PART B – AEIS

15. GROUNDWATER

15.1. Regulatory framework

15.1.1. Fitzroy Basin Water Resource Plan (WRP) 2011

The Department of Environment and Heritage Protection (DEHP) identified that the EIS had not referenced the Water Resource (Fitzroy Basin) Plan 2011 (Fitzroy Basin WRP) and the *Sustainable Planning Act 2009* (SP Act), the former of which is relevant to groundwater planning in the Project area and the latter which relates to the construction of dewatering bores or artesian monitoring bores.

The Fitzroy Basin WRP provides a framework for sustainably managing water and the taking of water within the Fitzroy Basin. The Fitzroy WRP applies to surface water catchments and declared groundwater management areas within the basin. While the Project sits within the Carnarvon Groundwater Management Area, it is important to note that the WRP only applies to subartesian groundwater that is not connected to artesian water.

In the Project area, the Water Resource (Great Artesian Basin) Plan 2006 (GAB WRP) applies for all artesian groundwaters. The GAB WRP and its relevance to the Project were described in Section 15.1.1.3 of the EIS.

Works related to interfering with or taking (sub-artesian) groundwater within the Carnarvon Groundwater Management Area are considered assessable development under the SP Act.

15.1.2. Water Act 2000

DEHP also suggested several points listed under Section 15.1.1 of the EIS in relation to the application of the *Water Act 2000* to SunWater activities were not relevant unless SunWater were seeking a driller's licence.

While SunWater is not seeking such a licence, the points were included because SunWater needs to be aware of these requirements when commissioning any drilling related to the Project.

It is also acknowledged that Sections 10 and 11 of the *Water Act 2000,* which provide general context on sustainable management and efficient use of water resources, are also relevant to the Project in addition to the more specific sections of the Act referred to in the EIS.

15.2. Regional hydrogeology

15.2.1. Conceptual understanding of regional hydrogeology

Submissions received from the DEHP and the (then) Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC), now Department of the Environment (DoE) queried the extent and utility of the data and information used to inform the conceptual and numerical groundwater models. The concerns raised included:

- the appropriate use of data from existing groundwater bores;
- a need for drilling and construction of new bores to supplement existing data; and
- appropriate interpretation of new data based on the conceptual understanding of the groundwater system.

Specifically DoE suggested further investigation into the hydrogeology of the Project area to better understand paths for preferential aquifer recharge.

To address the above concerns, SunWater commissioned additional desktop and field based hydrogeological assessments over the period from July 2012 to December 2013. A full report on these additional assessments can be found in **Appendix B15**. The additional desktop and field based hydrogeological assessment were reviewed by an independent peer reviewer on behalf of the Coordinator General and DoE. The scope of this independent review was to assess the adequacy and appropriateness of the data gathered, the hydrogeological conceptualisation and the impact assessment conclusions with regard to the Great Artesian Basin Springsure Group springs. This review concluded that the EIS and AEIS presented '*sufficient data to adequately evaluate risks to groundwater in the Nathan Dam study area*'.

The desktop assessment involved a comparative review of recent literature to determine the appropriateness of the EIS conceptual groundwater model. Specifically, the desktop assessment found that the conceptualisation of groundwater flows and spring processes presented in the EIS agrees with other relevant studies in the Project area. Additionally, while significant additional data has been collected for some springs in the Project area, none of the new data contradicts the conceptual model developed as part of the EIS. Thus the conclusions drawn from this review support the main assumptions and understanding of the conceptual model presented in the Nathan Dam EIS. Section 2.2 of **Appendix B15** presents a full description of this review.

The field program was developed to fill data gaps identified during the desktop assessment, increase understanding of the regional groundwater system, confirm some of the assumptions and increase confidence in the numerical model developed for the EIS in the areas of greatest interest i.e. around the springs. This work included the construction of new groundwater monitoring bores to gather data on the nature of the local and regional hydrogeology and hydrostratigraphy.

Five new bores were installed and two pre-existing bores were refurbished during this field program. A summary of the bore locations and purpose are provided in **Table 15-1**.

Table 15-1 Summary of new and refurbished observation bores

Feature	Observation Bore ID	Aquifer Monitored	Purpose
Dawson	MB01	Hutton Sandstone	Located within the modelled impact zone within the west of the inundation area. Used to observe any changes to the groundwater system in the Hutton aquifer towards the township of Taroom.
Dawson	MB02	Hutton Sandstone	
Boggomoss	MB02	Precipice Sandstone	Located within the modelled impact zone to the north of the inundation area. Used to observe any changes in the Precipice aquifer associated with Boggomoss springs
Boggomoss	MB03	Precipice Sandstone	
Boggomoss	MB04	Precipice Sandstone	
Cockatoo	RN67229*	Precipice Sandstone	A control site located to the south of the inundation area and outside of the modelled impact zone
Spring Creek	PB01*	Precipice Sandstone	Located at the proposed dam wall site

*Refurbished bores

Measurements of potentiometric head, water table levels and aquifer water quality were taken from both GAB springs and observation bores. Analysis of water quality samples collected in this field program further confirms the groundwater conceptualisation presented in the EIS. Further information on the desktop and fieldwork program is provided in **Appendix B15**.

Overall, the results of the desktop and field assessment confirm that the fundamental assumptions and conceptualisation presented in the EIS remain appropriate for assessing the impacts to the groundwater system from the Nathan Dam Project. Further, the data collected as part of these studies confirm the conceptualisation developed as part of the EIS.

15.2.2. Bore surveys

A submission by DEHP raised concern over the quality of bore survey information used for the EIS, specifically the reliance of the EIS on licenced bore data. The submission suggested the need for a bore survey to be undertaken to supplement this information. Further, DEHP indicated the need for a monitoring program to asses, rehabilitate or replace bores that may be at risk of failure through increased groundwater pressure.

It is acknowledged that the EIS relied upon current data available at the time of the impact assessment.

The proponent has committed within the EIS to undertake a bore field survey prior to commencement of the construction phase of the Project that will classify the current condition of bores in the Project area. This work will occur after the completion of the AEIS process. The bores to be surveyed will be those determined to be within the radius of influence of at least a 2 metre increase in groundwater pressure as modelled in the AEIS.

The program of bore surveys will determine the condition of the specified bores, including bore age, depth, type and condition of casing and headworks, water level/pressure, and groundwater quality. A judgement will be made in each case about the likely impact of the modelled increase in groundwater pressure and the condition of the bore to determine what rehabilitation or replacement of the bore infrastructure may be required to mitigate the possible impacts. A discussion between the proponent and the bore owner will occur around funding for the proposed upgrades should any alteration to bore infrastructure be suggested.

15.3. Nathan Dam groundwater model

15.3.1. Accuracy of the groundwater model

As part of the EIS, a numerical groundwater model was developed to estimate potential impacts of the Project on the surrounding groundwater including aquifers, bores and GAB springs.

DEHP raised concerns over the validity of the groundwater model including assumptions used to formulate the model and predict impacts and questioned whether the groundwater study met the requirements of the Terms of Reference. Specific concerns were raised over the acknowledgement of errors in bore measurements that were identified during the model construction, making them unsuitable for use during calibration. DEHP stated that the groundwater model did not adequately assess potential impacts as sufficient input data (particularly around the interaction between the alluvial aquifer and adjacent aquifers) was not available.

Additionally DoE suggested that the accuracy of the modelled artesian potentiometric surface (in some places modelled above the ground surface) was limited due to the lack of temporal water level records.

Section 15.2.1 (and Appendix B15) outlines the additional desktop and field program undertaken subsequent to the EIS to further the understanding of groundwater processes in the Project area. The outcomes of the desktop assessment and additional data captured during the field program have been used to determine if the conceptual and numerical groundwater models developed during the EIS were, and remain valid.

As described in **Section 15.2.1**, the desktop assessment and additional field work confirmed the validity of the conceptual groundwater model presented in the EIS that was used as the basis for the groundwater numerical model.

The EIS groundwater model and associated assumptions were fully documented in Appendix 15E of the EIS. The model was calibrated to an inferred potentiometric surface. Due to the artesian nature of aquifers in this area, in some places this inferred surface is above ground level. Comparison between this potentiometric surface and the observed measurements from the new bores indicates that the model has provided a reasonable estimate of hydraulic head which is consistent with the Australian Groundwater Modelling Guidelines (NWC, 2012) and accepted industry standards.

During the additional field work, temporal data was discovered and analysed for two existing bores at the dam site. The results of this additional temporal groundwater data and hydrostratigraphic information collected during the field program indicate that the potential impact of the dam is likely less than that presented in the EIS.

Overall the additional desktop and field assessments have concluded that the groundwater model provides a reasonable representation of the system and is a satisfactory tool for prediction of the effects the Nathan Dam will have on local and regional groundwater systems. If anything, the initial numerical modelling undertaken during the EIS is likely to provide a conservative estimate (over prediction, but within realistic bounds) of the potential groundwater impacts of the Project.

Furthermore, the level of modelling and impact assessment undertaken for the EIS is consistent with current industry standards; in particular it is generally consistent with the form and level of assessment completed as part of Queensland Water Commission's Underground Water Impact Report.

15.3.2. Increased groundwater levels associated with dam inundation

DEHP requested further explanation as to the difference in predicted increase in flow from springs up and downstream of the dam.

As discussed in Section 15.2.3 of the EIS, the model predicted increases to flows from springs located downstream of the dam wall were 660%. These springs are primarily located in outcropping Precipice Sandstone. Upstream of the dam wall, the model predicted increase to spring flows was 94% for the springs fed from the Precipice Sandstone. Downstream of the dam wall (where the groundwater gradient is greatest), movement of water in this formation is generally unrestricted by overlaying confining layers of rock as erosion in the river valley has worn away the overlaying geology to expose the Sandstone in places.

15.4. Groundwater Impacts

15.4.1. Groundwater dewatering impacts

Several submissions raised concern that the dewatering of the dam chimney filter will impact local groundwater levels and affect the availability of water for current users (i.e. stock watering, household, domestic and garden use) with specific reference made to the Taroom town bore.

Modelling of the likely drawdown from the dewatering activities of the dam was reported in Section 15.2.3 of the EIS. This modelling showed that the drawdown in groundwater level will be restricted to a radius of approximately

1.5km centred on the proposed dam wall site. Based on a search of the DERM groundwater database, the EIS concluded that there are no registered groundwater users, including in Taroom, that will be affected by dewatering activities. As such, mitigation strategies are not required.

15.4.2. Groundwater use

A submission raised concern regarding the appropriateness of use of mean electrical conductivity (EC) to characterise water quality in aquifers due to potential accuracy limitations associated with the groundwater database. The submission also raised concerns that this information was used to characterise the suitability of the water for a range of uses, based on the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000* and the A*ustralian Drinking Water Guidelines 2004*. It was suggested that actual water use data collected from bore owners be used instead.

SunWater acknowledges that actual water use data could be collected from bore owners and this will form part of the bore survey SunWater has committed to prior to construction. The use of a range of EC data from multiple sample sites and times would provide additional information on aquifer water quality. However, given negligible impacts to groundwater quality are expected, the value of this data collection is limited for the Project.

15.4.3. Groundwater dependent ecosystems

DoE requested that SunWater provide further information to support the claim that the Springsure Supergroup spring community should be defined as a recharge system, rather than a discharge system as it is defined in the Recovery Plan. The submission suggested that SunWater conduct a groundwater flow study to determine the nature of the Springsure Supergroup community hydrogeology.

A field program, as outlined in **Section 15.2**, has been undertaken to further develop a conceptual understanding of the regional groundwater. This program included assessment of groundwater and surface water interactions associated with Great Artesian Basin (GAB) springs.

Specific discussion on the classification of GAB springs as either discharge or recharge is dealt with in **Chapter 28 MNES**.

15.5. Groundwater monitoring

15.5.1. Groundwater monitoring program

Several submissions requested further detail on the Project related groundwater monitoring program, including an indication of the monitoring timeframes and management measures to respond to any unforeseen impacts.

A comprehensive groundwater monitoring and management program capturing new bores drilled as part of the post-AEIS works, as well as existing bores, is detailed in **Appendix B29** – Draft Environmental Management Plan (EMP) and will be initiated prior to the commencement of the construction phase of Project works. The initial suite of parameters sampled under this program is likely to include electrical conductivity (EC), pH, iron, and major anions and cations.

The design of the groundwater monitoring proposed for the Project has taken into account the modelled timeframes of any potential impact of the Project on the local groundwater system.

Although no unacceptable impacts to groundwater are expected, SunWater commits to managing any unforeseen and unacceptable impacts that may be determined through the monitoring program committed to as part of the EIS and detailed in the revised EMP in **Appendix B29**.

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