17 Topography, geology and soils

The airport site comprises approximately 1,780 hectares of undulating terrain. Soils at the airport site are primarily firm residual clays with areas of alluvial gravels, sands, silts and clays associated with Badgerys Creek. A major bulk earthworks programme would be carried out for the construction of the Stage 1 development. To achieve a level surface suitable for the construction of airport facilities the earthworks programme would essentially involve the redistribution of about 22 million cubic metres of soil across a construction impact zone covering about 60 per cent of the airport site. Measures including erosion control structures, sediment basins and stockpile management are proposed to mitigate and manage potential soil erosion and degradation associated with earthworks. Fuel and other chemicals would be responsibly stored and handled in accordance with relevant standards, minimising the potential for contamination to occur. Due to the prior land uses at the airport site, including agriculture, light commercial and building demolition, there is potential for contaminated land to be present. Any contamination discovered during construction would be managed and mitigated to make the land suitable for its intended use and to prevent impacts on human health and the environment. Construction and operation would also involve the controlled storage, treatment and handling of fuel, sewage and other chemicals with potential to contaminate land if improperly managed. The potential impacts of the operation of the proposed airport are typical of a large scale infrastructure project and would be managed with the implementation of stormwater, erosion and dust controls and adherence to relevant industry standards for the storage and handling of chemicals. Waste water would be treated and irrigated on site in accordance with an irrigation scheme that maintains the receiving soil in a stable and productive state.

17.1 Introduction

This chapter provides an assessment of the existing topography, geology and soils that would be affected by the development of the proposed airport. The assessment draws on a number of field assessments including geotechnical investigations and a preliminary contamination assessment.

The methodology is described further in Section 17.2 while the existing environment is described in Section 17.3. Potential impacts of construction and operation are described in Section 17.4 and Section 17.5 while measures to mitigate and manage impacts are described in Section 17.6.

17.2 Methodology

The following tasks were undertaken to describe the existing environmental values of the airport site and to assess the impact of the airport with regard to topography, geology and soils:

- desktop reviews of prior reporting, mapping and databases;
- geotechnical investigation of the airport site to characterise soils and geology;
- contamination assessment of the airport site to identify potentially contaminated land;
- identification of potential impacts on topography, geology and soils; and
- development of mitigation and management measures.

17.2.1 Geotechnical investigation

The purpose of the geotechnical investigation was to determine the constructability of soils at the airport site. The geotechnical investigation involved sampling at 137 boreholes, 11 test pits and 10 kilometres of seismic survey across the airport site. This sampling distribution and density was selected to provide confidence in planning bulk earthworks, particularly hard rock excavation.

The samples collected during geotechnical investigation underwent laboratory testing for their geotechnical properties. Field testing was also undertaken to identify potential for acid sulfate soils.

Further geotechnical investigations would be undertaken prior to construction to supplement the investigations to date.

17.2.2 Contamination investigation

The purpose of the contamination investigation was to identify potential sources of land contamination at the airport site. The contamination investigation included a Phase 1 (preliminary) contamination investigation followed by a Phase 2 (detailed) site contamination investigation.

The Phase 1 contamination investigation involved an initial desktop analysis to identify properties at the airport site which may be of potential concern due to known prior land uses. The desktop analysis was followed by visual inspection of properties and analysis of samples gathered during the geotechnical investigation.

Properties that were of potential concern were subject to an on-site visual inspection, while remaining properties were inspected from the roadside to confirm their low risk status. Samples gathered during the geotechnical investigations underwent laboratory testing for potential contamination indicators.

The Phase 2 site contamination investigation involved sampling including:

- Sampling for asbestos in soil at 50 sites;
- Sampling for asbestos fragments at 162 sites;
- Sampling for chemical contamination at 147 sites;
- Sampling for groundwater contamination at 16 boreholes; and
- Sampling for surface water and sediment contamination at 30 dam sites.

The identified potential sources of land contamination were then assessed for their potential impacts on human health and the environment. This assessment was conducted through the development of a site conceptual model that charted potential pathways between potential sources of land contamination and human or environmental receptors.

Further contamination investigations are expected to be undertaken before construction. In addition, the proposed airport will be subject to ongoing obligations in the Airports (Environment Protection) Regulations 1997 (AEPR) to prevent, monitor and manage soil pollution at the airport site.

17.3 Existing environment

17.3.1 Topography

The topography of the airport site is depicted in Figure 17–1. The airport site is part of an elevated ridge system dividing the Nepean River and South Creek catchments. The site is characterised by rolling landscapes typical of Bringelly Shale (see Section 17.3.2). The site features a prominent ridge in the west, reaching an elevation of about 120 metres Australian Height Datum (AHD), and smaller ridge lines in the vicinity with elevations of about 100 metres AHD. The broad topography of the airport site generally slopes away from the ridges in the west, with elevations generally between 40 metres and 90 metres AHD, with the lower elevations toward Badgerys Creek.

17.3.2 Geology

As outlined in Figure 17–1 the dominant geological formations beneath the airport site are Bringelly Shale, the Luddenham Dyke and alluvium.

Bringelly Shale is a Triassic geological unit mainly comprising claystone and siltstone, with some areas of sandstone. This unit underlies most of the airport site (Coffey Partners International 1990). Bringelly Shale is the top unit of the Wianamatta Group and is about 150 metres thick beneath the airport site, along with some overlying weathered material.

Luddenham Dyke is a Jurassic groundmass of olivine basalt, analcite, augite, feldspar and magnetite in the west of the airport site (Bannerman and Hazelton 1990). The dyke outcrops towards the peak of the ridge in the west of the airport site (see Section 17.3.1).

Alluvium at the airport site comprises of Quaternary sedimentary deposits along Cosgroves Creek and Badgerys Creek. These sedimentary deposits can be up to five metres thick and are made up of fine sands, silts and clays with some areas of gravelly clay (Coffey Partners International 1990).

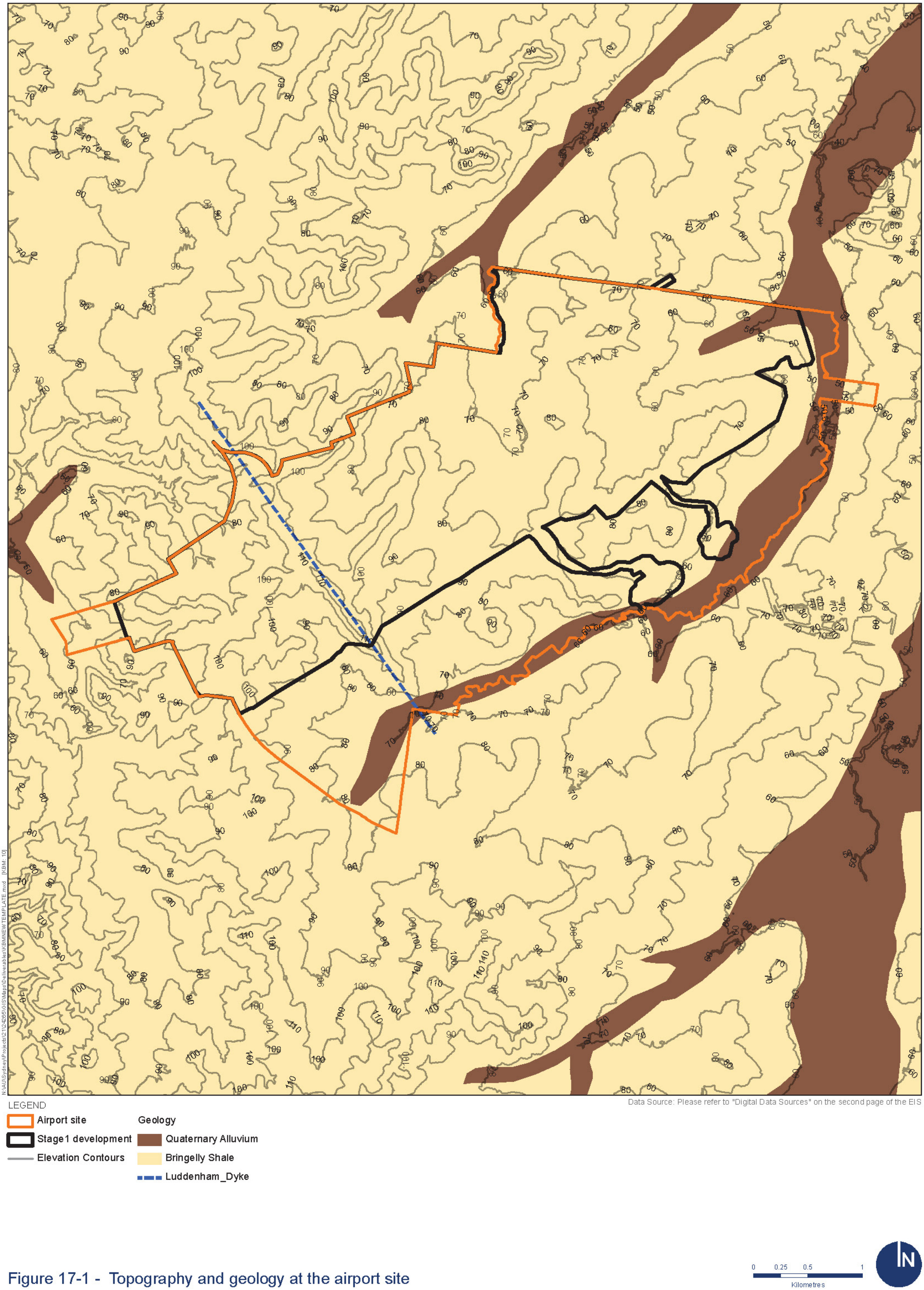

Figure 17-1 - Topography and geology at the airport site

17.3.3 Soils

17.3.3.1 Soil types

Geotechnical investigations at the airport site generally indicated surficial silt and/or clay topsoils overlying firm residual clays from the weathering of Bringelly Shale, with areas of alluvial gravels, sands, silts and clays associated with Badgerys Creek.

The soils at the airport site are categorised as the Blacktown, Luddenham and South Creek soil landscapes – based on consistent soil type, material, depth and erosion characteristics. The characteristics of these soil types are summarised in Table 17–1.

Soils at the airport site have also been mapped in line with the Australian Soil Classification (see Figure 17–2). The mapped soils are classified as Kurosols, which occur over the majority of the airport site, and Hydrosols in the vicinity of Badgerys Creek. Kurosols are characterised by a strong texture contrast between their A horizons (topsoils) and their strongly acid B horizons (subsoils). Hydrosols are characterised by prolonged periods of saturation.

Parts of the airport site have been used for agricultural activities including cattle grazing and horticulture. The site is not mapped as biophysical strategic agricultural land (high quality soil capable of sustaining high levels of productivity) in the associated mapping for the NSW *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*.

17.3.3.2 Saline soils

Soil salinity mapping of Western Sydney (DIPNR 2002) indicates moderate salinity potential. Additionally, there are some localised areas of high salinity potential associated with Badgerys Creek and drainage lines to the south and west of the airport site. Selected soil samples gathered during the geotechnical investigations were tested for salinity. The selected samples returned relatively low salinity levels, between 120 and 384 mg/L. Given the recognised potential for salinity to occur, further soil salinity sampling would be undertaken before construction to supplement the investigations to date.

17.3.3.3 Acid sulfate soils

Acid sulfate soils are naturally occurring sediments containing iron sulfides, which produce sulfuric acid when exposed to air. Acid sulfate soils are widespread in Australia's estuarine floodplains and coastal lowlands. Acid sulfate soils are not expected at the airport site given that it is not a coastal location and has an elevation ranging between 40 and 120 metres AHD. Previous acid sulfate soil risk mapping indicated no known occurrences at the airport site (OEH 1993). Field testing during the geotechnical investigation indicated that isolated acid sulfate soil may be present, but not to an extent requiring measures for acid sulfate soil management.

Table 17–1 Soil landscape characteristics

Unit	Soil matter	Soil depth	Soil fertility	Erosion potential
Luddenham	Brown loams, clay loams or clays with clay subsoils.	Shallow on crests (<100 cm) and moderately deep (< 150 cm) on slopes and depressions.	The soil landscape has generally low to moderate fertility. It is generally capable of being grazed and cultivated.	The potential for erosion in the soil landscape is moderate to very high with slopes of 5–20 per cent and certain clays considered highly erodible. Minor gully erosion and moderate sheet erosion are evident in disturbed areas.
Blacktown	Brownish black loams and brown clay loams with clay subsoils.	Shallow to moderately deep (>100cm).	The soil landscape has generally low to moderate fertility. It is generally capable of being grazed and cultivated.	The potential for erosion in the soil landscape is typically slight to moderate, with slopes usually greater than five per cent. Some clay subsoils are sodic and dispersive making them highly erodible. Existing minor gully erosion and sheet erosion may be found in disturbed areas.
South Creek	Brown sandy loam, sandy clay loams or clay loams with clay subsoils.	Shallow to moderately deep (>100 cm) in low terraces and channels, with deeper stratified clays (> 190 cm) on terraces.	The soil landscape has generally low fertility but is capable of supporting grazing and cultivation.	The potential for erosion in the soil landscape is potentially very high to extreme. The erodibility of the soil material is high. Stream bank and gully erosion are common results of concentrated water flows.

Source: (NSW Environment and Heritage 2015a; 2015b; 2015c)

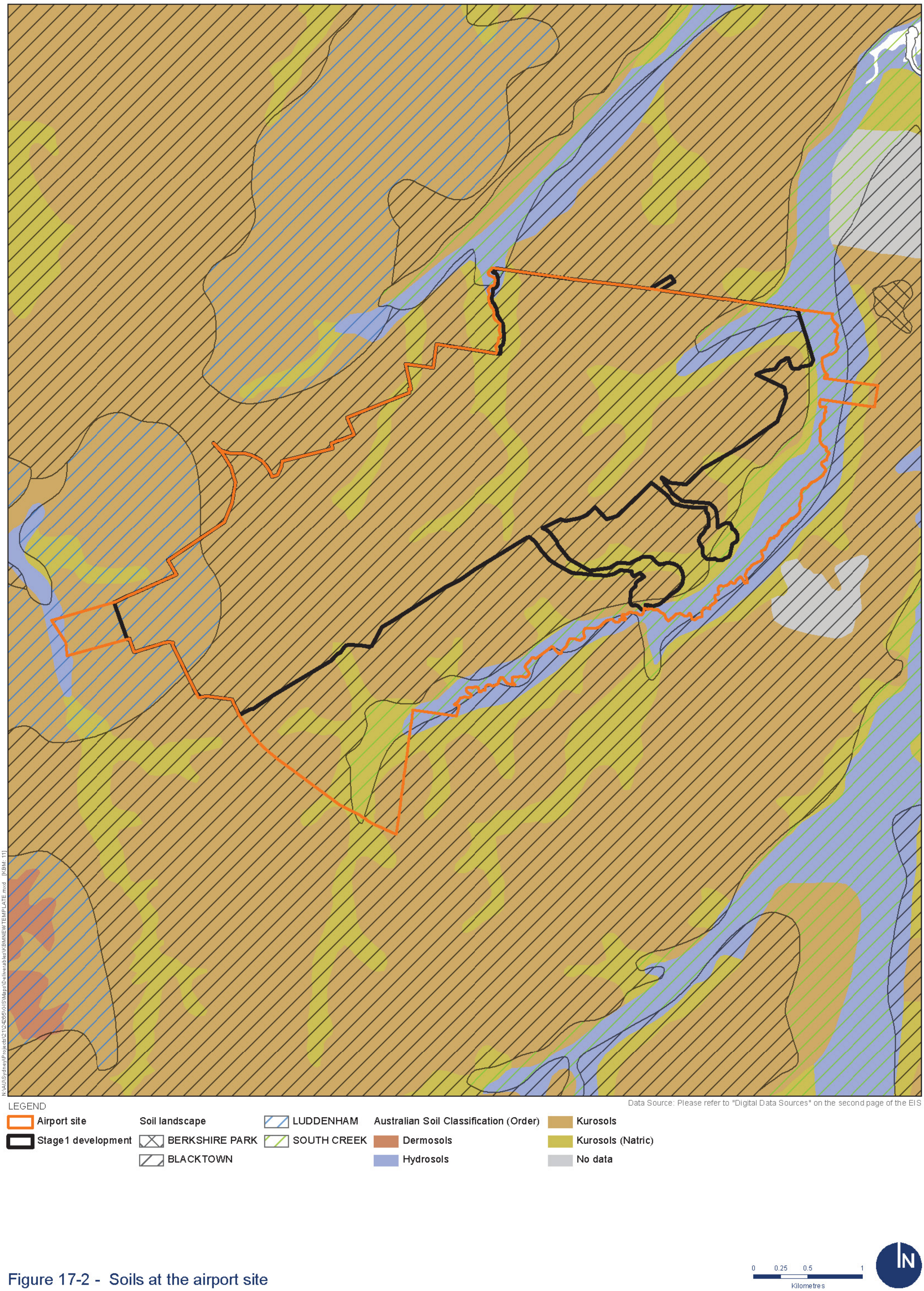

Figure 17-2 - Soils at the airport site

17.3.4 Contaminated land

A range of contaminants associated with prior land uses may be present at the airport site. Previous and current land uses at the airport site that may potentially result in contamination include agriculture, light commercial and building demolition works.

The contaminants associated with these land uses are of concern due to their potential to affect human health or the environment if not effectively managed. Potentially contaminated land is identified here while Section 17.6 discusses its effective management.

The NSW Environment Protection Authority (EPA) administers a number of records relevant to contaminated land, including the record of regulatory notices issued under the NSW *Contaminated Land Management Act 1997* and the public register of environment protection licences and notices under the NSW *Protection of the Environment Operations Act 1997*.

The record of regulatory notices under the *Contaminated Land Management Act 1997* contains one notice at the airport site. The notice regards illegal dumping of chemical wastes and was issued in 1985. The property was subsequently remediated in 1996–97, including removal of 1,904 tonnes of contaminated soil. A following audit found the land suitable for residential use.

The public register under the *Protection of the Environment Operations Act 1997* contains one licence at the airport site. The license is for dairy animal accommodation, indicating potential for farm chemicals or other contaminants. The licence was issued in 2002 and is held by Leppington Pastoral Company. No other environment protection licences are registered at the airport site.

A review of the contamination register administered by the Department of Infrastructure and Regional Development, historic aerial photos (from 1947, 1965, 1975, 1986, 1991 and 2005), and subsequent inspection of the airport site identified further evidence of potential contamination.

Evidence included chemical storage tanks and drums, rubbish dumping, stockpiled demolition waste, fibre cement sheeting, hydrocarbon stains and stockpiled fill material of unknown origin. Contaminants associated with this evidence include fuels, lubricants, solvents, acids, asbestos, heavy metals, ash, herbicides, pesticides and pathogens.

About half the properties were considered to present at least moderate risk of contamination. In particular, historic demolition sites, stockpiled demolition waste and fill material of unknown origin indicated potential for asbestos to be present.

Samples were collected during the detailed site contamination investigation and tested for the presence of contaminants. A number of samples collected at the airport site returned contaminant levels posing a risk to human health or the environment, including:

- lead at one property;
- asbestos in soil at 13 properties;
- asbestos fragments at 65 properties;
- total hydrocarbons at eight properties;
- poly aromatic hydrocarbons at 28 properties; and
- elevated levels of copper, nickel and zinc at 10 properties.

Elevated levels of copper, nickel and zinc were identified across the airport site. In general, these levels are considered attributable to natural background conditions – except for localised elevated levels of metals detected at 10 sites. Surface water and groundwater sampling also returned elevated concentrations of metals attributable to natural background conditions.

In addition to the general obligations to prevent, monitor and manage soil pollution under the AEPR, a construction environmental management plan would require the remediation of soil prior to the start of construction. Elevated levels of heavy metals would also be addressed in this plan. Measures to mitigate potential impacts on human health and the environment are detailed in Section 17.6.

17.4 Assessment of impacts during construction

17.4.1 Topography and geology

The bulk earthworks programme proposed to be carried out for construction of the Stage 1 development would change the topography of the airport site from rolling landscapes to a built environment with some landscaping. The earthworks would affect the upper geological units of the Bringelly Shale, Luddenham Dyke and alluvium down to approximately 30 metres depth.

Following bulk earthworks, the elevation of the airport site within the construction impact zone would be generally level with elevations between approximately 50 and 100 metres AHD, with no major embankments. The secondary impacts of this change would mainly relate to hydrology (see Chapter 18) and visual amenity (see Chapter 22).

17.4.2 Soil erosion and degradation

The bulk earthworks programme carried out for construction of the Stage 1 development would involve the excavation of approximately 22 million cubic metres of material including about two million cubic metres of topsoil within the construction impact zone (see Figure 17–2).

Topsoil would be stockpiled while the remaining excavated material would be distributed within the construction impact zone. As cut and fill requirements are expected to be equal, most soil material would remain at the airport site and would not generally be moved further than two kilometres.

Clearing and bulk earthworks would increase the surface area, and in some instances, the slope of exposed soil at the airport site. These changes to the landscape would increase the risk of erosion. The majority of bulk earthworks would occur in the Blacktown soil landscape which has slight to moderate erosion potential for non-concentrated flows. The Luddenham and South Creek soil landscapes, and some subsoils in the Blacktown soil landscape, have higher erosion potential and would potentially require specific mitigation and management measures. Erosion may occur in the form of runoff during rainfall or windblown dust.

If improperly managed, topsoil stockpiles would not only present an erosion hazard but would also potentially lose their chemical and physical fertility over time.

Potential soil erosion and degradation impacts would be avoided, mitigated or managed by implementing standard stormwater, erosion and dust control measures detailed in Section 17.6. As a result, the impacts are not expected to be significant.

17.4.3 Land contamination

Construction of the Stage 1 development has the potential to interact with existing sources of potential contamination (see Section 17.3.4). Construction would also involve the storage, treatment and/or handling of fuel, sewage and other potential contaminants.

Any contamination discovered during construction would be managed and mitigated to make the land suitable for its intended use and to prevent impacts on human health and the environment.

Demolition works before construction would include measures to mitigate contamination risks of asbestos and lead based paints, including site clearance during site preparation works.

Although unlikely, the accidental release or mobilisation of contaminants has the potential to affect human health and the environment through contact with pathogens (such as sewage), inhalation (such as asbestos or chemical vapours), or mobilisation to surface waters and bioaccumulation.

These events would be managed in the first instance through implementation of applicable Australian Standards for the storage and handling of hazardous materials. In the unlikely event of a significant leak of spill or contaminants, remediation would be implemented as soon as practicable.

Potential contamination impacts are not expected to be significant and would be avoided, mitigated and managed by implementing the measures further detailed in Section 17.6.

17.5 Assessment of impacts during operation

17.5.1 Soil erosion and degradation

Operation of the Stage 1 development would not involve any significant direct disturbance or exposure of soils. The design of the proposed airport would incorporate landscaped areas and stormwater drainage including grassed swales and detention basins to control the quantity and quality of stormwater runoff. The operation of the proposed airport is therefore not expected to have a material impact in terms of soil erosion and degradation.

Saline soils have the potential to damage subsurface infrastructure and disrupt revegetation. Some soil samples gathered during geotechnical investigations have indicated some areas of relatively low level soil salinity. Given the recognised potential for salinity, further soil salinity sampling is expected to be undertaken prior to construction to supplement investigations to date.

17.5.2 Land contamination

Operation of the Stage 1 development would involve the storage, handling and treatment of potential contaminants including fuel, sewage and other chemicals, particularly near fuel farms, fuel reticulation and maintenance areas.

Contamination would be avoided in the first instance through meeting obligations under the AEPR to prevent, monitor and manage soil pollution, and the implementation of applicable Australian Standards for the storage and handling of hazardous materials. In the unlikely event of a significant leak or spill of contaminants, remediation would be implemented as soon as practicable.

17.5.3 Reclaimed water irrigation

An estimated 2.5 ML of wastewater per day would be generated during operation of the Stage 1 development. Wastewater would be reticulated to a water treatment facility. The water treatment facility is expected to have membrane biological reactor technology, which produces high quality reclaimed water suitable for various beneficial reuses including recycling and irrigation.

Recycling opportunities include the reuse of reclaimed water in maintenance of plant and infrastructure, industrial cooling processes, and landscaping. On average, these activities are expected to use around 1.8 ML of reclaimed water per day. Irrigation of excess reclaimed water, which is expected to average around 0.72 ML per day, could occur in areas previously disturbed by bulk earthworks, such as grassed areas between aprons and taxiways. Irrigation areas would be designed and operated in accordance with the guidelines discussed in Section 17.6.

The key risks to soils associated with the irrigation of reclaimed water include adverse physical or chemical changes, which may lead to an ongoing reduction in fertility and potential to grow turf or pasture. The principal cause of these risks is excess irrigation, causing waterlogging, leaching of nutrients, rising water tables and increases in soil salinity or other soil properties. These risks are therefore expected to be adequately managed through the planning, design and operation of the irrigation area – including active control of water application rates (see Section 17.6).

17.6 Mitigation and management measures

Measures to manage soil erosion and degradation, land contamination and treated water irrigation during construction and operation are discussed below and itemised in Table 17–2.

A Soil and Water Construction Environmental Management Plan (CEMP) and Operation Environmental Management Plan (OEMP) will be prepared and submitted for approval prior to Main Construction Works and operation of the Stage 1 development respectively. The plans would collate the mitigation and management measures discussed in this section and itemised in Table 17–2. These and other environmental management plans are discussed in further detail in Chapter 28 (Volume 2b).

The establishment of erosion controls in line with *Managing urban stormwater: soils and construction* (Landcom 2004) would be central to the management and mitigation of soil impacts. Erosion controls would be employed to reduce the area of exposed soil, the volume of water that reaches the exposed soil, and the quality of water that runs off. Controls would include:

- site stormwater drainage and sediment basins;
- sediment fencing around all disturbed sites;
- stabilisation (such as vegetation) on soil stockpiles; and
- progressive revegetation of landscape areas.

A remedial action plan would be prepared prior to construction of the Stage 1 development. The plan would guide the remediation of contamination identified at the airport site to ensure the land is suitable for its intended use prior to construction. The plan would outline measures for the management of contaminated material including on-site containment and off-site disposal. Measures to remove asbestos containing material would be in accordance with the relevant guidelines including *Managing asbestos in or on soil* (WorkCover 2014) and *How to Safely Remove Asbestos Code of Practice* (Safe Work Australia 2011).

An unexpected finds protocol would be prepared to account for any areas of contamination not already identified by site contamination investigations. The protocol would define the response of personnel in the event of an unexpected find and would link with the remedial action plan. Together, the plan and protocol would facilitate the quarantining, isolation and remediation of contamination identified through the construction programme.

The irrigation areas would be designed and operated in accordance with the risk framework and management principles contained in the *National Guidelines on Water Recycling* (EPHC 2006) and the *Environmental guidelines: Use of effluent by irrigation* (DEC 2004). It is considered that this approach would avoid environmental harm and maintain the receiving soil in a stable and productive state, given the following points.

- The irrigation area would be delineated based on the expected rate of irrigation and the drainage characteristics of the receiving soil.
- The quality of treated water would be determined to prevent accumulation of contaminants, with reference to the relevant guidelines.
- The irrigation area would be designed to include capacity to store treated water for the duration of typical wet weather events.
- The rate of irrigation would be optimised to avoid waterlogging or ponding of reclaimed water.
- Soil and groundwater conditions would be monitored to identify and correct trends in soil salinity or other potential effects of irrigation.

Table 17–2 Mitigation and management measures

Issue	Measure	Timing
Erosion and sedimentation	Impacts associated with erosion and sediment will be mitigated through: • installing a site drainage system prior to commencement of bulk earthworks; • minimising the surface area disturbed at any one time by, where practical, staging construction works and stabilising soils with vegetation or appropriate cover materials; • establishing erosion and sediment controls in accordance with the 'NSW OEH Blue Book – *Managing urban stormwater: soils and construction'*; • providing intermediate sediment retention basins within the construction impact zone to provide additional treatment prior to completion of the airport's site drainage system. Specific erosion control measures would be developed for the management of highly erodible soils such as those anticipated in the Luddenham and South Creek soil landscapes; • mulching cleared vegetation for use in erosion control at construction sites; • covering and stabilising soil stockpiles with vegetation or mulch; • stockpiling topsoil at a maximum height of two metres, where practicable; and • distributing and seeding topsoil over landscaped areas at the completion of bulk earthworks.	Construction
Leaks or spills of fuel or other chemicals	To minimise the risk of leaks or spills the following mitigation measures will be put in place: • maintenance areas, fuel farms and other areas where fuels or chemicals are stored or handled will be bunded to contain any accidental spills or leaks; • fuel and other chemicals will be stored and handled in accordance with relevant Australian standards such as: ▪ AS 1940-2004 The storage and handling of flammable and combustible liquids; ▪ AS/NZS 4452:1997 The storage and handling of toxic substances; ▪ AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods; and ▪ AS/NZS 1547:2012 On-site domestic wastewater management; and • a protocol will be developed and implemented to respond to and remedy leaks or spills.	Construction Operation
Land Contamination	A remedial action plan and unexpected finds protocol would be established to facilitate the quarantining, isolation and remediation of contamination identified throughout the construction programme.	Construction
	Any asbestos identified on site would be managed in accordance with applicable regulatory requirements.	Pre-construction Construction
Wastewater reuse	The treated water irrigation scheme will be designed and operated in accordance with the risk framework and management principles contained in the National Guidelines on Water Recycling (EPHC 2006) and Environmental guidelines: Use of effluent by irrigation (DEC 2004).	Operation

17.7 Conclusion

Potential impacts of the construction of the Stage 1 development are typical of large scale construction projects and would be managed with the implementation of standard stormwater, erosion and dust controls and adherence to industry standards for handling of chemicals.

The major bulk earthworks required for site preparation would substantially alter the natural landscape of the airport site. Measures to mitigate and manage soil erosion and degradation, land contamination and wastewater reuse will be collated in environmental management plans to be approved prior to Main Construction Works and operation of the Stage 1 development.