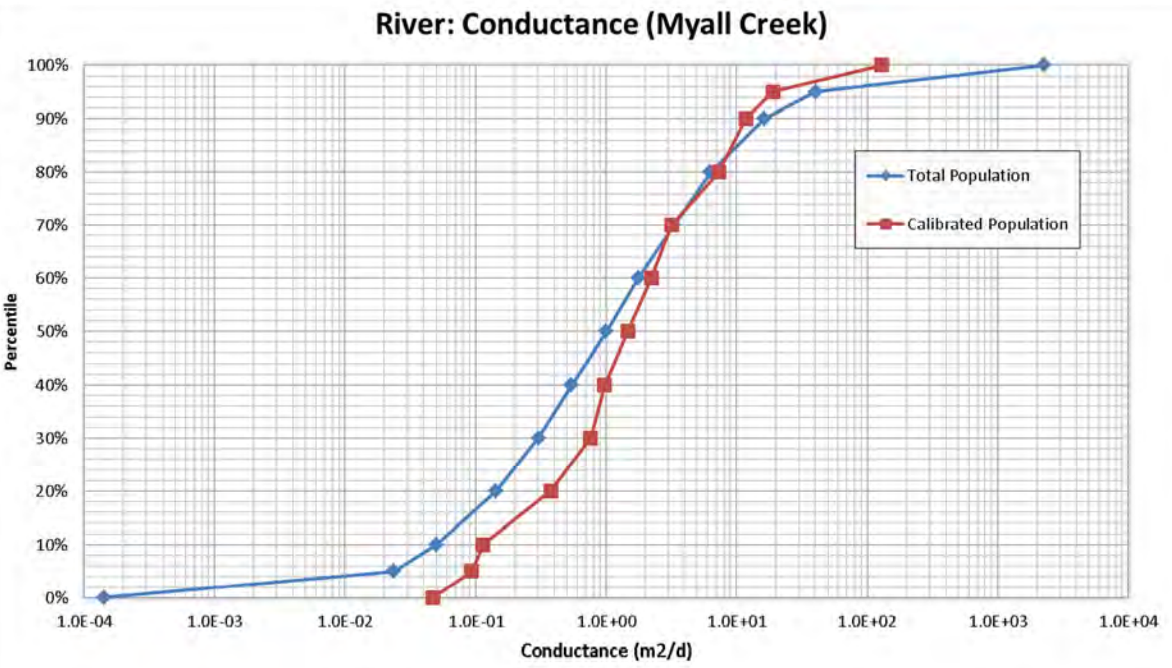


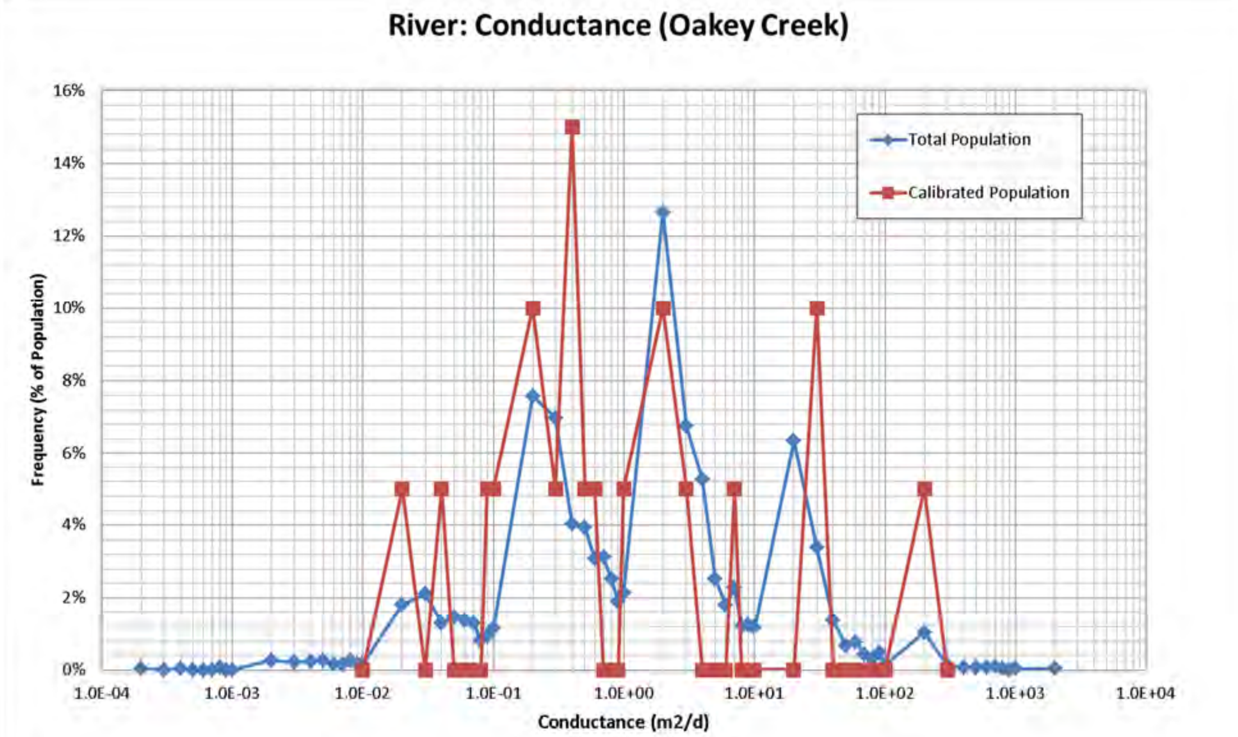
Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.





Note: The "Total Population" (blue line) frequency is calculated by dividing the total number of models simulated within the above parameter ranges by the total number of models simulated. For the "Calibrated Population" (red line) the frequency is calculated by dividing the number of models simulated within the above parameter ranges that meet calibration criteria, by the total number of models simulated that meet calibration criteria.





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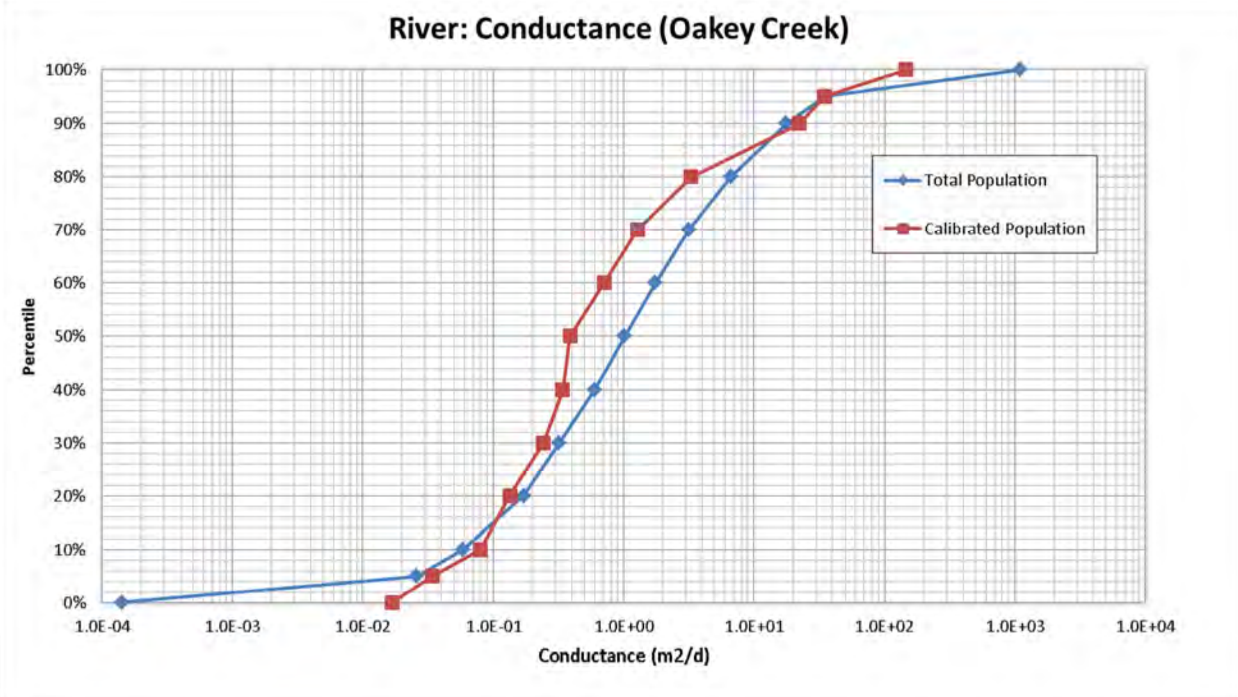

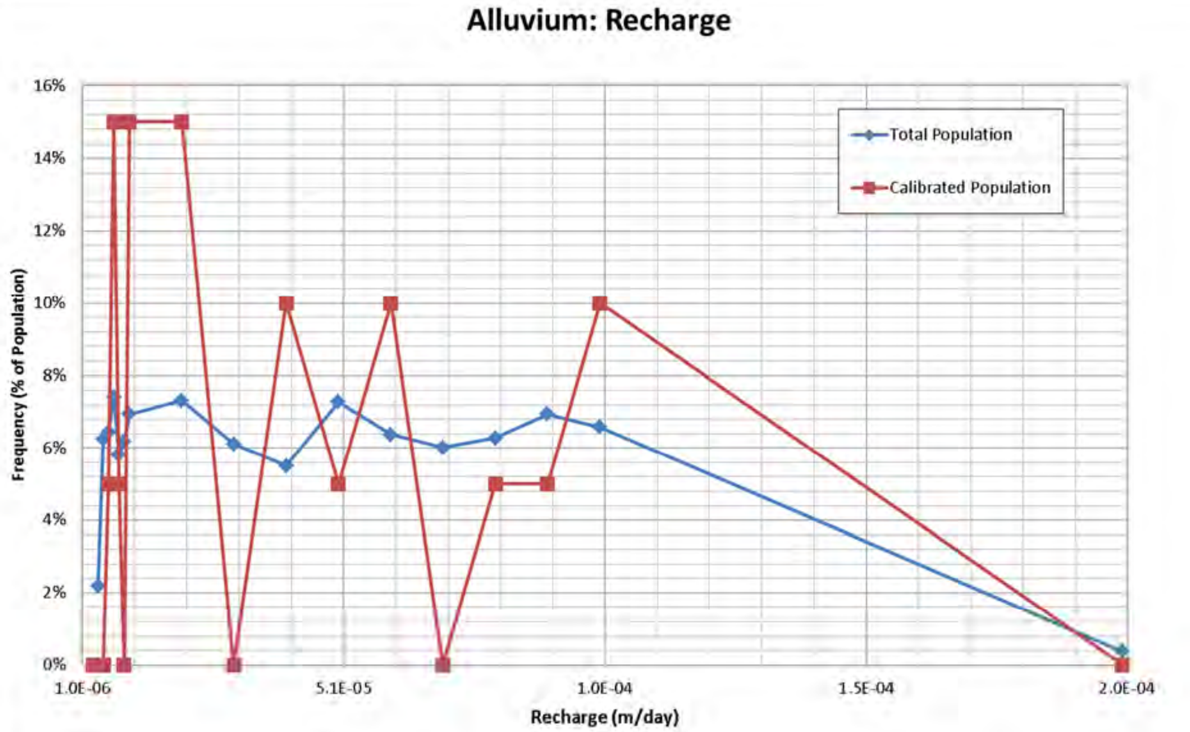

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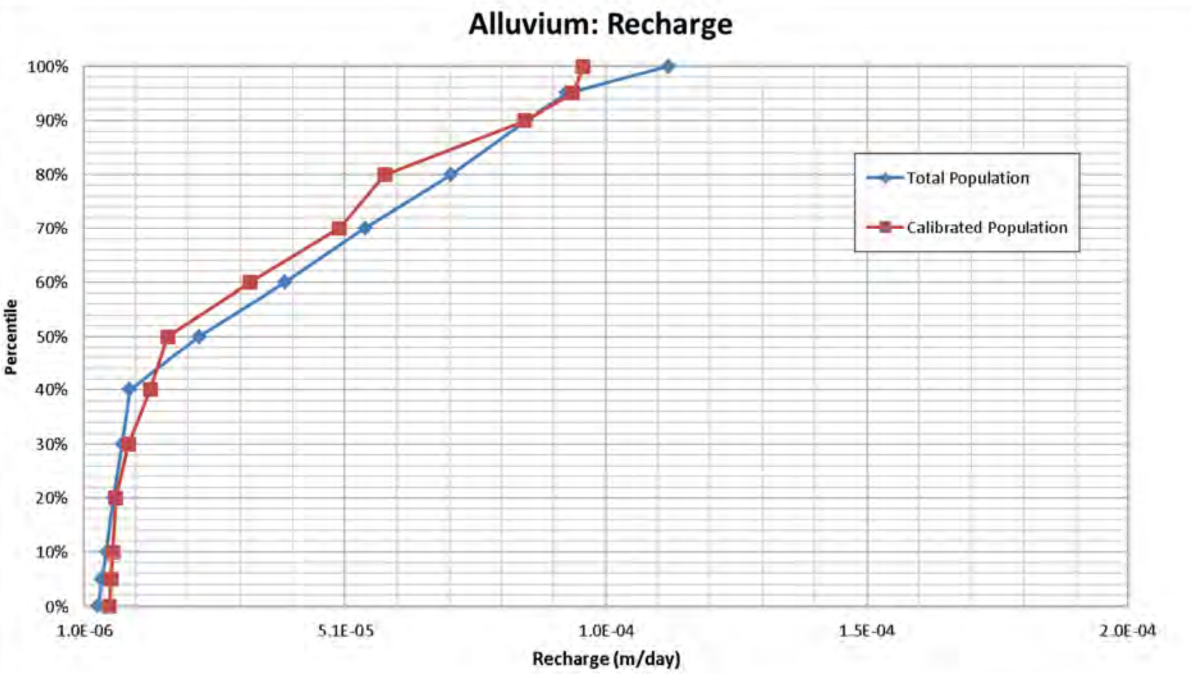

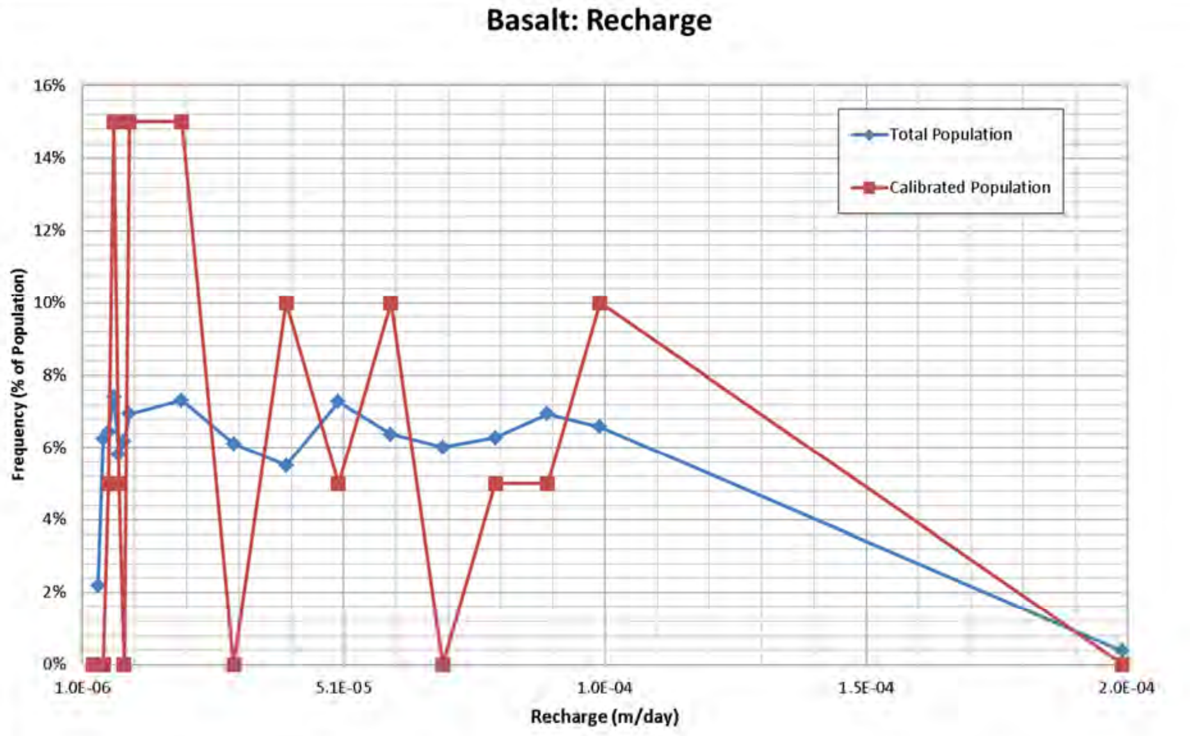

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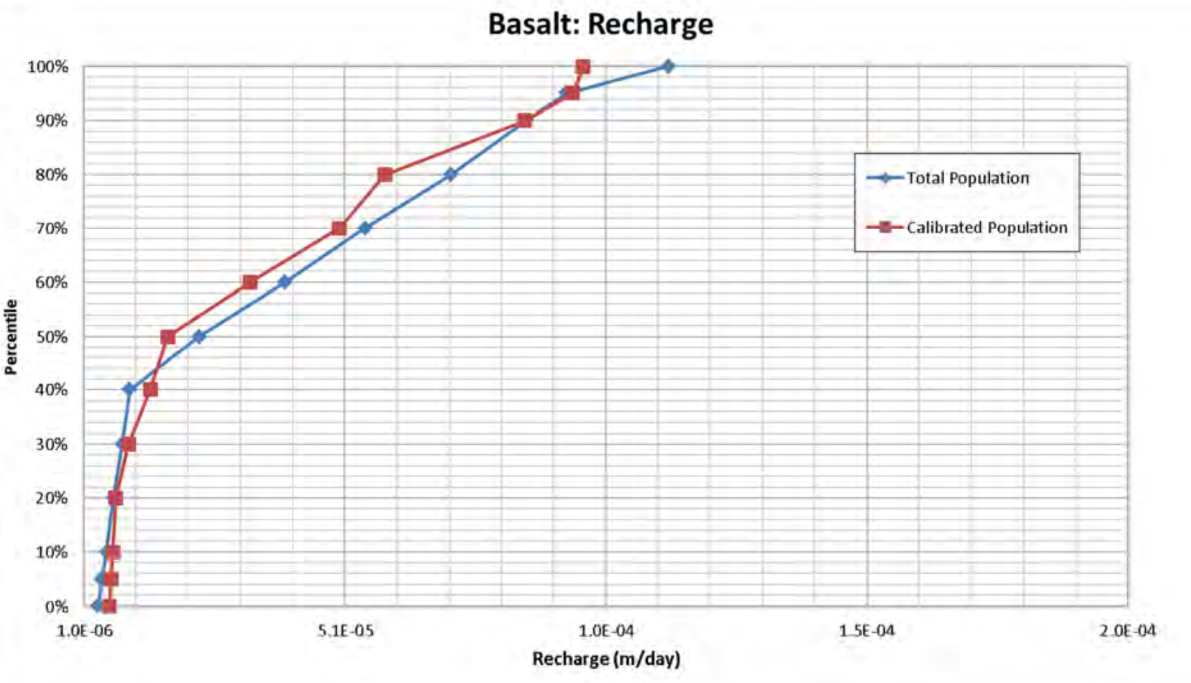

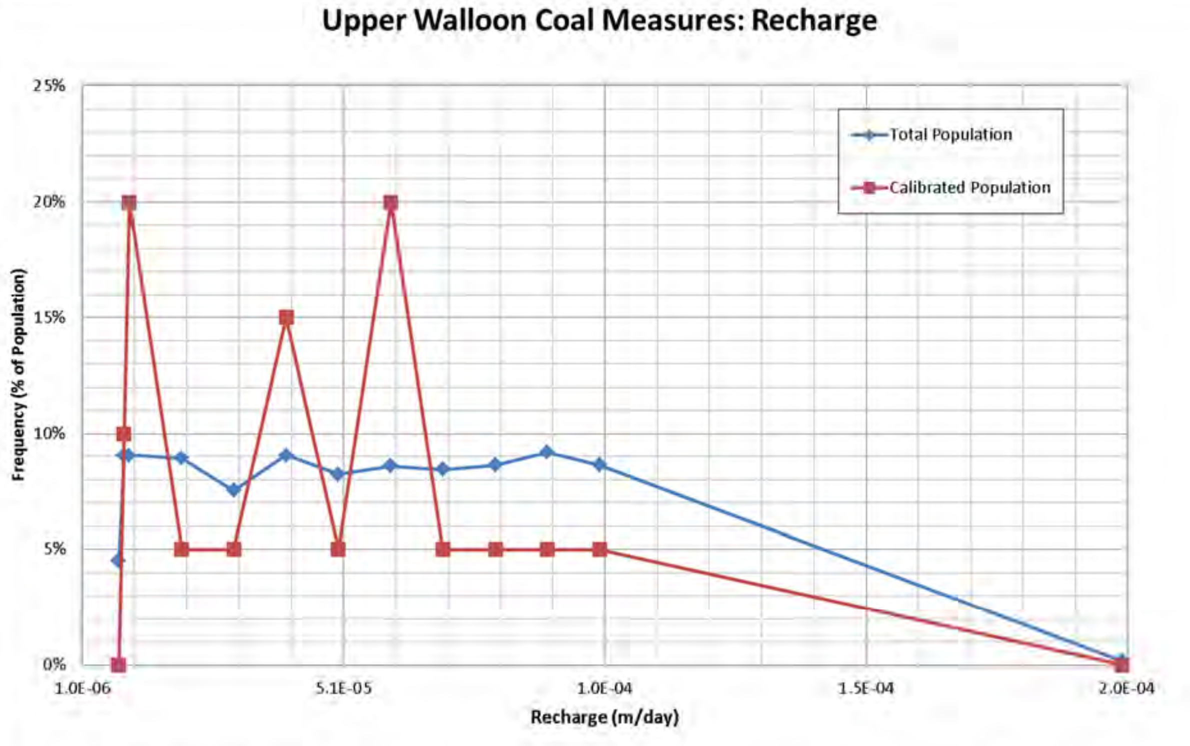

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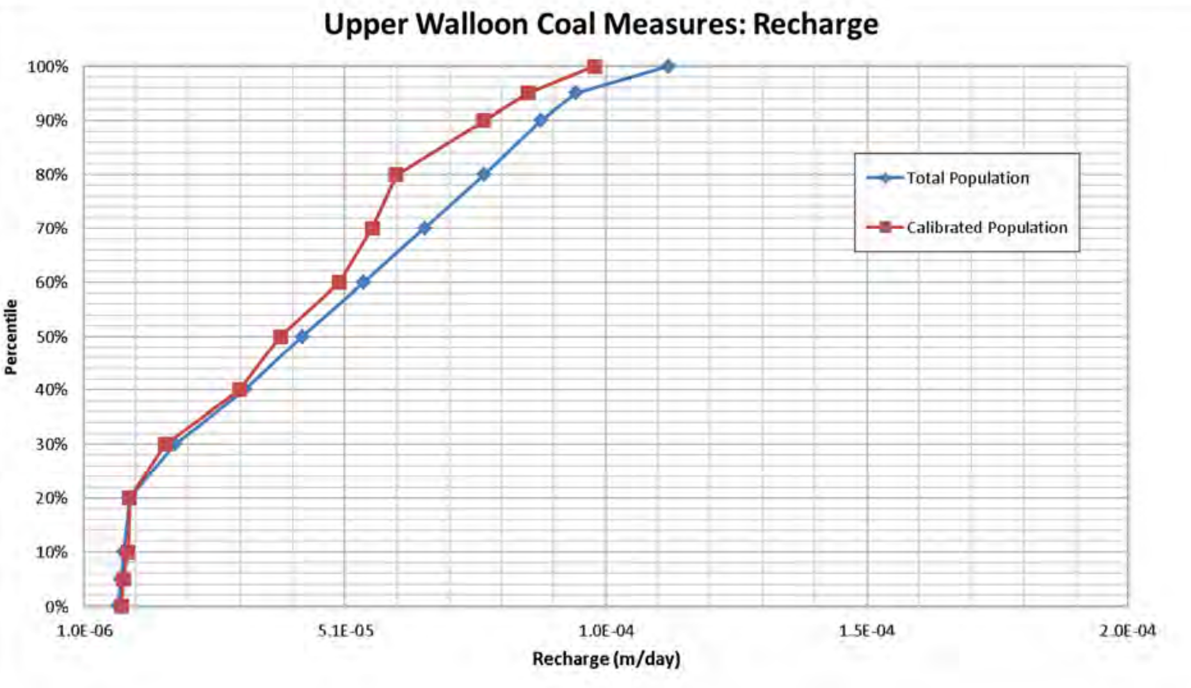

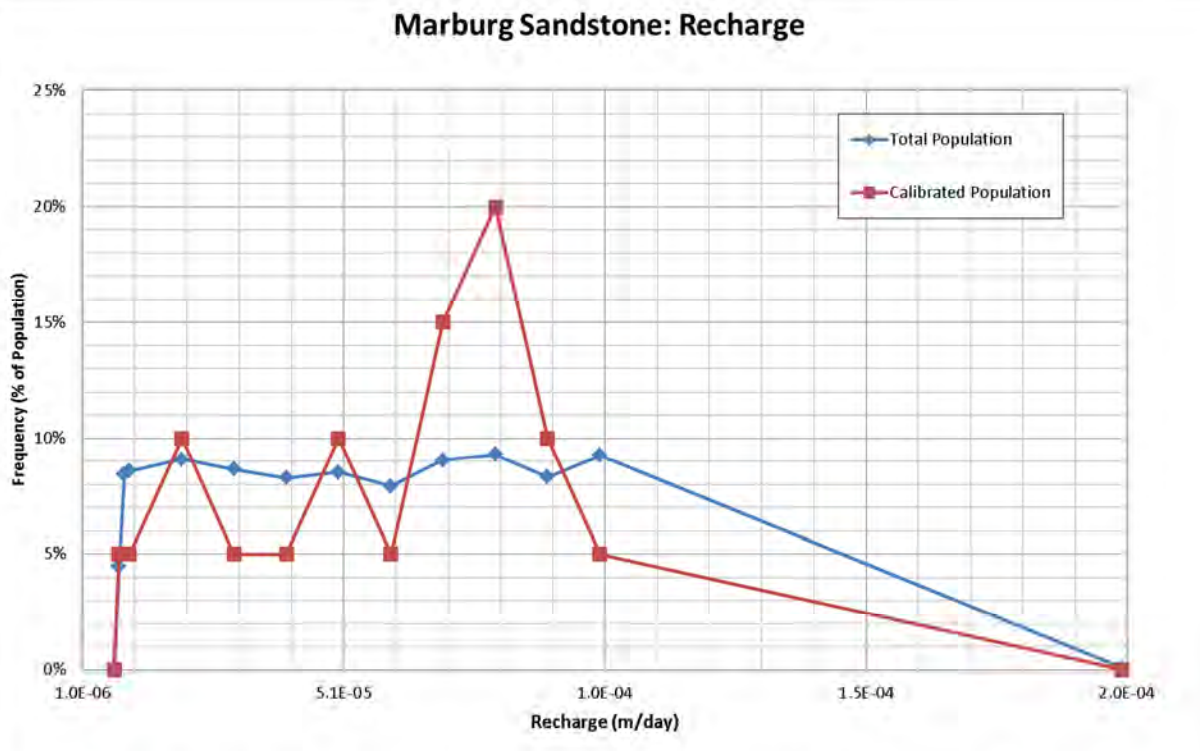

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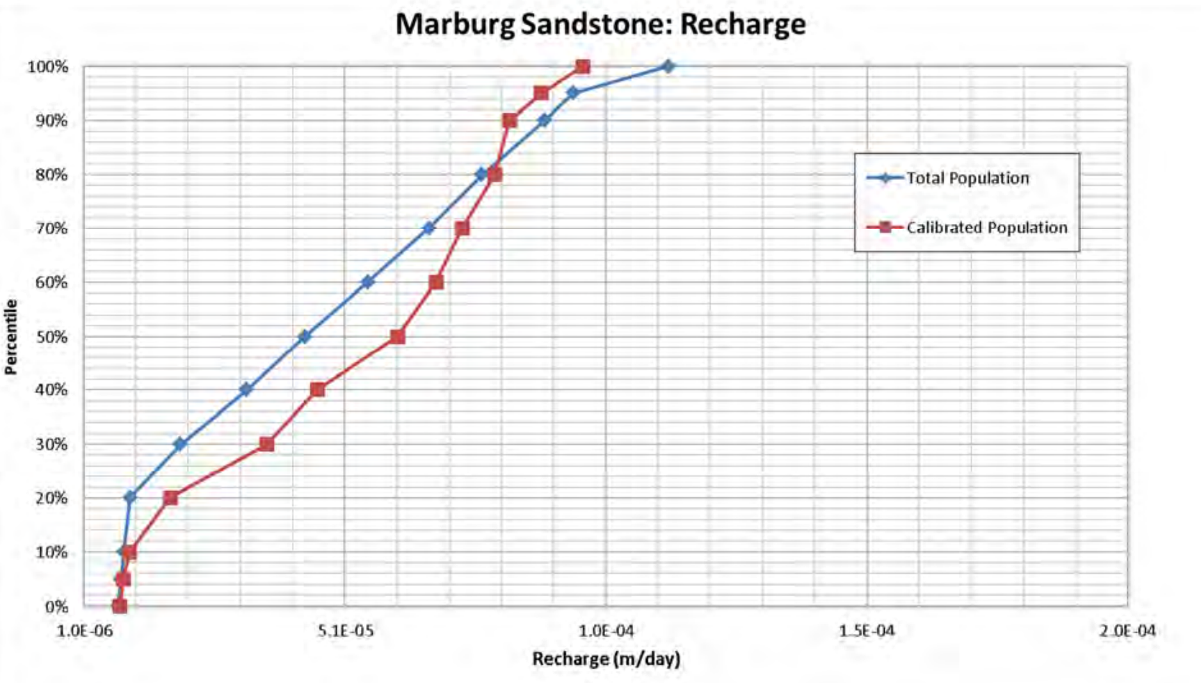

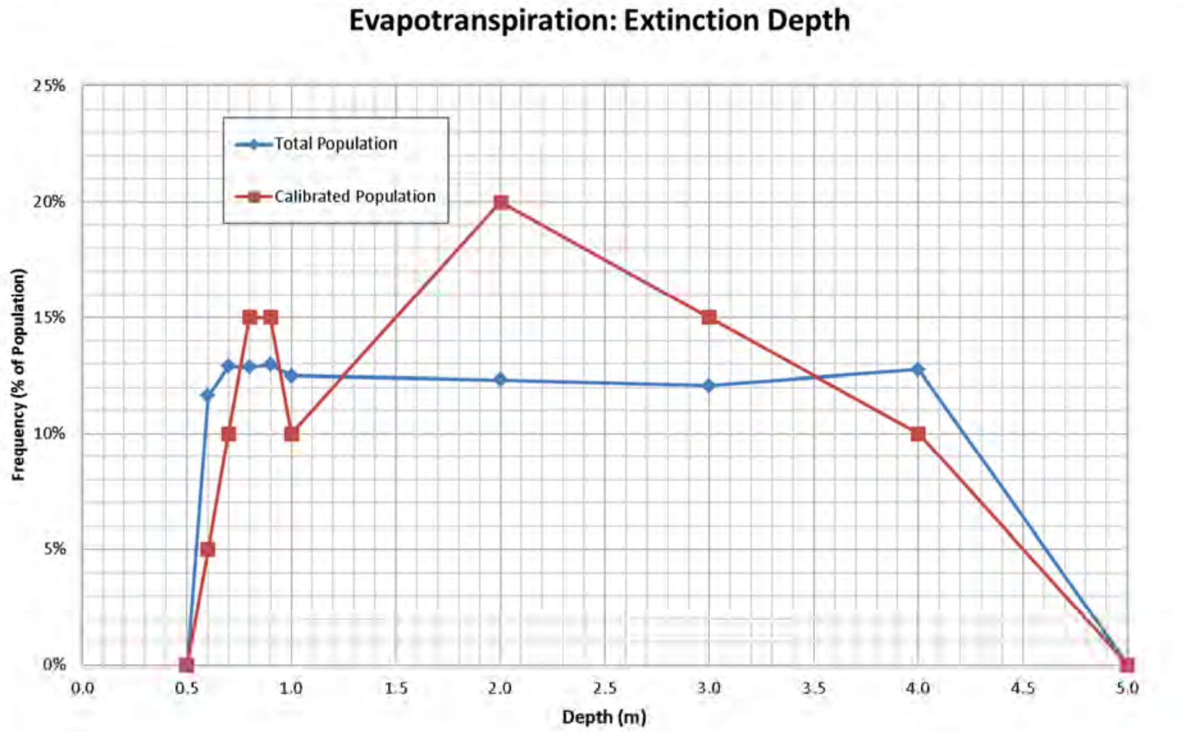

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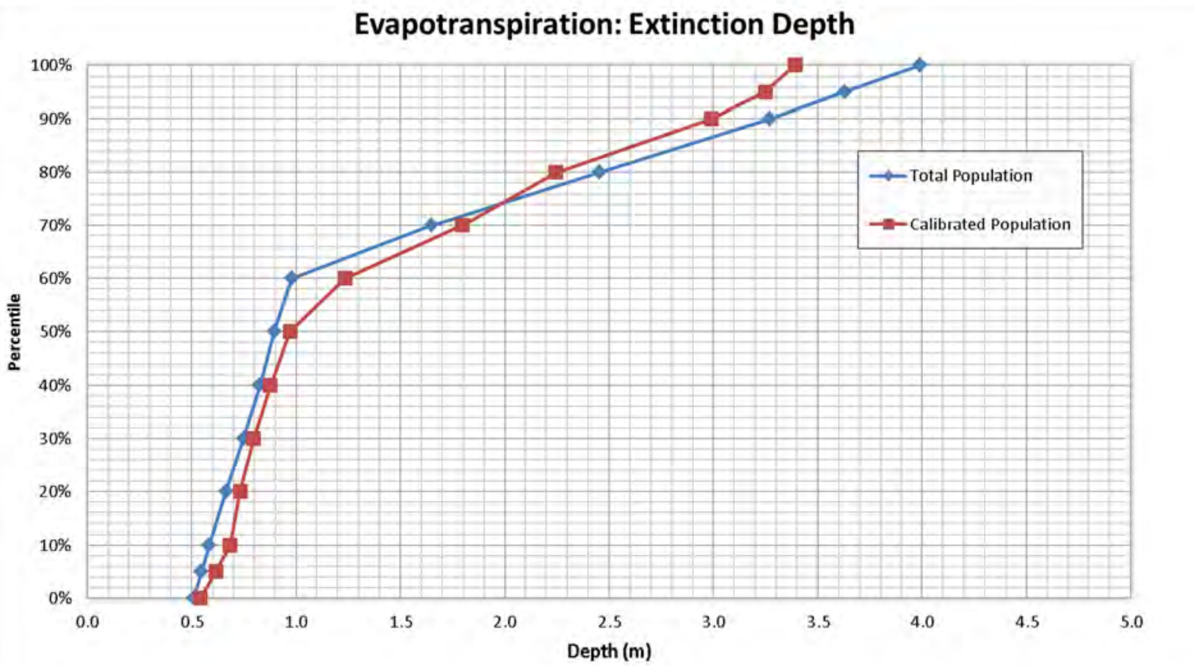
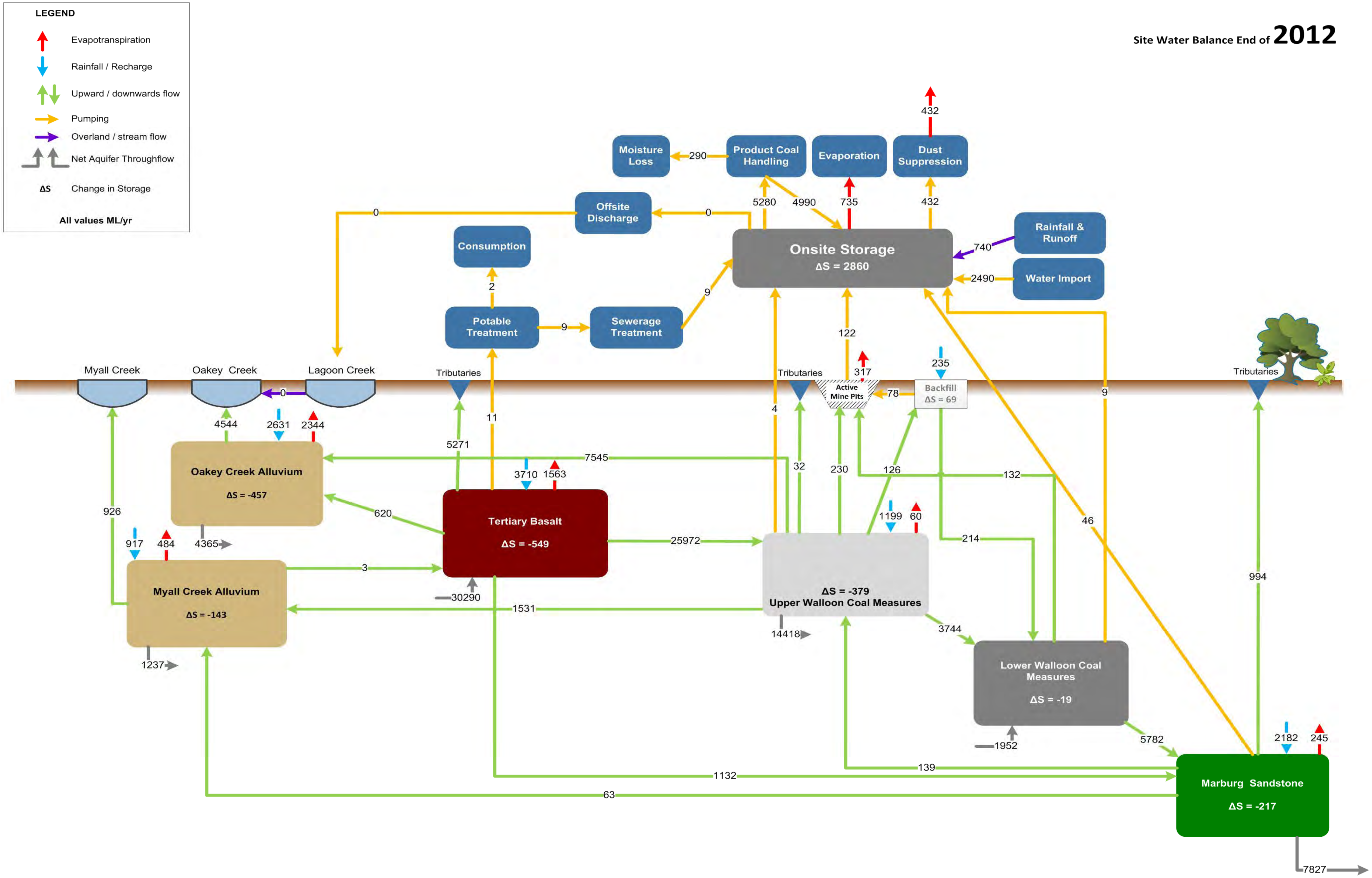


Appendix C. IESC Water Balance Diagrams


LEGEND
Evapotranspiration
Rainfall / Recharge
Upward / downwards flow
Pumping
Overland / stream flow
Net Aquifer Throughflow
ΔS Change in Storage
All values ML/yr
Site Water Balance End of 2012
Moisture Loss
Product Coal Handling
Evaporation
Dust Suppression
Offsite Discharge
Consumption
Onsite Storage ΔS = 2860
Rainfall & Runoff
Water Import
Potable Treatment
Sewerage Treatment
Myall Creek
Oakey Creek
Lagoon Creek
Tributaries
Active Mine Pits
Backfill ΔS = 69
Oakey Creek Alluvium ΔS = -457
Tertiary Basalt ΔS = -549
Upper Walloon Coal Measures ΔS = -379
Myall Creek Alluvium ΔS = -143
Lower Walloon Coal Measures ΔS = -19
Marburg Sandstone ΔS = -217
432
290
5280
4990
735
432
0
0
740
2490
2
9
9
122
317
235
78
9
4544
2631
2344
0
11
5271
4
32
230
126
132
7545
3710
1563
620
926
917
484
4365
3
30290
25972
1199
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1237
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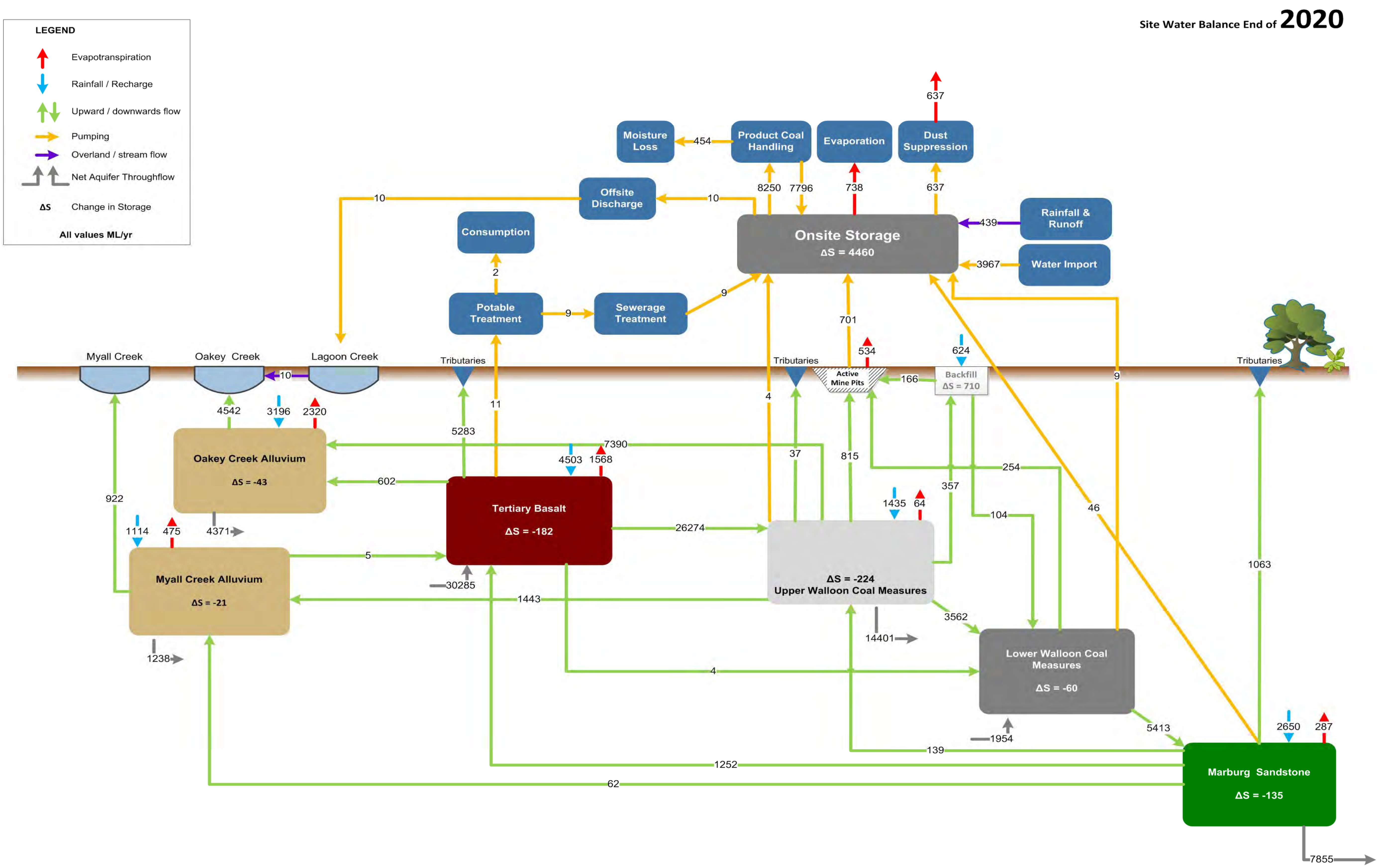
5782
2182
245
139
1132
63
7827


Site Water Balance End of 2020
LEGEND
Evapotranspiration
Rainfall / Recharge
Upward / downwards flow
Pumping
Overland / stream flow
Net Aquifer Throughflow
ΔS Change in Storage
All values ML/yr
Moisture Loss
Product Coal Handling
Evaporation
Dust Suppression
Offsite Discharge
Consumption
Onsite Storage
ΔS = 4460
Rainfall & Runoff
Water Import
Potable Treatment
Sewerage Treatment
Myall Creek
Oakey Creek
Lagoon Creek
Tributaries
Active Mine Pits
Backfill
ΔS = 710
Oakey Creek Alluvium
ΔS = -43
Tertiary Basalt
ΔS = -182
Myall Creek Alluvium
ΔS = -21
ΔS = -224
Upper Walloon Coal Measures
Lower Walloon Coal Measures
ΔS = -60
Marburg Sandstone
ΔS = -135
637
454
8250
7796
738
10
439
3967
2
9
701
534
624
166
4542
3196
2320
5283
11
7390
4503
1568
602
37
815
254
357
1435
64
104
46
922
1114
475
4371
26274
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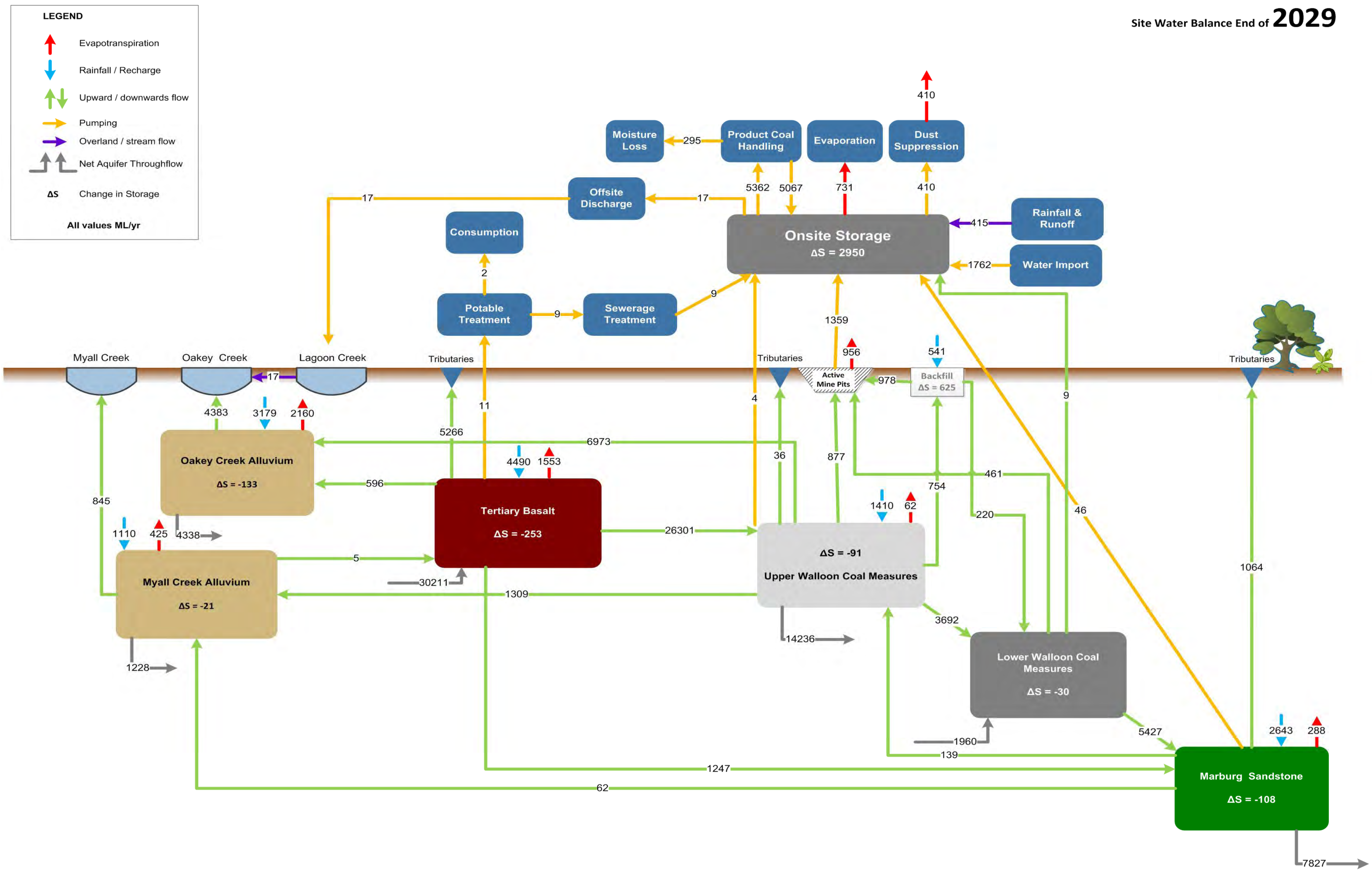
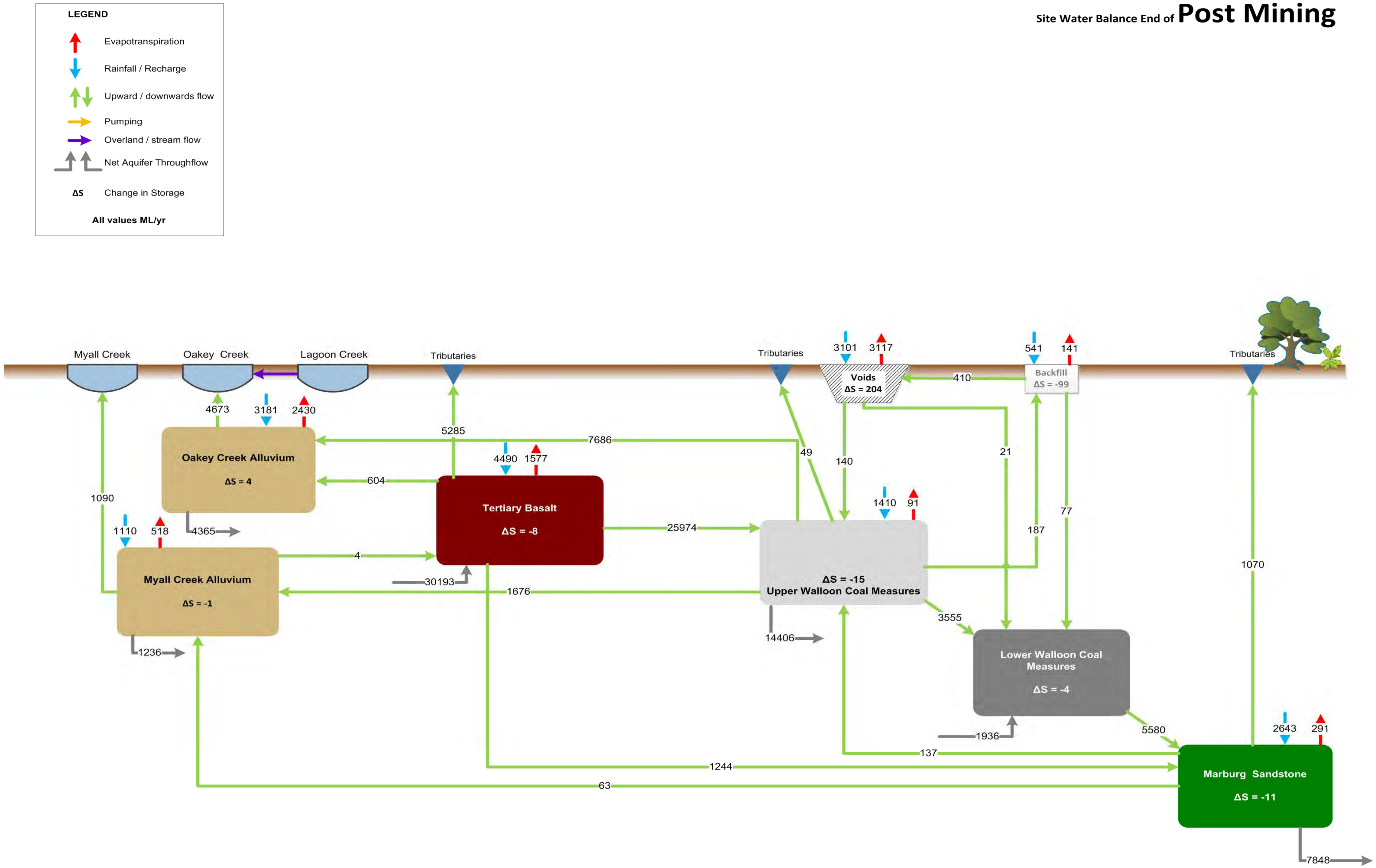
1252
62
1238
7855


LEGEND
Evapotranspiration
Rainfall / Recharge
Upward / downwards flow
Pumping
Overland / stream flow
Net Aquifer Throughflow
ΔS Change in Storage
All values ML/yr
Site Water Balance End of 2029
Moisture Loss
Product Coal Handling
Evaporation
Dust Suppression
Offsite Discharge
Consumption
Onsite Storage
ΔS = 2950
Rainfall & Runoff
Water Import
Potable Treatment
Sewerage Treatment
Myall Creek
Oakey Creek
Lagoon Creek
Tributaries
Active Mine Pits
Backfill ΔS = 625
Oakey Creek Alluvium
ΔS = -133
Tertiary Basalt
ΔS = -253
ΔS = -91
Upper Walloon Coal Measures
Myall Creek Alluvium
ΔS = -21
Lower Walloon Coal Measures
ΔS = -30
Marburg Sandstone
ΔS = -108
410
295
5362
5067
731
410
17
17
415
1762
2
9
9
1359
956
541
978
4
9
4383
3179
2160
11
5266
6973
4490
1553
596
36
877
461
754
845
1110
425
4338
220
1410
62
46
26301
5
30211
1309
1064
3692
14236
1228
1960
139
5427
2643
288
1247
62
7827


LEGEND
Evapotranspiration
Rainfall / Recharge
Upward / downwards flow
Pumping
Overland / stream flow
Net Aquifer Throughflow
ΔS Change in Storage
All values ML/yr
Site Water Balance End of Post Mining
Myall Creek
Oakey Creek
Lagoon Creek
Tributaries
Tributaries
Tributaries
Voids
ΔS = 204
Backfill
ΔS = -99
3101
3117
541
141
410
4673
3181
2430
5285
7686
49
140
21
Oakey Creek Alluvium
ΔS = 4
4490
1577
604
Tertiary Basalt
ΔS = -8
1090
1110
518
4365
25974
1410
91
77
187
Myall Creek Alluvium
ΔS = -1
4
30193
1676
ΔS = -15
Upper Walloon Coal Measures
1070
3555
14406
1236
Lower Walloon Coal Measures
ΔS = -4
1936
5580
2643
291
137
1244
Marburg Sandstone
ΔS = -11
63
7848