17. Topography, geology and soils

The airport site comprises about 1,700 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. The 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, to achieve a level surface suitable for the construction of airport facilities. Construction and operation would involve the controlled storage, treatment and handling of fuel, sewage and other chemicals with potential to contaminate land.

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, minimising the potential for contamination to occur.

Prior activities at the airport site including agriculture, light commercial and building demolition mean 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.

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 industry standards for the storage and handling of chemicals. Sewage effluent 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 analysis of the existing topography, geology and soils that would be affected by the development of the proposed airport. It draws on a number of field assessments including geotechnical investigations and contamination assessment. Potential impacts of the construction and operation of the airport are characterised, and measures to mitigate and manage these impacts are identified.

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;
- review of surface water and groundwater assessments of the airport site;
- 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 of bulk earthworks, particularly hard rock excavation. The samples underwent laboratory testing for their geotechnical properties. Further geotechnical investigations would be undertaken before 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 investigation involved a desktop analysis and visual inspection of all properties at the airport site. Properties of potential concern due to their registered uses were visited, while remaining properties were inspected from neighbouring roads. Samples gathered during the geotechnical investigations underwent laboratory testing for potential contamination indicators. The identified potential sources of land contamination were assessed for their impacts on human health or the environment.

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 the Bringelly Shale (see Section 17.3.2) with a prominent ridge in the west of the site, 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 topography of the airport site generally slopes away from the ridges in the west, at elevations 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, with 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 toward 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 Cosgrove 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).

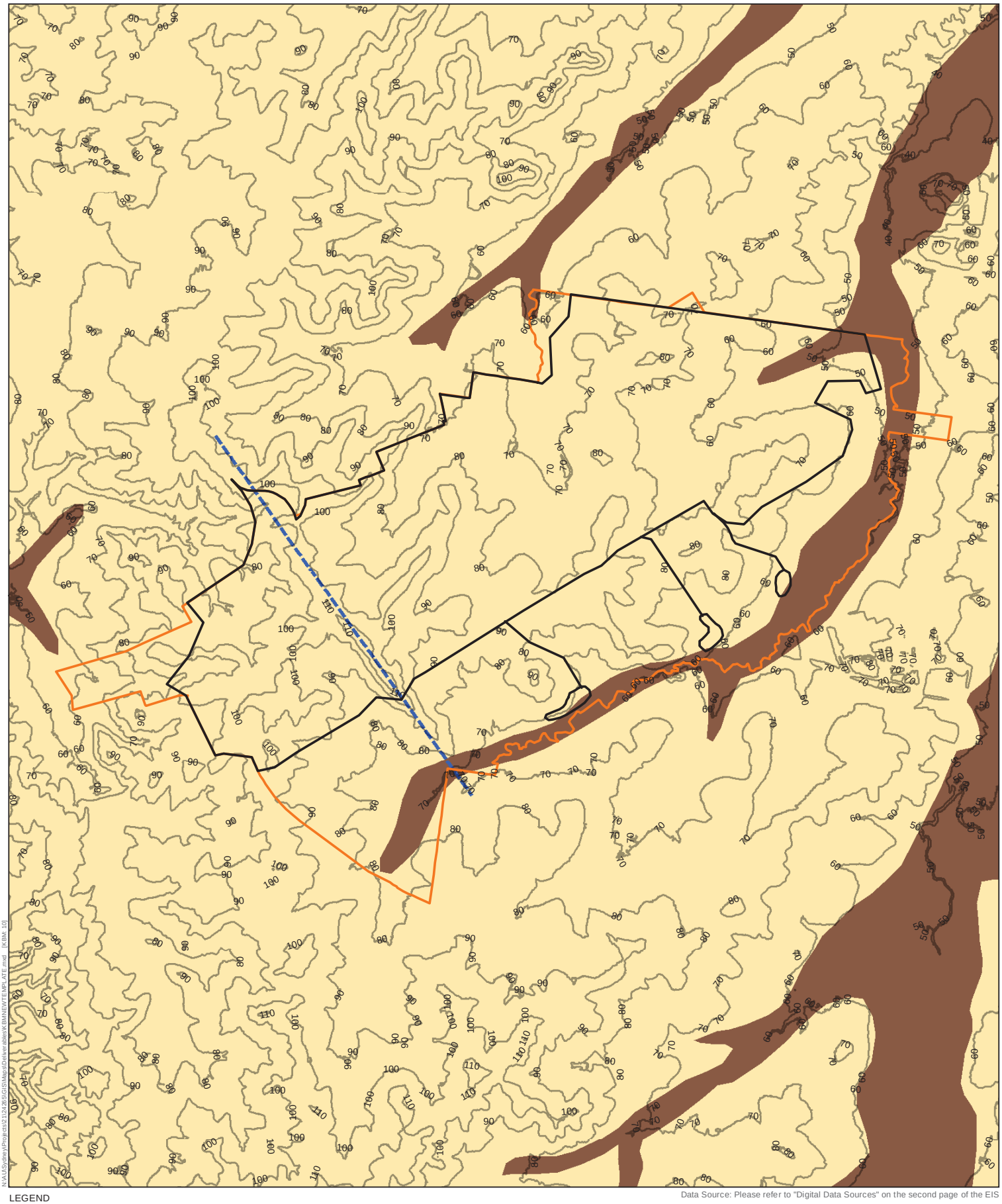

Figure 17-1 - Topography and geology at the airport site

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. These soil landscapes are mapped in Figure 17–2 and their characteristics are summarised in Table 17–1.

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

Parts of the airport site are used for agricultural activities including cattle grazing and horticulture (see Chapter 21). 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 broadly moderate salinity potential with localised areas of high 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. These soils usually occur in coastal areas less than one metre above sea level. 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. Acid sulfate soil risk mapping indicates that there are no known occurrences at the airport site (OEH 1993).

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)

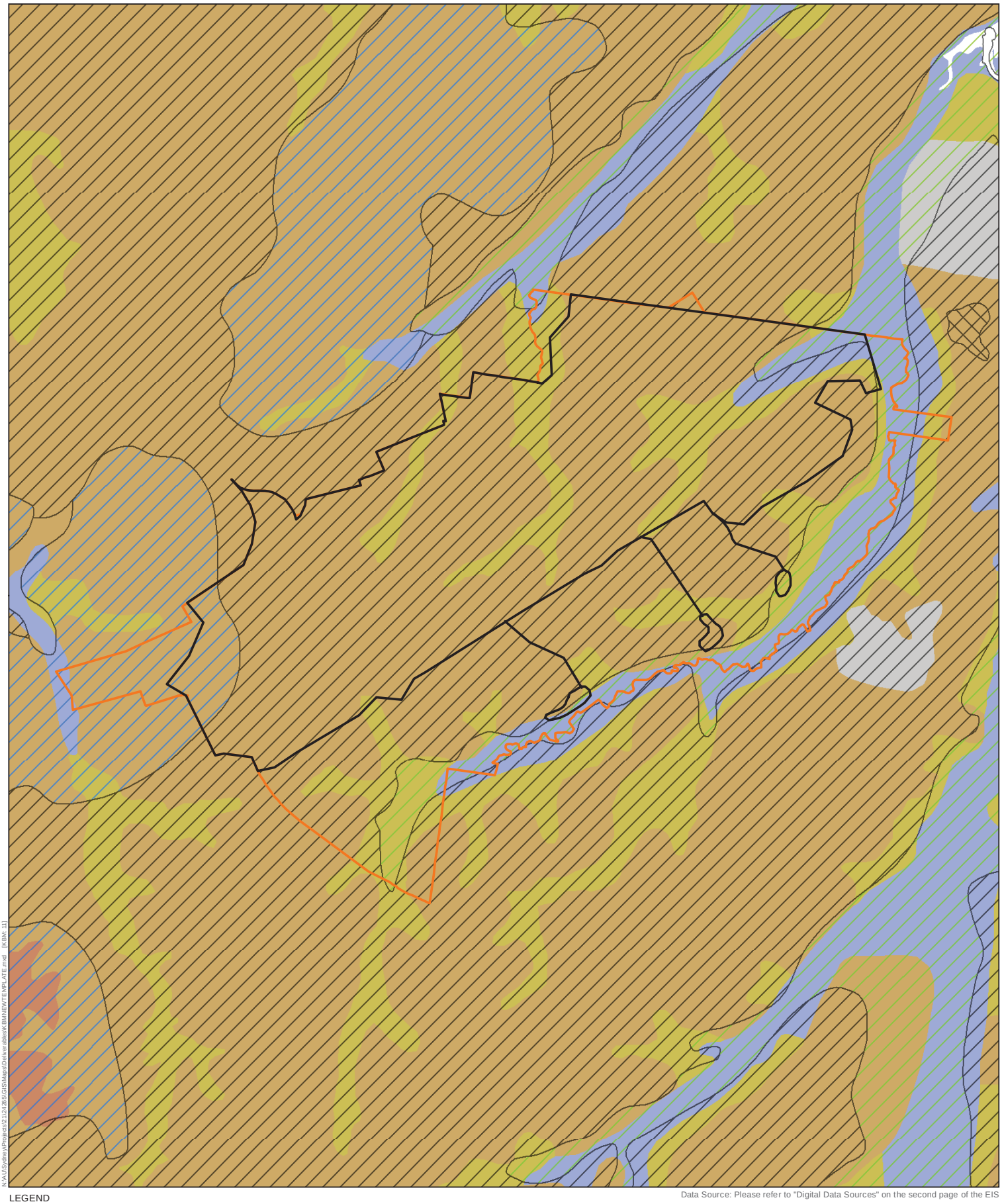

Figure 17-2 - Soils at the airport site

17.3.4. Contaminated land

A range of contaminants associated with prior land uses may be present at the airport site. Previous and current activities at the airport site that may potentially result in contamination have included 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 therefore identified here, while its management is discussed in Section 17.6.

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 record at the airport site, regarding dumping of chemical wastes. The notice was issued in 1985 and the property was subsequently remediated in 1996–97, including the removal of 1,904 tonnes of contaminated soil. Remediation and a following audit found that the property was suitable for residential use.

The public register under the *Protection of the Environment Operations Act 1997* contains one licence at the airport site for dairy animal accommodation, indicating the 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 airport site contamination register administered by the Department of Infrastructure and Regional Development, along with 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, and stockpiled fill material of unknown origin. The associated contaminants include fuels, lubricants, solvents, acids, heavy metals, ash, herbicides, pesticides and pathogens. About half of the properties at the airport site were considered to have at least a moderate risk of contaminants.

Stockpiled demolition waste and fill material at multiple properties indicated potential for asbestos. Asbestos may also be present in soil beneath former demolition sites, as evidenced in historic photographs. About half of the properties at the airport site were considered to have at least a moderate risk of asbestos.

Selected soil samples gathered during the geotechnical investigations were tested for the presence of contaminants including fuels, heavy metals, herbicides and pesticides. The limited samples did not return contaminant levels presenting a significant risk to human health or the environment. Given that sample sites were selected for geotechnical purposes, further contamination investigations are expected to be undertaken before construction.

Any contamination discovered during the construction and operation of the proposed airport would be managed and mitigated to make the land suitable for its intended use and to mitigate potential impacts on human health and the environment (see 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 and would have 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 cut material, including about two million cubic metres of topsoil within the construction impact zone (see Figure 17–2). Topsoil would be stockpiled and the remaining cut material would be distributed within the construction impact zone. As cut and fill requirements are expected to be equal, most soil material would generally remain at the airport site and would not generally be moved further than two kilometres within the site.

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 present a risk of increasing 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 (see Section 17.6).

Erosion may occur in the form of runoff during rainfall or windblown dust. Topsoil stockpiles would also present an erosion hazard and would be subject to potential degradation of chemical and physical fertility over time.

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

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 controlled storage, treatment and/or handling of fuel, sewage and other chemicals with potential to contaminate land.

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 at the end of demolition. However, historic demolition sites and land use also present a risk of existing contamination.

Although unlikely, the accidental release or mobilisation of contaminants has the potential to affect human health and the environment through contact with pathogens (in the case of sewage), inhalation (in the case of asbestos or chemical vapours), mobilisation to surface waters or 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. As such, the operation of the proposed airport is not expected to have a material impact in terms of soil erosion and degradation.

If present, saline soils have the potential to damage subsurface infrastructure and disrupt revegetation. Selected soil samples gathered during the geotechnical investigations have indicated relatively low soil salinity at the airport site. Given the recognised potential for salinity to occur, further soil salinity sampling is expected to be undertaken prior to construction to supplement the investigations to date.

17.5.2. Land contamination

Operation of the Stage 1 development would involve the controlled storage, treatment and handling of fuel, sewage and other chemicals with potential to contaminate land, in relation to fuel farms, fuel reticulation and maintenance areas.

Contamination would be managed in the first instance through 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 high quality treatment facility before being recycled or irrigated at the airport site. The wastewater treatment process is expected to utilise membrane biological reactor technology, which produces high quality reclaimed water suitable for a range of beneficial reuses. Recycling opportunities include the use of reclaimed water in maintenance of plant and infrastructure, industrial cooling processes or landscaping. It is expected that irrigation of excess reclaimed water would occur in areas previously disturbed by bulk earthworks, such as grassed areas between aprons and taxiways and landscape areas.

The irrigation area would be designed and operated in accordance with the relevant guidelines and management practices discussed in Section 17.6.

The key risks to soils associated with the application 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 risk associated with the operation of a reuse scheme is excess irrigation, leading to additional waterlogging, leaching of nutrients, a rise in water tables and increases in soil salinity or other soil properties. These risks are expected to be adequately managed through the planning, design and operation of the irrigation area (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 listed in Table 17–2.

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.

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.

Prior to site preparation for the construction of the Stage 1 development, further contamination investigations are expected to be undertaken to validate contamination risks. These investigations would be conducted with reference to the *National Environment Protection (Assessment of Site Contamination) Amendment Measure 1999* and *Guidelines for Consultants Reporting on Contaminated Sites* (OEH 2011). Any areas with significant contamination would require remediation before the start of site preparation activities.

An asbestos management plan would be prepared to mitigate risks to human health before and during construction of the Stage 1 development. The plan would identify areas of known risk and include a safety protocol, including a procedure to be followed in the event of an unexpected encounter.

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

ID	Issue	Measure	Timing
17.1	Soil and water management plan	A soil and water management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on soil and water.	Construction
17.2	Soil erosion and degradation	Erosion controls would be established in line with *Managing urban stormwater: soils and construction* (Landcom 2004).	Construction
17.3		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.	Construction
17.4		Cleared vegetation would be mulched and used to control erosion at construction sites.	Construction
17.5		Soil stockpiles would be covered and stabilised with vegetation or mulch.	Construction
17.6		Topsoil would be stockpiled at a maximum height of two metres.	Construction
17.7		Topsoil would be distributed and seeded over landscape areas at completion of bulk earthworks.	Construction

17.8	Land contamination	Fuel and other potential contaminants would 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* • *AS/NZS 1547:2012 On-site domestic wastewater management*	Construction Operation
17.9		An unexpected finds protocol and Remediation Action Plan would be established to facilitate the quarantining, isolation and remediation of contamination.	Construction
17.10		Any asbestos identified on site would be managed in accordance with applicable regulatory requirements.	Construction
17.11	Treated water irrigation	The treated water irrigation scheme would be designed and operated in accordance with the risk framework and management principles contained in the National Guidelines on Water Recycling (*Environment Protection and Heritage Council 2006*) and *Environmental guidelines: Use of effluent by irrigation* (DEC 2004).	Operation

17.7. Conclusion

The potential impacts of the construction of Stage 1 development are typical of a large scale construction project and could be managed with the implementation of standard stormwater, erosion and dust controls and adherence to industry standards for the storage and 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 treated water irrigation would be collated in environmental management plans before construction and operation.