Airport Link

Phase 2 – Detailed Feasibility Study

CHAPTER 6

TOPOGRAPHY, GEOLOGY, GEOMORPHOLOGY & SOILS

- October 2006

Contents

6. Topography, Geology, Geomorphology and Soils

This Chapter addresses part of Chapter 5.1 of the Terms of Reference. Construction spoil is addressed in Chapter 4. Significant topographical, geomorphological and geological features of the study corridor are described, along with any potentially economically significant mineral, energy or extractive material resources. Any potential impacts on these through soil erosion, slope instability, sterilisation of resources and settlement are described. The likely occurrence of acid sulphate soils in the study corridor is reported, and the means by which the potential effects of run-off from acid sulphate soils and any required disposal will be managed, along with the proposed approach to their management. Potential disturbance to existing contaminated land sites and the proposed management of movement of contaminants from those sites is outlined.

6.1 Description of Existing Environment

6.1.1 Topography

The topography of the study corridor consists of generally undulating terrain with minor surface catchments between hills. The study corridor traverses two main drainage catchment areas and three minor drainage areas:

- The very south of the study corridor includes the minor drainage through Victoria Park and the RNA Showgrounds that originally meandered to the Brisbane River at Newstead, but is now essentially confined in stormwater pipes below ground and diverted to Enoggera Creek;
- This minor drainage is bounded to the north by the low east-west ridge that extends from the 45 metre high point of Royal Brisbane Hospital along the 10-15 metre high saddle in the line of O'Connell Terrace, Bowen Hills;
- North of this east-west ridge is the catchment of Enoggera Creek which, in the study corridor, drains most of Windsor and the southern parts of Lutwyche and Wooloowin;
- On the northern side of Enoggera Creek the land rises slowly to a low westerly rising, east-west ridge crest at about 18 metres at the Newmarket-Lutwyche Roads intersection;
- The study corridor descends to the north into a minor tributary catchment of Enoggera Creek that crosses Lutwyche Road at the Bowen Street intersection. This catchment drains the area west of Lutwyche Road as far as Eildon Hill and as far north as Rupert Street, Windsor;
- The major catchment divide between Enoggera Creek and Kedron Brook is the ridgeline corresponding approximately to Maygar Street, Windsor and Chalk Street, Wooloowin. This ridgeline is approximately at about the 30 metre contour level, rising to 50 metres along the western corridor margin;
- The main northern drainage is to Kedron Brook, the catchment of which drains the majority of Lutwyche and Wooloowin and northern parts of Clayfield. The study corridor crosses Kedron Brook in the north-west near Gympie Road to include south-eastern parts of Kedron; and
- A secondary stream, joining Kedron Brook at Sandgate Road, runs approximately parallel to and south-east of Kedron Brook on the eastern side of the study corridor draining Eagle Junction, and Kalinga from Melrose Park and its headwaters further south in the southern Kedron Park Road/Chalk Street area.

6.1.2 Landforms

The study corridor encompasses a range of low landform elements. The major landform patterns within and surrounding the study corridor are described below.

Bowen Hills

The crestal zone and associated moderately inclined, undulating topography of the Bowen Hills area is bounded to the east and south by Fortitude Valley. To the south-west and west, Bowen Hills is surrounded by the steep hill slopes of Spring Hill and Kelvin Grove and to the north by the low lying alluvial floodplain flanking the channel of Enoggera Creek. A gently inclined, undulating alluvial floodplain intrudes into the corridor separating the southern slopes of Bowen Hills and the steep slopes of the north-eastern portion of Spring Hill.

Enoggera Creek

The banks of Enoggera Creek intersected by the study corridor are gently inclined, with the slope morphology consisting of a crest, simple slope and open depression forming the creek bed. The creek is around 7km long and originates from Brisbane Forest Park. The creek has been created by alluvial processes and the erosion of the channel by stream flow and sheet wash. The stream channel can be described as having a tributary channel pattern.

Windsor/Lutwyche Divide

The landform of elevated areas of Windsor and Lutwyche is a series of undulating hills. Within the study corridor this landform commences on the northern side of the relatively flat alluvial floodplain of Enoggera Creek. The hills are the weathered hard bedrock of Neranleigh-Fernvale Formation and Brisbane Tuff, with moderate to steep slopes along the flanks of the ridgeline.

Kedron Brook

The Kedron Brook area is comprised of a gently undulating alluvial floodplain surrounding a modified open depression, which forms the Kedron Brook channel.

The channel of Kedron Brook is lined with concrete and significantly modified in a number of areas along its alignment. It meanders from west to east through the northern suburbs of Brisbane, commencing near Samford and discharging into Bramble Bay in the vicinity of the Brisbane Airport.

The alluvial floodplain is bounded to the north and south by a series of undulating hills. The floodplain provides physical separation between the ridgeline that intercepts the corridor at Lutwyche and terminates at the intersection between Lutwyche Road and Gympie Road from the ridgeline that terminates at the northern edge of the floodplain in the vicinity of the Gympie Road/Stafford Road intersection.

The corridor continues east along the transition between the lower slopes of the hill and southern edge of the floodplain through Wooloowin and terminates within the floodplain at Toombul.

6.1.3 Geology

The oldest bedrock of the Brisbane area is the Neranleigh-Fernvale Formation of approximately Devonian to Carboniferous age (420 – 350 million years old). During the Late Triassic (approximately 220 million years ago) exposed Neranleigh-Fernvale Formation was covered in volcanic ash falls of the Brisbane Tuff. The ash fell on a highly irregular land surface with localised incised valleys and some isolated elevated regions. The ash falls were short-lived and progressively buried soils, lake deposits and stream sediments. Much of the tuff was eroded and re-worked by stream action and these processes resulted in the formation of a tuffaceous claystone. More massive eruptions at the end of the Late Triassic produced an ignimbrite that extends through the central Brisbane region.

Due to the deeply weathered and undulating land surface prior to deposition of the Brisbane Tuff, fragments of country rock have been incorporated into the ignimbrite and similarly, the earlier ash deposits have penetrated joints in the bedrock. Following the Triassic volcanic eruptions, rivers deposited sands and gravels along channels and floodplains to produce the conglomerates and sands of the Aspley Formation and more mature finer silts and shales of the Tingalpa Formation. In the recent past, after widespread erosion, deposition of Quaternary Alluvium occurred particularly during high stands of the sea.

Quaternary Alluvium has been deposited over the last 2 million years and can be subdivided into Holocene (young) and Pleistocene (older) Alluvium. The two main areas of alluvium along the study corridor are associated with Enoggera Creek in the south and Kedron Brook in the north and north-east.

Geological units in the study corridor are shown on **Figure 6-1**. These appear in order of decreasing age.

6.1.4 Faults and Folds

There is some evidence that a north-east to south-west trending fault may occur under Kedron Brook in the vicinity of the Gympie Road Bridge. Apparently minor faults of the order of 1-10m of movement were reported in the now abandoned coalmine on Kedron Brook outside but adjacent to the study corridor. These faults are unlikely to be structurally significant. Two faults in the Neranleigh Fernvale Beds were detected in boreholes near the Ferny Grove Railway and at Newmarket Road but they do not penetrate the Brisbane Tuff and thus have been inactive since before the Triassic. The boundary between Brisbane Tuff and Tingalpa Formation in the vicinity of Felix Street ahs been interpreted as possibly faulted but palaco topography may produce some boundary geometry.

6.1.5 Rock Defects

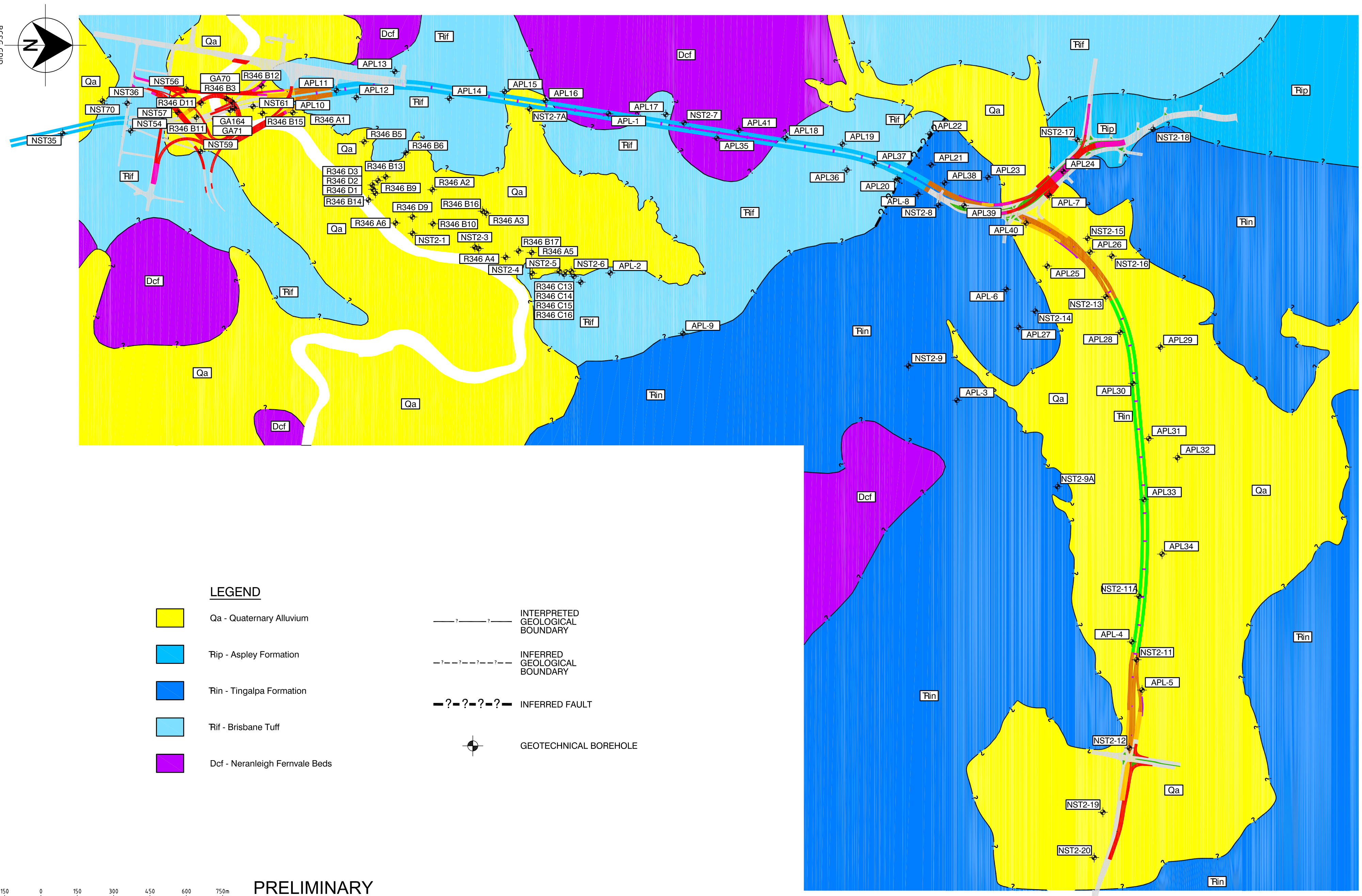
The Neranleigh Fernvale Formation is generally weathered to about 10m depth in hilly terrain but to depths of 4m or less in stream channels where decomposed rock has been scoured by erosion.

In outcrop, the Brisbane Tuff, weathering effects often extend to 10-20m depth resulting mainly in colour changes but little or no decrease in rock strength. Major decomposition of the tuff is usually limited to the uppermost 2-4m but this may vary down to 10-15m in some local areas as demonstrated in a few of the geotechnical boreholes for the project.

Sandstones of the Aspley and Tingalpa Formations are susceptible to deep weathering down to 10-15m, due to a high content of labile particles (mostly feldspar and lithic grains) and the shales and mudstones readily breakdown to clay. However, the conglomerate beds are not susceptible to deep weathering.

6.1.6 Economic Minerals

The ignimbrite of the Brisbane Tuff was quarried along Lutwyche Road on the corner of Newmarket Road and in the Windsor Town Quarry from the 1860s until the 1920s at least. However, the Windsor Town Quarry was for much of the later 20th century a Brisbane City Council works depot and was in 1993 turned into public parkland. The O'Connell Town Quarry on the corner of Newmarket Road was privately run and supplied building stone for many public buildings in the city (e.g. the Treasury Building in Queen Street, the Government Printing Office in George Street and St John's Cathedral in Ann Street). It ceased operations some time before 1939 as the site was used for naval fuel storage during the Second World War and is now occupied by a retail centre.



LEGEND

Qa - Quaternary Alluvium

Rip - Aspley Formation

Rin - Tingalpa Formation

Rif - Brisbane Tuff

Dcf - Neranleigh Fernvale Beds

INTERPRETED GEOLOGICAL BOUNDARY

INFERRED GEOLOGICAL BOUNDARY

INFERRED FAULT

GEOTECHNICAL BOREHOLE

150 0 150 300 450 600 750m

SCALE 1:7500

PRELIMINARY

NOT FOR CONSTRUCTION

Rev.	Date	Revision Details	
01	30.06.06	REFERENCE DESIGN	PDH

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BRISBANE CITY

Queensland Government

airportlink DETAILED FEASIBILITY STUDY

REFERENCE DESIGN
AIRPORT LINK
GEOTECHNICAL BASE MAP

CW Project No. 9991

Scale 1:7500 AT A1

Sketch No. FIGURE 6.1 Rev. 01

25.07.2006@17:28:56 G:\MIPO\Airport Link\C_Subjects\100_Engineering\105_CADD\AUTOCAD\drawings\REFERENCE DESIGN\Geotechnical\RD-GEO-OA-01.dwg LOGIN NAME : NSBT67

A small coalmine was established on the northern side of Kedron Brook (outside but adjacent to the study corridor) in the very early 1900s. It ceased production in 1909 due mainly to the difficulty of working the thin faulted seam. Geotechnical boreholes for the project intersected this coal in the north-eastern area just west of Sandgate Road. These coals could not be worked economically because of the thin faulted nature of the seam, the urban environment which developed above this area and the coal being of poor quality compared with other available deposits.

It is considered that the Airport Link project will not impact on any existing economic mineral deposits.

6.1.7 Soil Types

Review of *The Soil Landscapes of Brisbane and South-eastern Environs Queensland* 1:100,000 map, shown on **Figure 6-2**, has provided details relating to soil types in the study corridor. They are:

- The Logan soil type which comprises alluvial soils and some humic gleys. These are generally found on low terraces and floodplains of river sediment. Within the study corridor, this soil type is associated with the Kedron Brook floodplain in the Sandgate Road and Gympie Road areas. In the southern section Logan soils are found along the floodplain of Enoggera Creek both where that watercourse crosses the study corridor and in the vicinity of Bowen Street and further south in the drainage through Victoria Park and the RNA grounds;
- The Nundah soil type, comprising red-yellow podzolic soils with red earths. These are generally found on low hills of sandstone, shales and clay and are mapped in the study corridor in the Lutwyche/Gympie Road area;
- The Clayfield soil type, comprising red earths with some mottled yellow podzolic soils. These are generally found on low undulating surfaces on gravelly clays and sandstone. Within the study corridor Clayfield soil is encountered in the north-east through Eagle Junction and northern Clayfield;
- The Carbrook soil type, comprising yellow podzolic soils, alluvial soils and gleys. This soil type occurs adjacent to the Logan soils of the Kedron Brook drainage and intrudes on the study corridor on both sides of the Kedron Brook floodplain in the vicinity of Gympie Road (i.e. in southern Kedron and in Wooloowin south of Shaw Park);
- The Chermside soil type, comprising lithosols with shallow podzolic soils. These are generally found on low hills of rhyolitic tuff. The Chermside soil type is intercepted by the study corridor along Gympie Road, north of Kedron Brook. South of Kedron Brook Chermside soils are developed on the underlying Brisbane Tuff all the way to the southern margin; and
- The Beenleigh soil type, comprising red-yellow podzolic soils with lithosols and some gleyed podzolic soils. These are generally found on low hills of greywacke, phyllite and shale of the Neranleigh-Fernvale Formation. Beenleigh soils occur along the western extent of the study corridor on the metasedimentary rocks of the Neranleigh-Fernvale Formation.

6.1.8 Acid Sulphate Soils

Acid sulphate soils (ASS) are a feature of low-lying coastal environments in Queensland, particularly where elevations are below RL 5m Australian height datum (AHD). ASS contain appreciable amounts of iron sulphides generally in the form of pyrite within the subsurface profile. ASS are a by-product of the natural interaction between organic matter rich in iron and seawater rich in sulphate, which is usually found in low energy estuarine environments.

MAP LEGEND

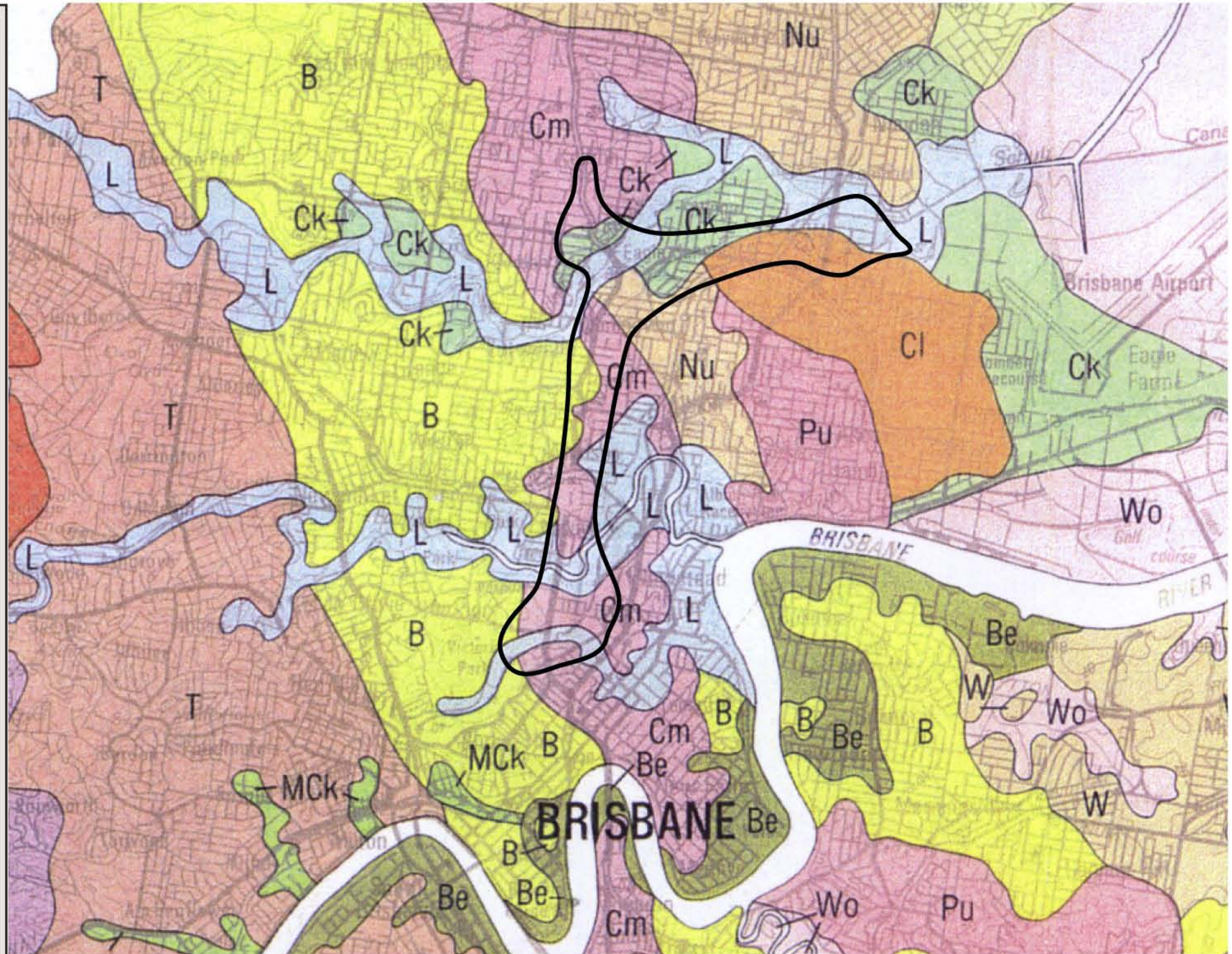
Code	SOIL LANDSCAPE	DOMINANT SOIL GROUPS	LANDSCAPE AND PARENT ROCK
	SOILS SHOWING LITTLE PROFILE DEVELOPMENT		
		LOWLANDS	
L	LOGAN	ALLUVIAL SOILS, some humic gleys	Low terraces and flood plains of river sediment.
MF	MUDFLATS	Saline mud	Tidal flats of estuarine muds.
SM	SALT MARSH	SOLONCHAKS	Low coastal plains of estuarine sediments.
		HIGH HILLS AND STEEPLY SLOPING AREAS	
Cm	CHERMSIDE	LITHOSOLS with shallow podzolic soils	Low hills of rhyolitic tuff.
En	ENOGGERA	Shallow stony LITHOSOLS and gritty yellow podzolic soils	Steep hills of granite.
MCo	MT COOT-THA	Gravelly LITHOSOLS with shallow gravelly podzolic soils	Steep high hills of phyllite and hornfels.
MC	MT COTTON	LITHOSOLS, some red clays	High hills of quartzite.
P	PRIESTDALE	Sandy LITHOSOLS	Steep hills of coarse sandstone.
Pu	PULLENVALE	LITHOSOLS with thin red-yellow podzolic soils	Low hills of greywackes, shales, phyllites, etc.
	SOILS SHOWING WEAK PROFILE DIFFERENTIATION		
A	ARCHERFIELD	Shallow BLACK EARTHS and wiesenboden	Low hills of basalt and plains of clay alluvium.
Be	BRISBANE RIVER	PRAIRIE SOILS with some sandy alluvial soils	Low undulating plain and terrace remnants of sandy alluvium.
Br	BROOKFIELD	PRAIRIE SOILS with some reddish prairie soils and lithosols	Hills of basic volcanic rock.
Ru	RUNCORN	PRAIRIE SOILS, dark acid clays, shallow black earths	Low hills of highly weathered basalt.
Wa	WATERFORD	Gilgaied acid clays	Terraces of clay alluvium.
	SOILS DOMINATED BY SESQUIOXIDES		
As	ASPLEY	RED EARTHS and krasnozems with gleyed podzolic soils	Hills of clays and sandy clays.
Bk	BIRKDALE	KRASNOZEMS, prairie soils	Low hills of weathered basalt.
BR	BRACKEN RIDGE	Sandy RED EARTH with minor podzolic soils	Low hills of ferruginous sandstone.
Cl	CLAYFIELD	RED EARTHS with some mottled yellow podzolic soils	Low undulating surface on gravelly clays and sandstone.
Co	CORINDA	RED EARTHS and krasnozems with dark clay soils	Low hills and undulating surface of sandstones and clays.
El	ELPHINSTONE	Stony KRASNOZEMS and lithosols	Steep hills of basic volcanic rocks.
M	MANLY	RED EARTHS and krasnozems	Gently undulating plateau surface and low hills of sandstone and basalt.
Mo	MOGGILL	KRASNOZEMS with red earths and minor red podzolic soils	Plateau remnants of deeply weathered sandstone and gravel beds.
R	REDLANDS	KRASNOZEMS	Low hills of deeply weathered (lateritized) basalt and clay.
S	SUNNYBANK	Lateritic RED EARTHS with some lateritic podzolic soils	Undulating plateau and slopes on Tertiary sediments.
	SOILS WITH MARKEDLY DIFFERENTIATED PROFILES		
B	BEENLEIGH	RED-YELLOW PODZOLIC SOILS, with lithosols, some gleyed podzolic soils	Low hills of greywacke, phyllite, shale etc.
Bo	BOOMBANA	RED PODZOLIC SOILS and lithosols	Steep hills of granodiorite.
Ck	CARBROOK	YELLOW PODZOLIC SOILS, alluvial soils and gleys	Low terraces and flood plains of alluvium.
CP	COOPERS PLAINS	RED-YELLOW PODZOLIC SOILS, lateritic podzolic soils	Dissected plateau edge, on sandy clays and sandstones.
Da	DARRA	Mottled PODZOLIC SOILS and soloths	Undulating surface on mudstone, siltstone and sandstone.
Je	JAMBOREE	Gravelly RED and YELLOW PODZOLIC SOILS and lithosols	Low hills of deeply weathered sandstone and conglomerate.
K	KENMORE	Gravelly RED PODZOLIC SOILS and podzolic lithosols, minor yellow podzolic soils	Hills of greywackes, siltstones and shales.
Nu	NUNDAH	RED-YELLOW PODZOLIC SOILS with red earths	Low hills of sandstones, shales and clay.
PR	PARK RIDGE	LATERITIC PODZOLIC SOILS and sandy red-yellow podzolic soils	Low hills and undulating surface on sandstone with shale and conglomerate.
Sa	SAMFORD	SOLOTHS and yellow podzolic soils	Low hills of granodiorite.
T	TOOWONG	RED PODZOLIC SOILS with lithosols	Low hills of phyllite.
Wy	WITTY	Gravelly RED PODZOLIC SOILS, with minor red earths – krasnozems	Hills of gravel beds, clays and weakly consolidated sandstone.
W	WOODRIDGE	RED-YELLOW PODZOLIC SOILS, with gleyed podzolic soils and lateritic	Low hills of sandstones and shales.
	SOILS SHOWING THE INFLUENCE OF POOR DRAINAGE		
Bl	BLUNDER	GLEYED PODZOLIC SOILS with siliceous sands and alluvial soils	Flood plains of sandy alluvium.
E	EPRAPAH	GLEYED PODZOLIC SOILS with alluvial soils and humic gleys	Low terraces of silty alluvium and flood plains of coastal streams.
Lt	LOTA	HUMIC GLEYS and siliceous sands	Low plains and beach ridges of sands.
MCk	MOGGILL CK	GLEYED PODZOLIC SOILS with minor prairie and alluvial soils	Creek flats of sandy and clayey alluvium.
Sw	SWAMP	PEATY GLEYS and humic gleys	Depressions on low coastal plains of sandy and clayey alluvium.
Wg	WILLAWONG	GLEYED PODZOLIC SOILS with solodic soils, podzolic soils, and soloths	Low-lying undulating plain and low terraces of sand and clayey alluvium.
Wo	WOONGOOLBA	HUMIC GLEYS, peaty gleys and solonchaks	Low coastal plains and narrow valley floors of alluvium.

Note: A soil landscape is a natural area of land in which the soils are derived from a limited range of rock types and have a specific relation to topography; each soil landscape has a characteristic drainage pattern, expressed as the "drainage net". Only the major soils of the unit are shown.

This map is a compilation based on geological and soil information, extended by air-photo interpretation. Except at widely separated points the unit boundaries were not mapped in the field; the units are based on an interpretation of soil distribution before disturbance by man.

Compiled by G. G. Beckmann, G. D. Hubble, C. H. Thompson, K. J. Smith, (1976).

The original map was compiled on the Geological Map of Brisbane (Tucker and Houston 1967) and the Beenleigh 1 mile military map (Australian Survey Corps, 1947, No. 193, Beenleigh 1 mile series, second edition). The boundaries have been transferred to a base at 1:100,000. This base map is Crown Copyright and has been reproduced by permission of the Director, Division of National Mapping, Department of Resources and Energy and by the Queensland Department of Mapping and Surveying.



0 2 4km

N

AIRPORT LINK - Figure 6-2

Soil Types in the Study Corridor

Source: Beckman et al 1987

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ASS in an undisturbed environment are termed Potential Acid Sulphate Soils (PASS), are generally anaerobic and have a neutral or slightly alkaline pH. However, when exposed to the atmosphere through excavation or changes to the surrounding watertable, pyritic material within the soil matrix is oxidised by sulphur oxidising bacteria forming sulphuric acid and the soils or sediments become Actual Acid Sulphate Soils (AASS). Runoff from AASS may liberate sulphuric acid or metal contaminants (particularly aluminium or iron) into surface or groundwater that could significantly damage aquatic flora and fauna and lead to deterioration in ecosystem health as well as having deleterious impacts on manmade structures.

Within the study corridor, most of the land is underlain by Triassic or older non-marine rocks. In those areas the potential for ASS generating conditions is negligible as none of the recognised criteria exist. A review of the NRM 2002 *Acid Sulfate Soils Tweed Heads to Redcliffe Map 1* (**Figure 6-3**) indicates two areas within the study corridor that should be assessed as potentially harbouring PASS. These are:

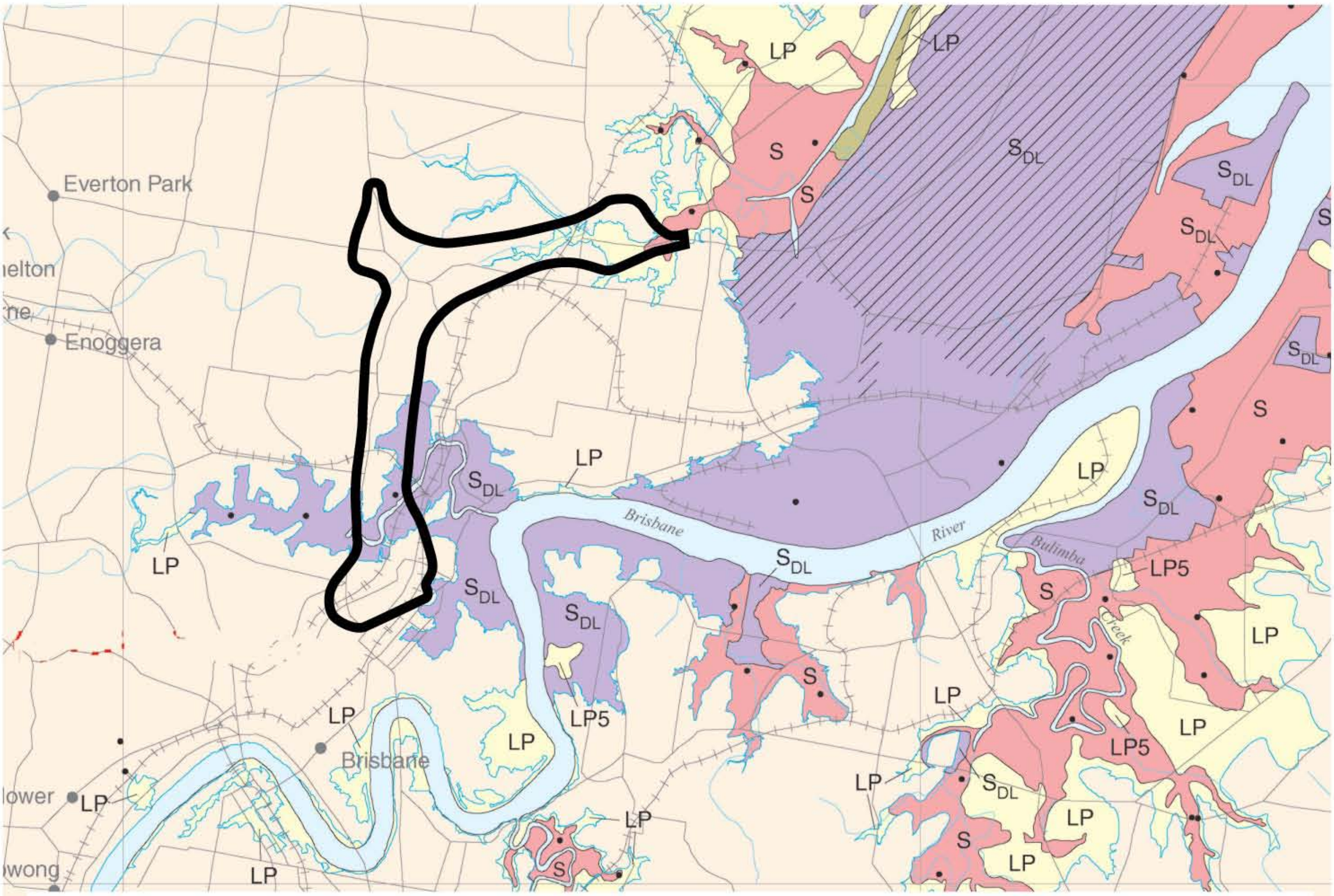
- Where Kedron Brook crosses the north-eastern corner of the study corridor. Here, its channel and floodplain have been mapped as having a low potential of ASS occurrence. This area is below the 5m AHD level, lies partially within the intertidal zone and is underlain by Quaternary sediments, giving it some potential for containing ASS that may require appropriate management in areas to be disturbed by construction. Despite the considerable earthworks that must have occurred there at the time the channel was straightened, any planned excavation in the alluvial flood plain of Kedron Brook may require an ASS delineation survey, appropriate treatment of the soils removed and the area excavated;
- The alluvial flood plain of Enoggera Creek is identified as disturbed land likely to contain ASS. It lies below the 5m AHD level, is under tidal influence along the main channel and is underlain by Quaternary alluvium. Alluvial sediments of this floodplain are encountered in two areas of the study corridor, namely adjacent to the channel of the creek where it cuts across the study corridor and a small area just north of the Ferny Grove railway line fanning out from Lutwyche Road east along Bowen Street. Any planned excavation in the alluvial flood plain of Enoggera Creek may require an ASS delineation survey, appropriate treatment of the soils removed and the area excavated.

Where Kedron Brook crosses the study corridor in the north-west, in the vicinity of the Lutwyche Road/Gympie Road Bridge, alluvium may be excavated. This alluvium is not of marine origin, is above the 5m AHD and is thus considered to have negligible potential for containing ASS.

6.1.9 Contaminated Land

The project has the potential to impact on contaminated land through excavation of contaminated soils and drawdown of groundwater, which may result in migration of contaminants. An investigation of possibly affected contaminated sites was undertaken, and this is described in Technical Report No 3 – Contaminated Lands in Volume 3 of the EIS.

The investigation for possibly affected contaminated sites has been extended beyond the study corridor along the Bowen Hills to Kedron section of the tunnel to include the area within which the groundwater level could potentially be lowered by 1 metre or more if the proposed tunnel was not to be lined. Similar expansion of the area of interest has not been undertaken for the Kedron to Clayfield tunnel because the geotechnical studies undertaken in the concept design development determined that this section of driven tunnel must be fully lined with concrete, thus strongly limiting the potential for groundwater drawdown.



REFERENCE

ACID SULFATE SOILS (ASS)[1] ON RELATIVELY UNDISTURBED LAND

S — Land where ASS occurs within 5m of the surface. Virtually all land in this category has at least one 'potential acid sulfate soil' layer[3] and some of this land will have an 'actual acid sulfate soil' layer[2].

NOTE: S^P - indicates sediments of Pleistocene age[1].

S_W — Areas associated with *Melaleuca sp.* wetlands and occasionally *Casuarina glauca* communities. Oxidisable sulfur % in surface layers may be highly variable and often exceeds the 'Action Criteria'[4]. This may include sulfur from organic compounds and modern accretion of sulfides in a wet, organic rich environment. ASS typically occurs at depth.

S_{LA} — Limited field assessment but occurs in a landscape position where there is a reasonable probability of ASS occurrence. This is usually land where the present use precludes any disturbance eg. National Parks, Reserves etc., or land where accessibility is severely restricted.

ACID SULFATE ON DISTURBED LAND[5]

S_{DL} — Disturbed land, eg. Canal estate, Marina, Aquaculture, Quarry, Urban, Industrial likely to contain ASS. (In some cases partial or full treatment may have been undertaken.). Limited field investigation.

5m AHD[6] CONTOUR - NORMAL LIMIT OF FIELD INVESTIGATION

The 5m contour line delineates the normal limit of field investigation of Holocene, estuarine sulfidic sediments[7] which form ASS. Holocene ASS has not been found in this study on land above 5m elevation. In some cases, the limit of Holocene ASS[8] is at the 5m contour. In other cases, the limit is <5m AHD. In the latter case, the land between the ASS limit and the 5m contour is designated LP explained below.

LAND WITH A LOW PROBABILITY OF ACID SULFATE SOIL OCCURRENCE

LP — Land between the 5m AHD contour and the outer limit[8] of Holocene, estuarine ASS (ie land <5m AHD) as mapped at this scale, with low probability of ASS occurrence.[9] Limited field investigation.

LP5 — Land >5m AHD with low or negligible probability of ASS occurrence.[9] Limited field assessment.

LAND NOT ASSESSED

NA — Land not assessed for ASS as part of this survey. It may include non ASS land beyond the boundary established as the limit of Holocene, estuarine, sulfidic sediments[8] but insufficient or no field testing was carried out.[9]

AIRPORT LINK - Figure 6-3

Acid Sulphate Soils

0 2 4km

Scale

N

Source: NRM 2002

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If disturbed, contaminated soil and/or groundwater can adversely affect human health and the environment. The Airport Link Project crosses, or passes by, a range of properties that may have been contaminated by past or existing land uses. This assessment, therefore, aims to:

- Identify properties with past or current land uses that may have resulted in the presence of soil and/or groundwater contamination;
- Identify potential impacts that require management in the design and construction stage;
- Where insufficient information is available, make recommendations for future investigations; and
- Where potential impacts are identified, make recommendations to mitigate such impacts.

Contaminated sites within this area that could be potentially affected by the project were identified from:

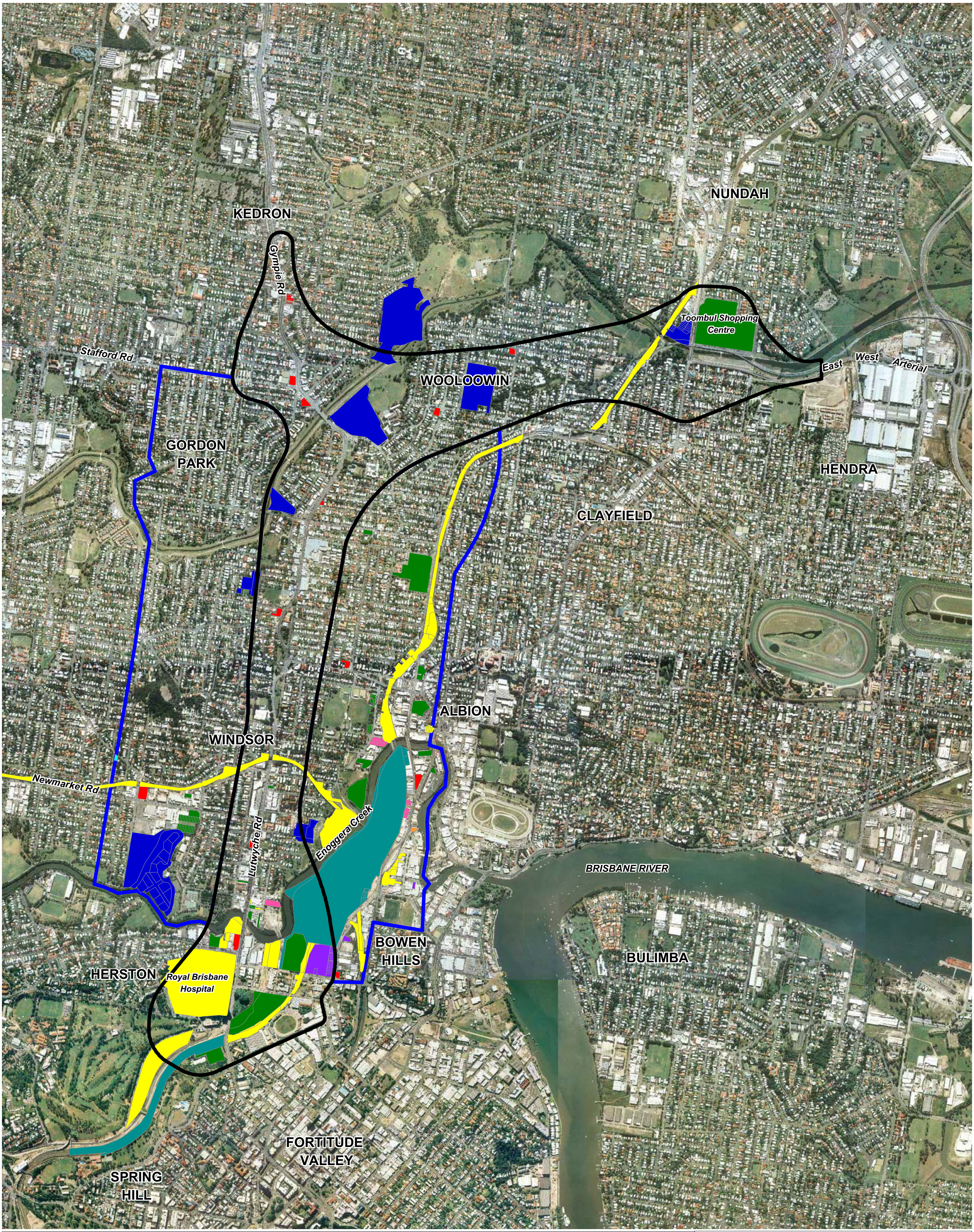
- A review of properties listed on the EPA's Environmental Management Register (EMR) or the Contaminated Land Register (CLR);
- A review of 1951 and 1965 land use plans and historical aerial photographs;
- Limited drive-by inspections of properties used for commercial/industrial purposes;
- BCC Licensing Web searches of properties containing *Dangerous Goods Safety Management Regulation 2001* (formerly Flammable and Combustible Liquid Licences) approvals; and
- Contaminated land information from Queensland Rail and reports held by EPA.

As there are only limited site investigation data, this assessment takes a conservative approach and assumes that any Airport Link construction activities within an identified property could disturb contaminated material. The nature and extent of the contamination that may be present has not been described. However, where possible, the areas where contamination may be present within the boundary of the larger identified properties have been defined, i.e. BCC landfill records and contaminated site reports held by the EPA.

The review showed 228 properties listed on the EMR and none on the CLR. These properties are located on **Figure 6-4**. Of these sites on the EMR, 108 were wholly or partly located within the study corridor and 135 EMR listed sites occur wholly or partly in the extra one km potential drawdown area. One site has been notified to the EPA for listing on the EMR. The site usages are given in **Table 6-1** and **Figure 6-4**.

- **Table 6-1 EMR Listed Properties within the Airport Link Project study corridor**

Notifiable Activity	EMR Search		
	Listed	'Managed'	Total
Scrap Yard	1	-	1
Hazardous Contaminant	21	2	23
Landfill	31	-	31
Petroleum Product or Oil Storage	11	2	13
Printing	24	-	24
Railway Yards	4	-	4
Service Stations	11	1	12
Total			**108**



LEGEND

- Hazardous Contaminants (50)
- Dry Cleaning (1)
- Service Station (16)
- Scrap Yard (15)
- Printing (26)
- Landfill (51)
- Petroleum Product or Oil Storage (54)
- Pest Control (1)
- Railway Yard (13)
- Airport Link Corridor
- 1km Groundwater Drawdown Area

0 0.5 1km

N

Figure 6-4

EMR Listed Sites

Airport Link

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‘Managed’ properties are each subject to a Site Management Plan (SMP) approved by the EPA. The SMP is a public document attached to the EMR listing of the property. The objective of an SMP is to manage the chemical contamination on the property in a manner that protects human health and the environment and ensures that the property is suitable for the specified use.

- **Table 6-2 EMR Listed Properties within the 1 km Groundwater Drawdown Area**

Notifiable Activity	EMR Search		
	Listed	‘Managed’	Total
Scrap Yard	11	3	14
Hazardous Contaminant	29	-	29
Landfill	24	-	24
Petroleum Product or Oil Storage	41		41
Printing	10	-	10
Railway Yards	11	-	11
Service Stations	4	-	4
Pest Control	1		1
Dry Cleaning	1		1
Total			**135**

The five ‘Managed’ properties within the study corridor are:

- Lot 733 on SL70090 located at 64 Gympie Road, Kedron. It is on the EMR for the notifiable activity of a service station and has an approved SMP. The site was formerly operated by Shell Engineering Pty Ltd and known as the Shell Kedron Service Station which operated from 1965 until 1999;
- Lot 51 on SL801574 located at 15-4 Butterfield Street, Herston. An SMP was approved by the EPA in February 2003; the site was remediated and a development permit issued November 2003 for “Material Change of Use”.
- Lot 18 on RP9934 located at 1 Butterfield Street, Herston. EPA records were unavailable;
- Lot 2 on SP144596 located at 52-4 O’Connell Terrace, Bowen Hills. BCC retained no records of the site;
- Lot 3 on SP144596 located at 52-4 O’Connell Terrace, Bowen Hills. BCC retained no records of the site.

‘Managed’ properties within the one km groundwater drawdown area are:

- Lot 2 on RP55530 located at 194-A Abbotsford Road, Bowen Hills;
- Lot 75 on RP9371 located at 194 Abbotsford Road, Bowen Hills; and
- Lot 74 on RP9371 located at 192-4 Abbotsford Road, Bowen Hills.

Detailed information on these sites, obtained from BCC, is provided in Technical Report No. 3 –Contaminated Land in Volume 3 of the EIS.

EMR Properties of Potential Concern

Direct property impacts to some EMR listed properties and other potentially contaminated properties have been identified. The Queensland EPA was contacted to obtain further information relating to the EMR listed properties that will be directly affected by the proposed alignment for the Airport Link Project. The Queensland EPA advised that contaminated site investigation reports exist for seven properties that are directly affected by the proposed alignment of the Airport Link Project. **Table 6-3** lists the properties and Technical Report No. 3 –Contaminated Land in Volume 3 of the EIS provides a brief summary of each report.

- **Table 6-3 EPA Contaminated Site Report Information**

Plan	Street Address	Notifiable Activity
Lot 544 SP119375	Royal Brisbane Hospital, 30 Bowen Bridge Road Herston 4006	Petroleum Product or Oil Storage
Lot 100 SP134740	Former Service Station 54-4 Bowen Bridge Road, Herston 4006	Service Station
Lot 18 RP9934	1 Butterfield Street Herston 4006	Hazardous Contaminants
Lot 51 SL801574	15-4 Butterfield Street Herston 4006	Hazardous Contaminants
Lot 733 SL7090	JB Hi-Fi 64 Gympie Road Kedron 4031	Service Station
Lot 4 RP98727	Ampol Service Station 110 Gympie Road Kedron 4032	Service Station
Lot 25 RP841248	Vacant Land 690-4 Lutwyche Road Windsor	Service Station

Brisbane City Council Landfills

BCC maintains a database of the locations of all of Brisbane's known landfill sites and summaries of their operational history. Limited information obtained from BCC of landfills in the study corridor identified in BCC's WebBASX is provided below:

- Lot 1 on RP19518 located at 2A Jimbour Street, Wooloowin. This was operated as a sanitary landfill from March 1958 to May 1958 and the depth of waste was approximately 2m. BCC does not monitor this landfill or surrounding water courses;
- Lot 2 on RP33818 located at 61 Bertha Street, Wooloowin. Within Kalinga Park, this area between Park Avenue and Bertha Street and bounded to the south by Henry Street was previously known as Nash Oval. In 1989 the soil on this oval was analysed and found to have elevated radioactive levels. BCC decided to cancel the lease on the oval that had been held by the Public Service Rugby League and declared it would remain as an open space not to be used for organised sport. Environmental Management of the site was undertaken in 1993. Queensland Health confirmed that this site (Lot 2 on RP33818) was remediated and validated in 1993 with all radioactive sand taken to the Mt Coot-tha Quarry. The site is not listed on the Environmental Management Register maintained by EPA. Brisbane City Council has concluded that the site was remediated in 1993 to a level within Queensland Health action levels and on this basis no further remedial action is required at the site.

Dangerous Goods Safety Management Regulation 2001 – Flammable and Combustible Liquid Licensed Locations

Flammable and Combustible Liquids (F&C) stored on properties having current and/or cancelled licences under the *Dangerous Goods Safety Management Regulation 2001* were identified. BCC's Licensing Web located current and formerly licensed F&C premises within the study corridor. General correlation was identified between properties on the EMR for the Notifiable Activity of "Petroleum Product or Oil Storage" and "Service Station" and properties with F&C licenses. Some 49 properties within the study corridor are listed on the EMR and the BCC Licensing Web for F&C licences with a further 15 properties in the study corridor holding F&C

licences but not listed on the EMR. These properties are identified in Technical Paper 3 – Contaminated Land in Volume 3 of the EIS.

Additional Potentially Contaminated Properties

A general inspection within the study corridor on 5th and 6th December 2005 identified properties that are not on the EMR or CLR, but which, due to past (e.g., land fill) or current land uses, may have the potential to cause land contamination within the study corridor. From this inspection and using information obtained through historical aerial photograph interpretation, the BCC 1951 and 1965 Land Use Plans and F&C licence information, 58 properties were identified. These properties and their current uses (detailed in Appendix B to Technical Paper No 3 –Contaminated Land in Volume 3 of the EIS) include:

- Mechanical repair workshop (19);
- Railway station (1);
- Service station (8);
- Vacant land/ Public open space (9);
- Landscaping and bitumen supply (1);
- Concrete batching plant (1);
- Large Retail/office space (12), including Homemaker City, Lutwyche City and Office Works;
- Schools/Hospital/Hospice/Retirement Centre (6); and
- Scrap Yard (1).

Historical Aerial Photograph Review of Airport Link Project Study Corridor

The historical review of air photographs allowed a further 10 properties to be identified within the study corridor and 4 in the 1 km drawdown area that were not in the BCC WebBASX searches. Historical information relating to these properties is provided in Technical Paper 3 –Contaminated Land in Volume 3 of the EIS and locations indicated on **Figure 6-1** and **Figure 6-2** therein. These include Service station (1), Quarry/Petroleum Product Storage (1), Railway yard/Wood treatment/Sawmill (1), Scrap yard (1), Petroleum Product Storage (3), Vacant Industrial Land (1), Mechanical Repair Shop (1), Motor Vehicle Servicing (1), Industrial Sites (1) and Possible Landfill/Ex-Army Base (3).

Of these properties the following have potential to be ‘high risk’:

- Site A - Lot 25 on RP8411248 (690-694 Lutwyche Road, Kedron): The site operated as a retail motor fuel outlet and motor vehicle workshop from 1932 to 1992, whence it became part of an extra lane in Lutwyche Road;
- Site C - Lot 2 on RP56087 (7 Earle Street, Windsor): The property has been used historically for numerous potentially contaminating activities including railway depot, timber storage yard/mill, petroleum product storage; and
- Site G - Lot 7 on RP223902 (214 Lutwyche Road, Windsor): Originally the site was quarried from 1910 onwards. In 1939, the quarry was resumed by the Navy and the site was known to have been a bulk hydrocarbon storage facility between 1946 and 1978, although the contents of the above ground storage tank are unknown. The site is currently the Homemaker City commercial precinct.

A detailed assessment of each property (i.e. the preparation of a Stage 1 Site History) would be required to assist with clarifying the identification of these properties prior to construction activities.

6.2 Potential Impacts and Mitigation Measures

6.2.1 Topography and Landforms

Impacts

Potential impacts to topography and landforms have been considered for tunnel portals, areas associated with cut and cover tunnel works, worksites, placement of ventilation outlets and spoil placement sites. Impacts to topography and landforms are most likely to occur during construction activities through the excavation, stockpiling and placement of surface/subsurface material and spoil, vehicle access routes and spoil relocation.

The scale of potential impacts in each of these areas is likely to disrupt existing visual landscapes due to extension of engineered landforms into areas that are dominated by open floodplains. The floodplain areas which may be affected in the north-west and north-east are green spaces surrounded by predominantly residential development. The areas potentially affected at the southern end are dominated by residential, commercial and industrial development and infrastructure.

There is also potential for impacts on landform stability, particularly settlement related impacts associated with tunnelling, which would potentially result in:

- Settlement arising from excavation of tunnel works;
- Settlement resulting from groundwater drawdown;
- Localised ground relaxation effects around trough structures and at tunnel declines; and
- Increased localised subsurface vibration during tunnelling.

Mitigation Measures

Mitigation measures during construction will reduce the impact on visual amenity of surface works and structures through appropriate landscaping principles including revegetation.

Mitigation measures to reduce the risk of landform instability and settlement would be adopted during the design and construction phases of the project. These would include:

- Measures to support the geological and landform stability of tunnel structures, particularly associated with geological unconformities, shear zones and areas of diminished geological strength due to weathering and/or rock defects; and
- Monitoring of changes to groundwater levels within the area of influence for groundwater drawdown.

Specific mitigation measures will be developed during the design phase and incorporated into the construction EMP as outlined in Chapter 19.

6.2.2 Soil Erosion

Potential Impacts

Potential soil erosion impacts have been considered for tunnel portals, areas associated with cut and cover tunnel works, worksites, ventilation outlet locations and spoil placement sites.

The southern worksite is likely to be located on Chermside and/or Logan Soil types within the Enoggera Creek floodplain. The two worksites in the north-west are likely to be on Logan and Nundah Soil types adjacent to Gympie Road and Logan and Chermside Soil types behind Kedron State High School. The north-eastern worksite is likely to intercept Clayfield and Logan Soil types. Both the north-western and north-eastern worksites are within the Kedron Brook floodplain. These soils are considered to be moderately to highly dispersive and their location within erosion prone floodplain areas heighten the potential for significant erosion impacts.

The works at each of these sites that are likely to occur during construction may include:

- Vegetation clearing and site preparation;
- Construction of laydown, material stockpile and equipment storage areas;
- Construction of worksites, haul routes and vehicular access tracks;
- Construction of embankments for elevated road alignments;
- Construction of new bridges and transition structures, including footings, abutments and piers;
- Modification of existing bridges and road infrastructure; and
- Site remediation/reinstatement works.

The potential impacts resulting from soil erosion within these areas and the surrounding environment include, but may not be limited to:

- Degradation of surface water quality in Kedron Brook and/or Enoggera Creek through sedimentation, increase in suspended solids concentrations and mobilisation of contaminants;
- Loss of fertile topsoil material during site preparation and from topsoil stripping and stockpiling material for extended periods;
- Erosion due to clearing vegetation, creating space for materials stockpiles, laydown activities and access routes;
- Poor quality stormwater runoff due to sediment loads during site preparation and construction; and
- Erosion of vulnerable soils on exposure to wind and water action.

Mitigation Measures

Mitigation measures developed during design will need to be incorporated into the detailed construction and operation EMPs, as outlined in Chapter 19. These mitigation measures would be implemented throughout each stage of the project to adequately manage and reduce the risk of erosion due to construction and operation activities.

Mitigation measures would include the development of specific topsoil management and rehabilitation methods and strategies for each stage of scheduled construction works including stripping, stockpiling, replacement staging activities and suitable storage times to minimise fertility degradation and soil loss. This would be achieved through preparation of construction works schedules to incorporate progressive stripping of topsoil material and site rehabilitation/revegetation in order to minimise stockpiling times and unnecessary broadscale disturbance and exposure of vulnerable subsoils. Stripped topsoil would be segregated from other material and where possible construction activities will be scheduled to minimise the disturbance of *insitu* soils and natural landform features. Within the worksites, all stockpiles, treatment areas, material storage and major disturbances would be preferentially located within stable areas that are already highly disturbed/modified.

Specific erosion and sediment control plans would be prepared and adopted for all areas of surface disturbance to ensure that erosion and sediment control measures are implemented and adequate to the nature and scale of disturbance and would include site reinstatement measures once works are complete.

6.2.3 Acid Sulphate Soils

Potential Impacts

The areas where there is the potential for disturbing ASS material during construction activities include:

- Worksites, surface works, bridge crossings, cut and cover or transition structures associated with the Enoggera Creek floodplain;
- Along the Kedron Brook floodplain in worksite, cut and cover and transition zones between the Kalinga Park worksite and connection to the East West Arterial Road in the vicinity of Widdop Street, Toombul; and
- Spoil placement sites at Viola Place (Brisbane Airport Corporation), the Old Airport Site (where the Gateway Upgrade Project is located) and at the Port of Brisbane (Clunies Flat and Fisherman Islands).

Potential impacts associated with disturbance of ASS material include:

- Changes to water chemistry which could lead to degradation of aquatic ecosystems in receiving water bodies (i.e. Enoggera Creek, Kedron Brook, Brisbane River and Moreton Bay) and/or groundwater resources;
- Sedimentation and erosion due to loss of aquatic vegetation;
- Increased potential for the mobilisation of contaminants (i.e. metals) within the groundwater and surface water systems due to acidified runoff/leachate contacting subsurface materials in the area;
- Increased risk of soil degradation, erosion and instability due to deterioration of the structure of vulnerable soils;
- Increased risk of damage to infrastructure and reduced life expectancy of concrete and steel structures due to attack from acidified runoff/leachate and/or direct contact with ASS material;
- Extrusion or displacement of ASS affected material above the groundwater table resulting in the accelerated oxidation of ASS; this could result from placement of fill material and/or structures so as to cause settlement of unconsolidated alluvial material during construction or disposal of spoil; and
- Accelerated oxidation of ASS and uncontrolled release of acidified runoff/leachate resulting from exposure/disturbance of ASS during excavation, filling or groundwater drawdown/dewatering activities.

The severity of these environmental impacts would be determined by a number of factors, including:

- The nature of the soil (e.g. soils will have varying acid generating potential subject to their texture characteristics, pyritic concentration and natural buffering/neutralising capacity);
- The period and frequency of ASS exposure/disturbance;
- The buffering capacity of the receiving water bodies (Enoggera Creek and Kedron Brook) – (acidified runoff can potentially be neutralised through contact with the alkaline buffering capacity of seawater, but heavy rainfall may deliver significant volumes of surface water to the receiving water body and estuarine/brackish creeks may tend toward freshwater and a reduced buffering capacity after such events); and
- The adoption of ASS management measures specifically developed to minimise the potential impacts of ASS disturbance.

Acid Sulphate Soil Mitigation Measures

The key mitigation measure for ASS disturbance is the quantification and delineation of ASS affected material that will potentially be disturbed as a result of the construction and operation of the project through a detailed ASS investigation completed in accordance with the State Planning Policy 2/02 *Planning and Managing Development Involving Acid Sulfate Soils* and the *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998* (Ahern *et al* 1998).

Mitigation measures for ASS disturbance would be developed and implemented during the design phase of the project and would extend through to the construction and operational phases to ensure that the potential for disturbance of ASS is minimised/controlled in both the short and long terms. Specific ASS management measures would be developed in consultation with the Department of Natural Resources, Mines and Water and would incorporate the principles of ASS management as outlined in *the Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines* (Dear *et al* 2002), which include:

- Avoidance;
- Minimisation of disturbance;
- Neutralisation;
- Hydraulic separation; and
- Strategic reburial (least preferred management measure).

In particular ASS management measures would specifically ensure:

- That changes to the natural groundwater levels and impacts to groundwater chemistry are minimised;
- The acid generating potential of material likely to be disturbed is adequately quantified, treated and managed throughout the construction phase;
- Where ASS disturbance is unavoidable, soil and leachate would be contained/captured and treated with fine agricultural lime and other suitable neutralising agents onsite to prevent downstream or off site impacts resulting from the activities;
- ASS stockpiling areas and treatment pads would be adequately designed, constructed, lined and bunded prior to the commencement of site disturbance to prevent uncontrolled release of ASS affected material and/or acidified runoff/leachate to the surrounding environment;
- ASS stockpiling and treatment areas would be designated for the management and handling of ASS affected material only and will be located near to areas of disturbance and a suitable distance from surface water bodies and identified sensitive receptors;
- Diversion drains would be installed to hydraulically separate areas of disturbance, ASS stockpiling and treatment areas from overland flow pathways and surface water bodies;
- Leachate treatment ponds (if required) would be designed and constructed to ensure that sufficient capacity exists to contain leachate for treatment as well as sufficient freeboard to prevent/minimise the risk of uncontrolled release of leachate;
- All leachate and runoff from or intercepting areas excavated/disturbed at or below 5m AHD, ASS stockpiling locations, ASS treatment pads and/or leachate ponds would be adequately captured, contained, analysed and treated (if necessary) prior to off site discharge; and
- All fill/soil material to be used onsite (i.e. for embankment structures, as imported fill material and/or landscaping) would be documented as being ASS-free or first evaluated for the presence of ASS and if

found, will first be treated with fine agricultural lime to adequately neutralise acid generating capacity within the material and verified as being effectively neutralised prior to use.

Water management is one of the key elements for the management and mitigation of potential impacts resulting from the disturbance of ASS affected material. Therefore, it is essential to identify runoff and drainage control points within and exiting the construction site and design suitable control measures and structures to be installed during construction that will divert or contain runoff from specific areas. Design considerations would incorporate the following as a minimum:

- Adoption of similar control measures and principles of containment and runoff control that are to be implemented for erosion and sediment control, with respect to the protection of nearby waterways and containment of runoff from disturbed areas and stockpile/treatment locations;
- Minimisation of disturbance of the natural surface and subsurface drainage regimes, such as retaining/maintaining existing flow pathways and directions for both surface water and groundwater resources and minimising changes to water table levels and tidal influences;
- Design of embankments, structures and other construction activities should incorporate measures to minimise/prevent subsidence, uncontrolled settlement of unconsolidated alluvial material, settlement creep and surface or subsurface heaving or deformation; and
- Planning and staging of proposed construction activities in areas rated as having moderate to extreme risk of ASS material to ensure that disturbance is minimised and rehabilitation/reinstatement of these areas is progressive and timely.

6.2.4 Soil Contamination

Potential Impacts

There is potential for contaminated soil to be encountered on land which would be excavated during construction of the tunnel. The full extent of such contamination is not known at present and the disturbance of contaminated soil may have a number of impacts. Contaminants in the soil may be released to the environment through contact with stormwater either *in situ* or at a disposal location, as well as by drawdown by groundwater.

Contaminated land may pose a risk to occupational and public health, or to the environment. If spoil is to be removed from the site for disposal elsewhere, there is potential for contaminated soil to be moved to a different location and then potentially causing health or environmental hazards. These impacts can be minimised through appropriate management.

Generally, all steps would be taken to avoid land contamination from project activities, but from time to time some small quantities of oil or other chemicals may be spilled and any necessary remediation would need to be undertaken as required. Contaminated soils would be remediated on-site or removed and disposed of off-site if required.

Mitigation Measures - Spillage

To remediate contaminated land, a number of systems will be implemented and will be detailed in a Construction EMP. All materials used on the project which have the potential to cause contamination will be listed in a Hazardous Materials Register. This register will include details on:

- Storage location;
- Storage requirements;
- Proper usage;

- Handling information; and
- Disposal procedures.

Much of this information would be available in Material Safety Data Sheets (MSDS) which would be kept for all materials and chemicals maintained within the Hazardous Materials Register. No substance would be used on the site if it has not been so registered.

Australian Standards such as AS1940: *Storage and Handling of Flammable and Combustible Liquids*, and AS3780: *The Storage and Handling of Corrosive Substances*, provide guidelines on storage requirements and particularly the adequacy and need for bunding around stores. All chemical and fuel storage areas would be designed to comply with these standards.

Fuels or other chemicals used during construction would be stored and handled in accordance with Australian Standards, State legislation and accepted best practice so as to avoid the risk of spills to the environment. This may include temporary containment of storage tanks as well as visual and inventory monitoring of storage tanks to ensure that product is not leaking from the tank. This would include specifications for storage vessels, containment of certain areas and procedures for manual handling.

Emergency response procedures would incorporate spill response procedures and appropriate spill response and containment equipment would be kept on the site in close proximity to storage and handling areas. Spills and leaks would be cleaned up and remediated promptly.

Consultation will be undertaken with local emergency services to ensure that appropriate spill response procedures are in place and adequate levels of support are available. Induction and training regarding contaminated land issues would be provided for construction staff.

Mitigation Measures - Excavation

As part of the Construction EMP, investigations would be carried out in locations where earthworks may potentially encounter contaminated soils, especially areas that are listed on the Environmental Management Register. Particular attention would be paid to any areas from where soils are to be excavated and disposed of away from the site. The site histories to be undertaken are expected to indicate that the highest potential for contamination occurs at the area within Campbell Street at Bowen Hills, as this is the area where the most activities likely to lead to contamination have been carried out. However, attention would also be paid to other areas as site history and observations alone are not completely reliable indicators of the potential for soil contamination.

Contaminated land investigations will include the steps outlined in **Table 6-4**.

During the design and conduct of contaminated land investigations, AS 4482.1-1997 *Guide to the sampling and investigation of potentially contaminated soil - Non-volatile and semi-volatile compounds* and the *Assessment Of Site Contamination National Environment Protection Measure (NEPM) 1999* will be adhered to.

If land to be excavated is subject to a Site Management Plan (SMP), the SMP would be followed, or if required amended to include the transport of contaminated soil offsite. In the event that contaminated soil needs to be removed, the project would require an EPA disposal permit to remove the contaminated material for disposal at a licensed landfill. Authorisation from the Brisbane City Council would also be required prior to disposal. If spills occur during the transport of contaminated land, the area affected would be remediated.

The preparation or alteration of a SMP, and any removal, or disposal or remediation of the contaminated material fill would be carried out in accordance with:

- ANZECC and NHMRC Guidelines for Assessment and Management of Contaminated Sites;
- The Environmental Protection Act (EP Act) 1994 as amended; and
- Other related Acts, Policies and Statutory Regulations of Commonwealth, State and Local Government.

Table 6-4 Contaminated Land Investigation

A detailed site history to identify the following: ▪ Past and current owners of the site ▪ Previous land uses ▪ Previous industries supported ▪ Wastes produced ▪ Chemical storage and transfer areas ▪ Disposal locations ▪ Product spills and losses ▪ Discharges to land or water bodies ▪ Any contaminated site investigations undertaken previously.
A soil-sampling regime to be adopted at the project site targeting: ▪ Potential sources of contamination identified in the site history search ▪ Locations which previously showed visual or olfactory evidence of contamination, but for which insufficient analyses have previously been conducted ▪ Previously unsampled areas of the site.
Laboratory analysis using a NATA accredited laboratory focussing on likely contaminants associated with the land uses undertaken.
Reporting by an EPA registered person.
Liaison with EPA Contaminated Land Unit regarding the results.
Development of a contaminated land management and remediation plan.

Alternatively, the project may opt to remediate or cover the site with packed clay or concrete to minimise potential to contaminate the local environment. The project would consult with the EPA to establish the standards required for the on-site remediation of any contaminated soil. Validation sampling would need to be carried out following remediation or covering, and sign-off given by the EPA and a certified, qualified auditor.

Mitigation Measures - Operations

The potential for soil contamination to occur during operations is considered low on the basis that:

- There would be few chemicals used during the operation of the tunnel, and most will be non-hazardous and therefore have low potential to cause soil contamination;
- Australian Standards and good practice guidelines would be adopted to ensure containment in the event of a spill or leak;
- Procedures for handling of chemicals would include minimisation of risk of chemical spills;
- Emergency response procedures would include appropriate spill response procedures and equipment;
- In the event that soil contamination does occur, it would be cleaned up and an incident investigation carried out to ensure that any measures necessary to prevent a re-occurrence are undertaken;
- The vast majority of the tunnel would be within bedrock in geological units such as the Brisbane Tuff, with smaller areas of Neranleigh-Fernvale Beds and Quaternary Alluvium. These areas all have a low permeability for groundwater movement, except where fissures occur; and

- Groundwater modelling (detailed in Chapter 7) showed that with the tunnel in place, groundwater flow directions within the "groundwater catchment" are towards the tunnel. The significance of this occurrence is that any groundwater, contaminated or otherwise, would ultimately drain to the tunnel. However, this water will be collected in a series of sumps and treated before discharge if and as required.

6.3 Conclusions

6.3.1 Topography, Geology and Landforms

Mitigation measures would be implemented during the construction phase of the project to reduce the impact to visual amenity of areas of surface works and structures through adopting appropriate landscaping principles during revegetation activities. Mitigation measures to reduce the risk of geological and landform instability would be adopted during the design phase of the project to ensure that potential impacts are adequately managed throughout the design life of the project. Specific mitigation measures would be developed during the design phase of the project and incorporated into the construction and operation EMPs.

To minimise the risk associated with settlement, it is important to adhere to proper engineering practices and ensure that effective management and monitoring approaches are implemented and reviewed from the onset of construction. Appropriate mitigation measures applied in the detailed design process would include design of tunnel support and liners, stability assessment of portals and as well as the driven tunnel and groundwater modelling of any impact by the tunnel. Comprehensive geotechnical investigations would fully define the subsurface profile and materials along the alignment. All buildings and structures within the areas where surface settlements and possible damage are predicted would have a building condition survey completed. Surveys and other displacement monitoring would be used to monitor the effects of settlement (if any) from tunnelling.

6.3.2 Erosion and Sediment Control

Sediment and erosion control measures would be implemented throughout the project to mitigate potential impacts and reduce the risks associated with wind and water erosion during construction and operation. Particular attention would be paid to the construction sites to ensure that rehabilitation of the sites is completed as soon as practicable after construction is completed.

Specific erosion and sediment control plans would be developed during the design phase and incorporated into the construction and operation EMPs.

6.3.3 Acid Sulphate Soils

An ASS investigation would be undertaken during preconstruction to quantify and delineate ASS material likely to be disturbed during construction. The ASS investigation will be completed in accordance with the requirements outlined in the *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998* (Ahern *et al* 1998) and the *Queensland Acid Sulfate Soil Technical Manual Acid Sulfate Soils Laboratory Methods Guidelines* (Ahern *et al* 2004).

Mitigation measures for managing ASS throughout the project would involve implementation of best practice monitoring and management practices, commencing at the design phase and extending through the pre-construction and construction phases. Permanent measures may also be required to mitigate long term impacts from ASS disturbance, particularly relating to groundwater drawdown and dewatering resulting in permanent changes to groundwater levels and tidal influences. The ASS impact mitigation measures would be developed in consultation with representatives of NRM and will incorporate the overriding principles outlined in the State Planning Policy 2/02 and *the Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines* (Dear *et al* 2002).

6.3.4 Contaminated Lands

To prevent and remediate contaminated land resulting from the project, a number of systems would be implemented and would be documented in detail in the construction EMP. Australian Standards such as AS1940*: Storage and Handling of Flammable and Combustible Liquids*, and AS3780*: The Storage and Handling of Corrosive Substances*, provide guidelines on storage requirements and particularly the adequacy and need for bunding around stores. All chemical and fuel storage areas would be designed to comply with these standards. As part of the construction EMP, broad investigations would be carried out where earthworks may potentially encounter contaminated soils at locations as identified in this EIS.