8. Hydrogeology

8.1 Introduction

Groundwater is contained within rocks and between sand grains beneath the land surface. It is recharged by water on the land surface that seeps through the soil horizon to the underlying geological formations. Hydrogeological assessment involves the study of the movement of groundwater beneath the land surface, its interactions with surface features such as creeks and wetlands, and the relationship with geology. Groundwater has the potential to impact the South East Busway extension from Rochedale to Springwood where it discharges to the surface (such as in creeks and low-lying topography) or where the land surface is excavated and exposes the groundwater resource.

8.2 Methodology

A desktop assessment of the groundwater conditions along the busway extension was undertaken that considered available information including literature, reports and data. Although no field investigation was undertaken, this assessment took account of previous reported field investigations.

8.2.1 Previous investigations

The following studies provide valuable field data that has been considered in collaboration with all other available data to provide a preliminary conceptualisation of the groundwater conditions along the South East Busway extension from Rochedale to Springwood.

Pacific Motorway corridor studies

Previous field investigations undertaken for the Pacific Motorway Transit Project, partly covers the area proposed for the busway extension. The investigation included geotechnical drilling, soil sampling and identification of the depth to groundwater at strategic intervals. This study is reported in a geotechnical report (Department of Main Roads 2005).

The Department of Main Roads (now known as the Department of Transport and Main Roads) has also investigated geotechnical and groundwater conditions along the South East Freeway for the last 20 years. Over this time a number of pavement cracking and slippages of cut batters have been noted. These reports have been reviewed to assess the influence of groundwater on these failures.

Brisbane Aquifer project

The Brisbane Aquifer project was undertaken by Environmental Hydrology Associates in 2006 and Kellogg Brown and Root in 2003. Its purpose was to supplement emergency water supplies from groundwater and it also investigated groundwater resources around Rochedale South.

Previous busway investigations

Information relevant to this assessment of the busway extension is also provided in the South East Busway Extension Stage 2 Pre-Feasibility Study (Connell Wagner 2008) and the Impact Management Plan for the South East Transit Project (Connell Wagner 1997). These reports provide background information on the geology of the area.

8.2.2 Additional investigations

The desktop assessment undertaken for this report included a review of the site's geology, relevant legislation, aquifer locations, cut batter instability, acid sulfate soils, contaminated land and groundwater conditions. Additional investigations were required where perched watertables were identified to be causing cut batter instability.

8.3 Preliminary analysis

8.3.1 Existing situation

Geology of the area

The oldest potentially exposed geology by the proposed works is the Moorooka formation which is Triassic in age. It consists of sandstones and conglomerates with minor shale and mudstones. The Moorooka formation is overlain by Tertiary sediments including the Corinda formation (consisting of sandstones and mudstones), Eight Mile Plains basalt member and Sunnybank formation (consisting of sand, sandy clay and mud).

The northern section of the extension is underlain by Tertiary consolidated sediments, including mudstones, sandstones and conglomerates. These sediments are exposed throughout this section and overlain in the area between Rochedale Road and Dennis Road by unconsolidated Quaternary sediments. These sediments are deposited in the creek and river floodplains and consist of clay, sand, silt and gravel. South of Dennis Road these Quaternary sediments are underlain by rocks of the Woogaroo subgroup which consist of sandstones, siltstones and shales. These rocks are exposed extensively in areas east of the extension.

Legislation

The South East Busway extension from Rochedale to Springwood does not fall within a designated water management area as regulated under the *Water Act 2000* (Queensland), therefore there is no requirement to licence groundwater extraction. No licence entitlements, purpose of use or usage data were available for groundwater extractions within the project area.

Aquifer locations

Investigations from the Brisbane Aquifer project suggested that the Rochedale area is underlain by a multi-aquifer system, including aquifers within the Quaternary and Tertiary sediment, and Triassic rocks (P Evans 2008, pers. comm., 14 July). Groundwater discharges to local creek systems that flow into Bulimba Creek. The groundwater discharge is seasonal, with flows increasing after rain events and reducing during periods of dry.

A 1981 report by the Department of Main Roads found that high groundwater levels were common between Logan and Underwood roads. The aquifers are mainly found within the weathered sandstones of the Moorooka formation, and sands and clays of the Sunnybank and Corinda formations. It found the aquifers were typically semi-confined.

Department of Main Roads investigations carried out in 1987 suggested moisture content was high in areas where clays (particularly illite-smectite mixed clay material) are present, heaving and surface cracking of pavements and roads can occur due to strong swelling and shrinkage tendencies. This was observed as cracking in the pavement along the Pacific Motorway between Logan and Underwood roads.

Areas experiencing instability

A 1997 report by the Department of Main Roads notes that perched watertables have been responsible for cut batter instability. It found that most failures were associated with the Tertiary deposits (Corinda and Sunnybank formations) and Triassic rocks (namely Moorooka formation) due to their poor drainage potential. Perched watertables have been noted near Underwood Road and Springwood Road. Cut batter failures were experienced in 1-on-1 cut batters in the Tertiary deposits. It also noted that a high regional watertable south of Logan Road was partially responsible for excessive wetting and premature pavement failure. It recommended that additional drainage and lowering the design subgrade was required in areas underlain by these sediments.

An internal Department of Main Roads memorandum (1987) found that a slumping failure had occurred in the cut face adjacent to townhouses south of the Underwood Road overpass. The memo noted that the groundwater system was maintaining a high watertable and surface water infiltration was 'aggravating' instability. Suggested remedial measures included flattening the cut batter, replacing the cut batter and drainage using counterfort drains.

Groundwater conditions

Registered bores

Data was obtained from the Department of Environment and Resources Management Aquatic Ecosystem Information System database on 10 June 2008 for an area covering a 5 kilometre radius along the South East Busway extension from Rochedale to Springwood. The data gathered includes a total of 225 bores registered within this area of which 33 bores are located immediately around the extension as shown in Figure 8-1. There is little groundwater information available from these 33 bores. The majority of registered bores are located north-east and north-west of the proposed Rochedale busway station.

The registered bores are drilled into a variety of geological formations, ranging from unconsolidated sediments of sands and clays, to volcanic, sedimentary and metasedimentary rocks of basalts, sandstones, shales and quartzites. The groundwater conditions, including water level, yield and water quality in these geological formations is highly variable across and within the geological formations.

A summary of the groundwater conditions for bores extracting groundwater around the project area is provided in Table 8-1. The registered bore data indicates that drilling depths are variable, averaging 25 metres and up to 75 metres. Groundwater extraction is primarily from unconsolidated sediments, although there is some extraction from consolidated/porous rocks. There are reports that the upper formations are being dewatered, with the underlying aquifer still providing reasonable flow.

Figure 8-1: Location of groundwater bores

Groundwater yields and quality

Groundwater yields are low, averaging 2 litres per second, with some high volumes potentially extracted from the shales. Figure 8-2 indicates that yields around the proposed Rochedale busway station are 1 to 3 litres per second. Water quality is reasonable, with many bores providing potable water. Total dissolved solids around the proposed Rochedale busway station are between 200 and 300 parts per million within the Quaternary sediments as shown in Figure 8-3. Potable supply is observed in bores east and west of the proposed busway station, within the Tertiary sediments. The non-potable supply found in Bore 134259 east of Springwood bus station in the catchment of Slacks Creek, was drilled into clays and back shale. It is unclear what parameter(s) is the cause of it being considered non-potable. Reports from the Brisbane Aquifer project noted that due to historical farming in the Rochedale area, nitrates levels in local groundwater can be elevated.

Figure 8-2: Groundwater yields

Figure 8-3: Groundwater quality

Table 8-1: Summary of groundwater conditions around the project area

Descriptor	Number/Count/Value
Number of registered bores	225
Number of licensed groundwater extraction	0
Max drill depth	74 metres (m)
Min drill depth	9 m
Ave drill depth	25 m
Number of bores with water level data	101
Max water level	0.00 m
Min water level	54.00 m
Ave water level	13.52 m
Number of bores with water quality data	79
Max electrical conductivity (EC)	16,500 micro-Siemens per centimetre **(**µS/cm)
Min EC	79 µS/cm
Ave EC	2389 µS/cm
Max total dissolved solids (TDS)	2700 parts per million (ppm)
Min TDS	92 ppm
Ave TDS	620 ppm
Potable	45
Salty	5
Brackish	2
Non-potable	1
Max pH	12
Min pH	3
Ave pH	3
Number of bores with yield data	209
Max yield	11 litres per second (L/s)
Min yield	0 L/s
Ave yield	2 L/s
Source of water	
Unconsolidated	66
Weathered zone	3
Fractured	10
Consolidated	24

Descriptor	Number/Count/Value
Geology types encountered	
Sandstone	n/a
Basalt	n/a
Shale	n/a
Clay	n/a
Sand	n/a
Quartzite	n/a
Mudrock	n/a
Greywacke	n/a

Groundwater levels

Water levels range from surface to greater than 50 metres in depth, and averaging 14 metres below surface. Figure 8-4 shows groundwater levels are shallow north of the proposed Rochedale busway station, between 5 and 8 metres in depth. These bores are located in unconsolidated (Quaternary) sediments, which are found around Rochedale and between Rochedale South and Springwood. Groundwater levels increase in depth with distance away from the busway extension and within the Tertiary sediments.

A total of 60 registered bores obtained from Department of Natural Resources and Water (now the Department of Environment and Resource Management) have water level data (i.e. for monitoring purposes). The majority of these sites have less than 10 measurements over a period from the mid-1980s to the mid-1990s. However, two sites (14300094 and 14300095), have time-series data measurements for a longer period from 1987 to 1999. These bores are located approximately 1 kilometre east of Eight Mile Plains Station. Hydrographs for these bores are shown in Figure 8-5. Water level variations suggest movements of up to 10 metres can be expected over time, which are likely to be seasonally dependent, with possible interference from nearby extraction. Over the early to late 1990s, water levels were on a declining trend. Department of Environment and Resource Management data for these bores is not available after 1999; therefore, an assessment of current conditions is not possible. The status of these bores is unknown.

Figure 8-4: Depth to groundwater

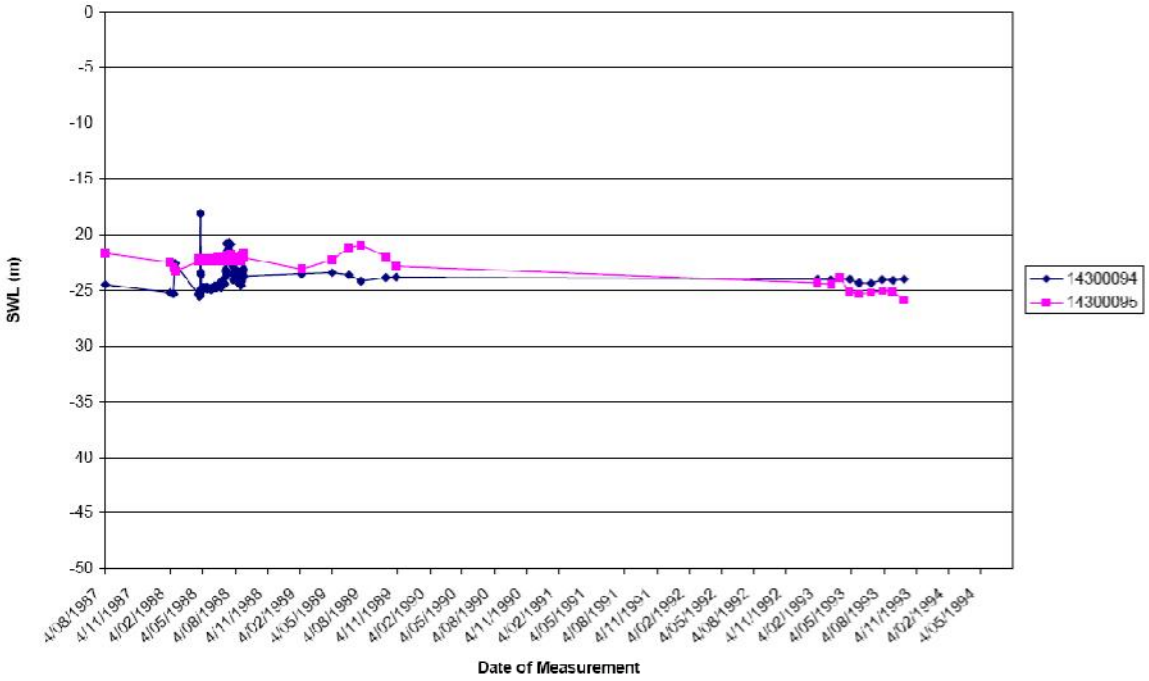

Figure 8-5: Hydrographs for registered bores within study area

The geotechnical investigation for the Pacific Motorway Transit Project (Department of Main Roads 2005) provides drilling results that show shallow water levels are likely in the area. There are a total of six piezometers located within the vicinity of the extension around Underwood Road. These bores indicate that water levels vary from 2 to 8 metres below ground surface. This is consistent with Department of Environment and Resources Management data reported earlier. The status and condition of these bores are unknown, as well as whether reliable monitoring data has been collected since installation.

Acid sulfate soils and contaminated land

Investigations, as reported in Chapter 7, found that there are no identified sites of acid sulfate soils along the South East Busway extension from Rochedale to Springwood. Searches of the Department of Environment and Resource Management's environmental management register and contaminated land register was also undertaken — see Chapter 7. These searches found no properties in the study area listed on the registers. However, a review of historical aerial photography found that a portion of land use within Springwood had previously been used for commercial purposes (including the potential storage of liquids). An additional investigation will be required to determine the presence of contaminated land at those sites.

Due to the shallow groundwater levels, any subsurface storage of liquids could be a source of contamination to the groundwater resource. Extraction of groundwater through bores and excavations exposing the groundwater could potentially draw contaminated water if located close to or down gradient of these contaminated sites.

8.3.2 Managing issues and opportunities

There are three main potential impacts from a groundwater perspective along the South East Busway extension from Rochedale to Springwood.

Shallow groundwater

- Shallow water levels are likely to be encountered in the unconsolidated sediments or weathered rocks of the Tertiary and Triassic formations, particularly between Rochedale South and Springwood, and close to creeks, such as at Springwood near Slacks Creek. The shallow groundwater aquifer could therefore easily be polluted from uncontained surface spillage. In locations where surface water and groundwater interaction occurs, the pollution could therefore migrate into the river ecosystems.
- The volume of seepage is unknown; however, volumes of up to 3 litres per second may be encountered.
- Dewatering may be required during the construction phase in areas of subsurface excavation. Ongoing seepage management through drains and sumps may be required during the life of the busway to mitigate this issue. Subsurface cut-off drains should be designed 900 mms below surface to ensure water levels are sufficiently lowered.

Contaminated groundwater

- Contaminated groundwater may be present where subsurface materials (such as liquids) are located, particularly where shallow groundwater is encountered. The locations of these sites have not been verified.
- Nitrate has been observed in groundwater around Rochedale that are the results of historical farming practices. The extent of this contamination has not been verified.
- Any groundwater that seeps into subsurface excavations needs to be tested for water quality (including nitrates, benzene, toluene, ethylbenzene, and xylenes (BTEX) and polycyclic aromatic hydrocarbons (PAH) and disposed of in an environmentally manner that complies with occupational health and safety standards).

Slumping

- Subsurface excavations may require stabilisation of the geological formation, particularly where excavations expose the weathered sandstones of the Moorooka formation or Corinda and Sunnybank sediments — with suitable structural design, this impact should be successfully mitigated.

8.4 Future investigations

The condition and most recent data availability for any monitoring bores along the busway extension should be collected, archived and analysed in the future. This data would be useful in conceptualising the dynamics of the groundwater system underlying the area. In addition, a report recently produced for Brisbane City Council by Environmental Hydrology Associates on the Brisbane Aquifer project would likely provide valuable information on groundwater conditions around Rochedale South. This report was not available for review at the time of the Concept Design Study.

Other future investigations may include the following:

- assess the outcomes of any future related reports with the findings of the Concept Design Study
- undertake geological mapping along the proposed route, particularly where cuttings are designed. To assist in construction design of subsurface drainage, the groundwater conditions of these excavations should be determined
- define the areas of nitrate contamination and correlate with areas of groundwater discharge along the busway extension
- identify the location and status of geotechnical bores installed as part of the Pacific Motorway
- install monitoring bores at strategic locations along the proposed motorway, particularly in areas of information gap and areas of shallow water level
- identify the presence of any contaminated sites along the busway extension. Correlate presence of these contaminated sites with shallow groundwater levels and any discharge zones (such as in creeks).

8.5 References

Connell Wagner 2008, 'Pre-Feasibility Study, South East Busway Extension Stage 2 – Rochedale to Springwood', report for Queensland Department of Main Roads/TransLink, Brisbane.

Connell Wagner 1997, 'Impact Management Plan 1997 South East Transit Project', Technical Papers. Volume 5B.

Queensland Department of Main Roads 1981, South East Freeway: Holmead Road to Underwood Road (11300 – 15300) Geotechnical Investigation', Materials Branch. R 1145.

Queensland Department of Main Roads 1987, 'Pavement Cracking Investigation South East Freeway (Logan Road to Rochedale Road)', Reference RP1103

Queensland Department of Main Roads 1997, 'Preliminary Technical Assessment. South East Freeway and Pacific Highway Bus Lane (Stanley St – Logan Motorway)', prepared for South East Transit. Report R3042.

Queensland Department of Main Roads 2005, 'Factual Report. Pacific Motorway Transit Project – Section A (or Set 5)', Geotechnical Investigation. Report R3373.