Table of Contents

Figures

Tables

8. Groundwater Resources

8.1 Introduction

With the expansion of Hinze Dam to the Stage 3 height, there is a need to assess existing groundwater resources within the area of inundation and investigate whether the project has the potential to result in groundwater-related environmental or social impacts. As part of the project the height of the main dam embankment crest will be raised from 93.5 m to 108.5 m AHD. The FSL will be raised 12.3m from 82.2 m to 94.5 m AHD increasing the area of inundation within the Hinze Dam catchment.

This section details the results and findings of a desktop review undertaken to assess potential groundwater impacts that may arise as a result of the current proposal. Consideration of mitigation and management measures to be applied throughout the construction and operational stages of the project was also undertaken as part of this assessment.

8.2 Existing Environment

An overview of the hydrogeological setting within the vicinity of Hinze dam is presented in this section. This assessment is based on the area subject to inundation as a result of the project. The existing extent of inundation together with the area of inundation following Stage 3 development is shown in **Figure 8-1** Hinze Dam Area of Inundation .

8.2.1 Hydrogeological Setting

Regional (1:250 000) geological mapping records published by the Department of Natural Resources & Water (DNRW) and the Geological Survey of Queensland (GSQ) (SEQGIS v2, 2000), were used to describe the hydrogeological setting of the assessment area. The spatial distribution of surface or outcrop geology is presented as **Figure 8-2**.

The surface geology in the vicinity of the Hinze Dam is dominated by the Neranleigh Fernvale beds. These beds are predominately composed of Carboniferous metasediments and include mudstone, shale, arenite, chert, jasper, basic metavolcanics, pillow lava and conglomerate, which generally have poor permeability characteristics.

Quaternary alluvial deposits consisting of gravels, silts, muds and clays are described along drainage lines feeding into and downstream of the dam. These deposits, while limited in aerial extent, generally display moderate permeability characteristics due to the relatively high clay and silt content.

The Main Range Tertiary volcanics to the south of the Dam are Tertiary hypabyssal intrusions consisting of Rhyolitic tuffs and lavas which correspond to topographically elevated areas. In general, non basaltic materials within these deposits commonly have poor groundwater potential (Swann 1997).

A north-east, south-west trending ridge line to the north-west of the dam is composed of olivine basalts (Main Range Tertiary volcanics). These olivine basalts can have reasonable to good groundwater prospects as is in agreement with Swann (1997), however it should be noted that this unit is located several kilometres away from the dam footprint.

Colluvium deposits consisting of basalts, soil, clay, cobbles and boulders flank the elevated ridge line. Permeability characteristics of these deposits are generally poor.

Drilling undertaken within close proximity of the dam wall, as part of the geotechnical program, indicated minor and localised bedding, jointing and fracturing within the Neranleigh Fernvale beds. In general however, the Neranleigh Fernvale beds have low groundwater potential (Swann 1997). On a regional scale, some north-east, south-west trending lineaments have been inferred from aeromagnetic interpretation; these are presented as **Figure 8-2**.

N

0 0.5 1 2

Kilometres

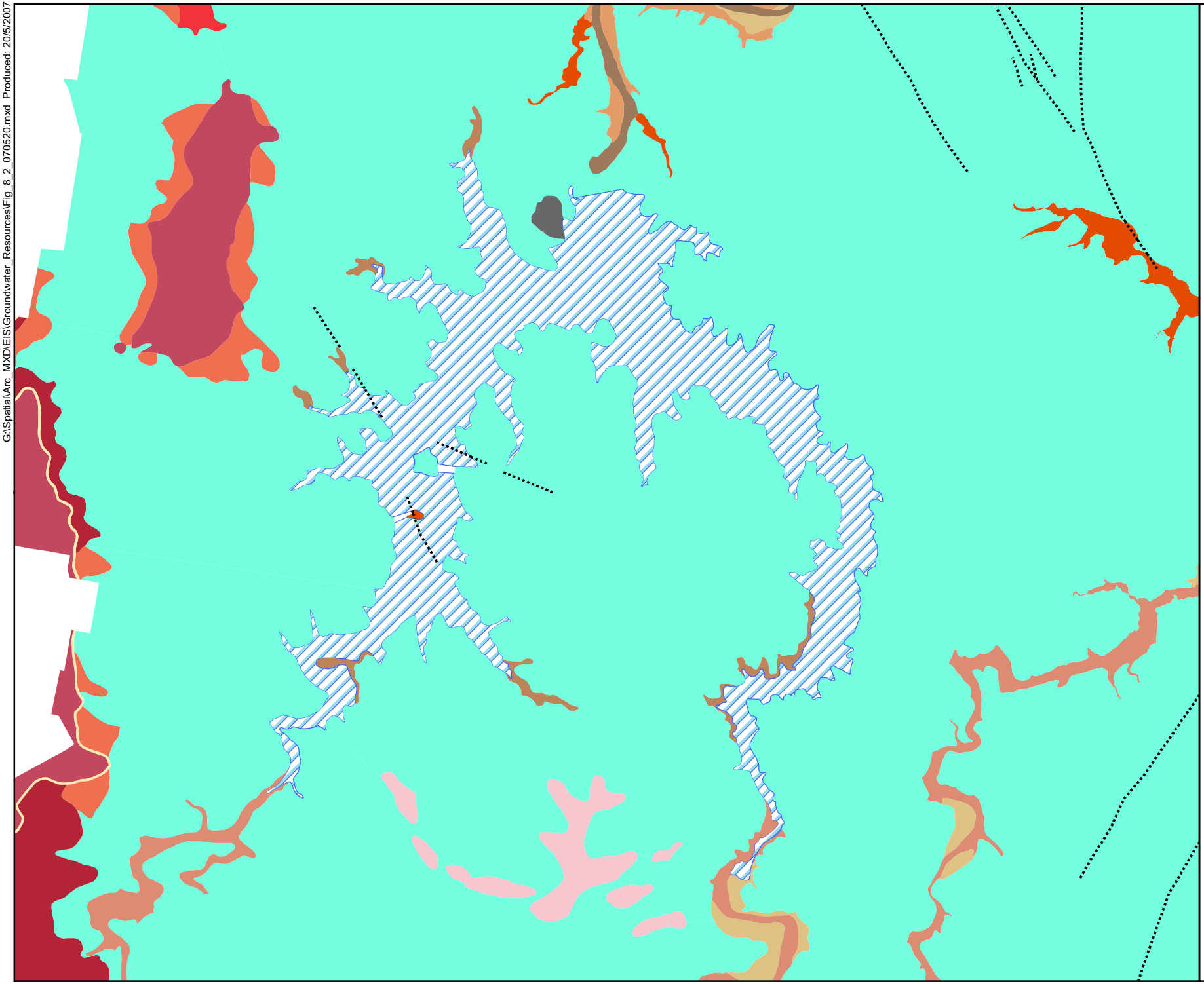
Scale - 1:60,000

Projection: MGA Zone 56

Figure 8-1

Footprint of Proposed Inundation Area

Hinze Dam Stage 3 EIS



G:\SpatialArc_MXD\EIS\Groundwater_Resources\Fig_8_2_070520.mxd Produced: 20/5/2007

N

0 0.5 1 2
Kilometres

Scale - 1:50,000
Projection: MGA Zone 56

Legend

- Lineament
- Qhh/Res - Hinze Dam
- DCf - Metasediments
- Qa - Alluvium
- Qhh/a - Quarry area
- Qha - Alluvium
- Qha1 - Alluvial terrace
- Qha2 - Alluvial terrace
- Qhac - Alluvium/Colluvium valley infill
- Qpa - Pleistocene alluvial terrace
- Tfg - Mount Gillies Rhyolite
- Tl - Lamington Group
- Tlb - Beechmont Basalt
- TQcb - Colluvium basalt
- T/r - Hypabyssal intrusions
- Rch - Chillingham Vocanics

Figure 8-2

Geological Map

Hinze Dam Stage 3 EIS

Fractured chert and greywacke associated with the Neranleigh Fernvale beds were identified on the eastern and southern sides (respectively) of the dam wall during the geotechnical investigations (URS 2007). Packer tests were conducted with hydraulic conductivity results of up to 1 x 10^{-5} m/s for these fractured materials. Packer tests conducted in competent greywacke displayed results ranging from relatively impermeable 1 x 10^{-9} m/s to 2.5 x 10^{-6} m/s.

8.2.2 Groundwater Occurrence

Regionally, the Neranleigh Fernvale beds rarely host groundwater resources of significance, except in areas associated with zones of structural deformation along drainage lines (Swann 1997). Assessment of available geological data (SEQGIS v2 2000) together with geotechnical investigations indicates zones of structural deformation are likely to be limited to inferred regional lineaments along with localised bedding, jointing and fracturing within close proximity of the dam embankment crest.

The increased permeability of the fractured greywacke and chert near the dam wall relative to the surrounding strata is likely to represent a localised secondary porosity aquifer system which is in hydraulic connection with and is recharged by the existing dam. Remedial geotechnical measures are currently being undertaken to grout the fracturing so as to ensure hydraulic losses are minimised. Localised hyporheic[1] groundwater systems may also be associated with areas of relatively permeable sands and gravels along drainage lines running into and downstream of the dam.

In general, groundwater occurrence within the area of inundation within the immediate vicinity of Hinze Dam is negligible.

The Neranleigh Fernvale beds do not host a groundwater resource of significance and aquifer prospects are poor given the extremely low in situ permeability of the formation. As such, the potential for the project to impact upon local or regional groundwater resources is considered negligible.

8.2.3 Groundwater Levels

Gold Coast City Council (GCCC) were consulted in relation to available groundwater data relevant to the study area. A review of (GCCC) groundwater monitoring level data recorded in and around the dam embankment as part of ongoing geotechnical studies was undertaken. It should be noted that most piezometers monitored as part of this program are installed in anthropogenic fill and not in natural materials. As such, the resultant water levels are unlikely to reflect true groundwater table elevations, however the data is useful and is presented below for reference purposes.

Groundwater levels within fill materials associated with the dam embankment tend to vary between 60 m and 75 m AHD with groundwater levels in close proximity to the dam wall displaying some correlation with recorded fluctuations in dam level. In general, groundwater levels in the fill materials vary from 4.5 to 30 m below surface due to differences in topographical elevation of monitoring parts. These results are generally comparable to regional groundwater level results extracted from the DNRW groundwater database. It should be noted however that there was a poor correlation between groundwater levels, topographic elevations and dam levels.

In the immediate vicinity of the dam, groundwater recharge is likely to be predominantly from rainfall with some input from seepage loss. There is a reasonable correlation between groundwater elevation records obtained from 1975 to 2005 in embankment fill materials and dam levels. However, piezometers installed in more coherent materials or away from the embankment show relatively stable groundwater level trends that do not vary in response to fluctuations in dam level, which is consistent with low permeability materials.

Transient regional-scale groundwater level data was not available, however it is considered likely that there is negligible regional hydraulic connectivity of the Neranleigh Fernvale beds. Following increased inundation

[1] Hyporheic zone is where there is mixing of shallow groundwater and surface water in a region beneath and lateral to a stream bed.

associated with dam wall height increase, there is likely to be a localised increase in groundwater levels in alluvial materials in the immediate vicinity of the area of inundation as a result of saturation of local structural defects.

8.2.4 Groundwater Users and Quality

Using database records obtained from consultation with the Department of Natural Resources & Water (DNRW), a facility survey was undertaken for the area within the vicinity of the project. There are 16 registered groundwater facilities within a 7 km radius of the dam, as presented in **Table 8-1** and shown on **Figure 8-3** Groundwater Facilities .

Data from this survey suggests that groundwater usage in the area is negligible due to the general absence of a groundwater resource within the region.

It should be noted that the water quality and groundwater level results presented in **Table 8-1** were not verified as part of this study and may not be characteristic of site conditions, particularly given that most results were recovered during private investigative groundwater drilling programs.

Table 8-1 Registered Groundwater Facilities within 7 km of the Hinze Dam

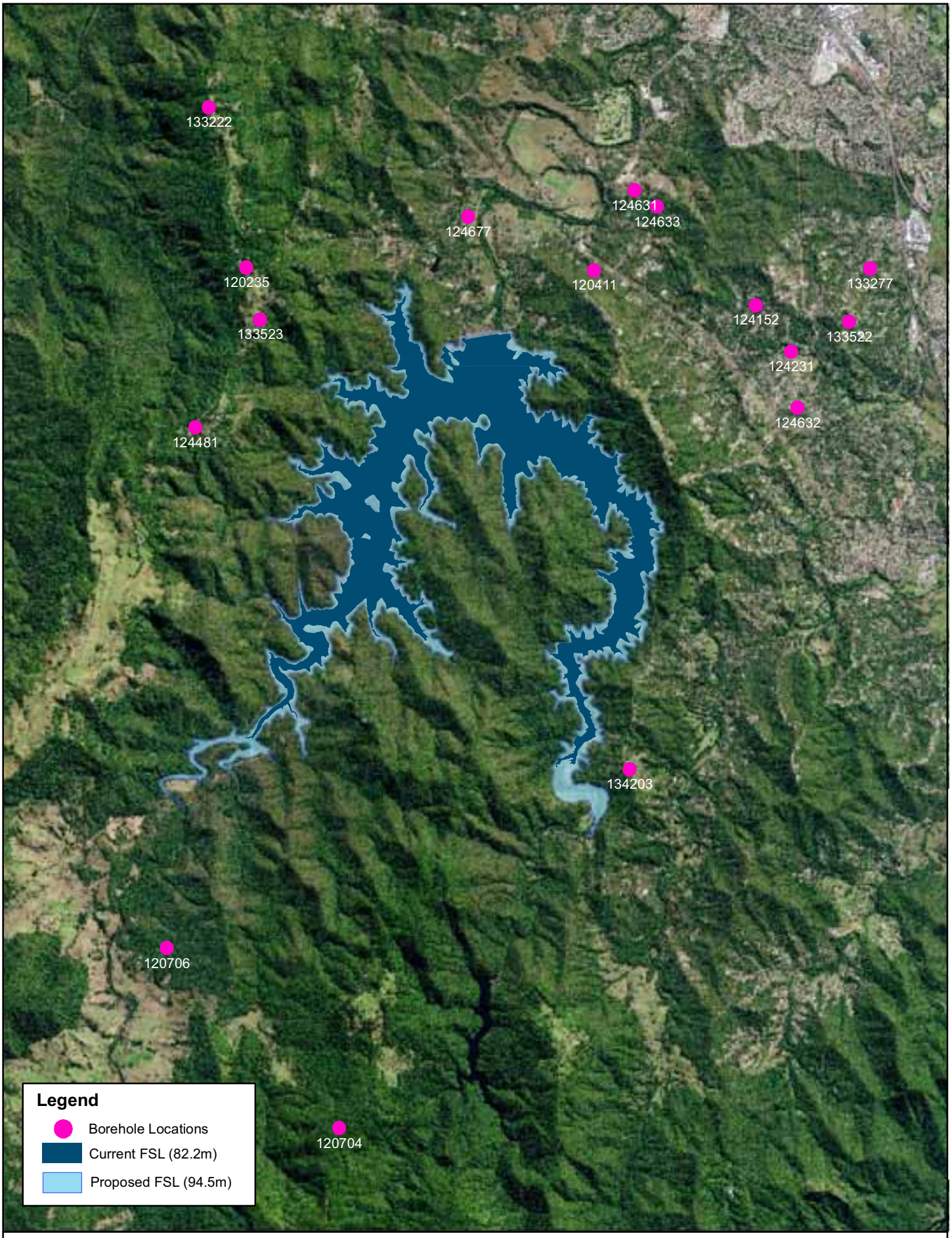
Registration Number	Year Drilled	Lithology	Yield (L/Sec)	SWL (mBGL)	Conductivity (µS/cm)	pH
120235	2004	Grey Wacke	0.06	NS	20	7.7
120411	2003	Gravel, Sand & Grey Wacke	1.5	-3.90	330	NS
124152	2004	Basalt	5	-50	80	NS
124481	2003	Clay, Mudstone, Wacke	0.28	-33.84	1600	NS
124631	2005	Basalt	0.07	-16	200	7.2
124632	2005	Clay, Basalt	0.22	-22	200	6.4
			0.16	-22	200	6.4
124633	2005	Shale	0.18	-30	NS	6.3
124677	2005	Grey Wacke	1.25	-8.80	NS	NS
133222	2005	Basalt	0.08	-32	NS	5.9
			0.05	-32	NS	5.9
133277	2005	Clay, Blue rock	3.13	-6	2600	NS
133522	2005	Shale	7.5	-18	100	6.2
133523	2005	Basalt	0.50	-30		6.0
134203	2006	Shale, Grey Wacke	0.20	-9	600	8.1

NS = Not Specified SWL = Standing Water Level mBGL = meters below ground level

Based on the data presented in **Table 8-1**, groundwater quality ranges from slightly acidic to slightly alkaline with pH fluctuating from 5.9 to 8.1. Conductivity results indicate that groundwater is fresh to slightly brackish. Groundwater yield is shown to be low to very low with yields of >5 L/sec occurring rarely, and only in the basalt and shale. In general, groundwater availability in the locale is negligible to opportunistic, particularly in the Neranleigh Fernvale beds which dominate the local geological setting.

No saline soils were identified in the area of inundation. Minor occurrences of sodic soils were identified however it is considered unlikely that vegetation clearing would result in soil-related impacts to groundwater or soil degradation as these materials would be inundated as a result of the project. Based on the absence of any

significant aquifer, associated impacts to groundwater as a result of vegetation clearing and sedimentation are considered negligible.



N

0 1 2 4

Kilometres

Scale - 1:80,000

Projection: MGA Zone 56

Figure 8-3

Borehole Locations

Hinze Dam Stage 3 EIS

8.2.5 Groundwater Dependent Ecosystems

There were no wetlands, baseflow-related surface water features or significant stands of vegetation associated with areas of shallow groundwater identified within the vicinity of the dam. As such, the potential for local vegetation to be dependant on groundwater to satisfy plant water requirements is considered negligible.

Vegetation rooted in alluvial sediments along drainage lines may potentially use shallow groundwater opportunistically, however in general it is considered unlikely that groundwater dependant ecosystems (GDEs) of any significance are present either within or near the proposed area of inundation. Nonetheless, as a result of the project, shallow groundwater availability would be at least maintained due to additional localised seepage, thus having a potentially positive effect outside of the proposed dam footprint as unidentified GDEs.

8.3 Potential Impacts

Groundwater impacts associated with the development, construction and operational phases of the project were considered.

Due to the general absence of any groundwater resource in the assessment area the potential for groundwater impacts to result from the current proposal are negligible.

However, with the increase in inundation area after the FSL increase, there is a possibility of a localised increase in groundwater level in the immediate vicinity of the dam. Based on the data available, the likelihood of the dam causing regional scale groundwater level increases through seepage loss is considered negligible.

The facility survey identified a series of water bores with low to very low yields. It should be noted that most records in the DNRW groundwater database were reported as ‘abandoned and destroyed’ and hence local groundwater use is low due to the insufficient yield and general absence of groundwater within the local geological formations. Similarly, based on the investigations conducted impacts to groundwater quality are considered negligible. As both the surface and groundwater reserves are fresh, the Potential for the proposal to impact on groundwater quality is considered low.

8.4 Summary and Conclusions

Assessment of existing data indicates that there is no regional groundwater resource of significance within the vicinity of the project. The Neranleigh Fernvale beds dominate the local geological setting in which the groundwater resource is generally absent or of negligible significance. As such the potential for groundwater related environmental or social impact to result from the development occurring is considered negligible.

Minor localised aquifer systems, have been identified in fractured strata located locally on the eastern and southern sides of the dam wall. Similarly, localised alluvial aquifer systems may exist along drainage lines upstream and downstream of Hinze Dam. Following inundation as a result of the project, localised increase in groundwater levels within these minor aquifer systems may occur, however recharge is likely to be localised and associated with structural defects.

Investigation of bore data identified moderate to good quality groundwater in most geological units within 7 km of the site. Due to the general absence of a groundwater resource, it is considered unlikely that impacts on groundwater quality would occur as a result of the project. Assessment of data obtained from existing groundwater bores identified groundwater usage within a 7 km radius of the site to be low due to the general absence of a groundwater resource.

Due to the general absence of any groundwater resource of significance within the vicinity of the Hinze Dam, and the low in situ permeability of the surrounding geological materials, the potential for the project to impact groundwater socially or environmentally is considered negligible.

8.5 Groundwater Impact Management Plan

Findings from the desktop groundwater investigation, have been analysed to identify the need for mitigation measures due to the project. Due to the absence of the groundwater resource of significance within the project area, potential impacts to groundwater as a result of the project are considered negligible.

Ongoing groundwater monitoring will be undertaken in the immediate vicinity of the dam as part of geotechnical requirements for the project. This is considered sufficient to monitor for potential changes in groundwater level that may result and will provide ongoing evaluation of the environmental performance of the project. No further management, remedial or monitoring measures are considered necessary beyond those described in the environmental management plan presented in **Section 19**.