16.0 Topography, Geology and Soils

16.1 Introduction

This chapter describes the topographic, geological and soil characteristics of the Study Area, and provides an assessment of the potential issues associated with the construction and operation of the Project and associated infrastructure from a geological perspective. The information provided in this chapter has been largely based on the findings of the Preliminary Geotechnical Assessment: Coopers Gap Wind Farm (Coffey Geotechnics, 2008) (refer to Appendix C, Volume 3), and has been supplemented, where appropriate, with searches of the Queensland Government's Environmental Management Register and the Contaminated Land Register. Based on this information, mitigation measures for implementation during design, construction and operation of the Project are identified to manage potential issues associated with the topographic and geotechnical characteristics of the Study Area.

16.2 Scope of assessment

The purpose of the assessment is to describe and characterise the existing environmental values of the land area that have the potential to be affected by the Project. Where the assessment identifies a potential adverse impact on a land based attribute due to Project activities, mitigation is applied to avoid or reduce the potential impact.

Several broad soils and geology based topics are considered as part of this chapter. These include:

- Geology
- Soils
- Potential land degradation and likelihood of contaminated land.

The assessment involved undertaking a range of desktop studies, preliminary site investigations, and detailed technical studies, as described in Section 16.4. Section 16.6 discussions potential impacts and Section 16.7 provides mitigation.

AGL is seeking approval for an area of land to install a maximum of 115 turbines and ancillary infrastructure. This area is described as the Project Site. The area of direct impact is referred to as the construction footprint.

16.3 Legislation and policy

16.3.1 State Development and Public Works Organisation Act 1971

The SDPWO Act provides for state planning and development through a coordinated system of public works organisation, for environment coordination and of related purposes to facilitate large projects in Queensland. The Project has been declared a 'coordinated project' by the Coordinator-General for which an EIS is required under Section 26(1)(a) of the SDPWO Act.

16.3.2 Environmental Protection Act 1994

The EP Act is the centrepiece of Queensland's environmental legislative system. The EP Act introduces fundamental definitions and provisions promoting the principles of ecologically sustainable development and environmental management. The EP Act describes and references a wide range of policies, processes, legislation and audit procedures applicable to development activities in general. The application of the EP Act's 'general environmental duty' to minimise and prevent 'environmental harm' is particularly relevant to this chapter in terms of soils erosion and potentially contaminating activities.

16.3.3 Nature Conservation Act 1992

The NC Act provides for the creation and management of Queensland's protected areas. The NC Act is administered jointly by the Department of National Parks, Recreation, Sport and Racing and the DEHP. The Project needs to consider the protected areas that are listed in Section 14 of the Act.

Protected areas are classified as:

- National Parks (scientific)
- National Parks

- National Parks (Aboriginal land)
- National Parks (Torres Strait Islander land)
- National Parks (Cape York Peninsula Aboriginal land)
- National Parks (recovery)
- Conservation Parks
- Resource Reserves
- Nature Refuges
- Coordinated Conservation Areas.

The NC Act also outlines processes for transferring land, such as state forest, into protected area estates. State forest is not a protected area under the NC Act, and is managed under the terms of the *Forestry Act 1959*.

Consideration is given to NC Act for the potential of the Project to affect resource reserves.

16.3.4 Soil Conservation Act 1986

The *Soil Conservation Act 1986* (SC Act) allows for the approval of soil conservation property plans to ensure the coordination of runoff to control erosion. The SC Act allows for two types of plans:

- Property plans
- Project plans.

Where runoff flow is not in accordance with an approved property plan, a runoff coordination notice may be issued requiring an owner to take appropriate action to discharge or receive runoff in accordance with the plan. Failure to comply with a notice can result in the issue of a court order to comply and/or a fine.

As with approved property plans, approved project plans are binding on all present and future owners and the Crown. A soil conservation order can be issued requiring an owner of land to comply with a project plan. Failure to comply with a soil conservation order can result in the issue of a court order and/or a fine. Alternatively, the Director-General can take whatever action is necessary to ensure compliance with the plan, and the owner is liable for the expenses incurred.

Consideration is given to theSC Act as part of the erosion controls applied to the Project.

16.4 Methodology

The impact assessment was conducted by undertaking a range of desktop studies, stakeholder consultations, and preliminary site investigations. The approach was designed to gather suitable information in order to assess the potential impacts arising from Project activities and provide mitigation measures. The methodologies for each of the topography, geology, soils and contaminated land studies are explained in the following sections.

16.4.1 Topography

The topography of the Project Site and surrounds was derived relative to the Australian Height Datum (AHD) and drafted according to the Geocentric Datum of Australia (GDA) 94 datum. Imagery was obtained from available aerial photography.

16.4.2 Geology

The geology assessment comprised of a desktop review of available information. This information included a review of a preliminary geotechnical assessment undertaken for the site (Coffey, 2008). The preliminary geotechnical assessment included a site visit on 21 and 22 May 2008 where 22 test pits were excavated using a rubber tyred backhoe to allow assessment of typical subsurface features and limited geotechnical assessment.

The test pits were distributed over several of the Project Site ridge lines to provide general characterisation of the range of ground conditions, rather than to investigate the specific wind turbine sites.

The test pits were excavated to refusal or in several cases were terminated at depths of 2 m below ground level where it was considered that no further useful information would be gained by proceeding further.

16.4.3 Mineral resources and ore reserves

Desktop searches were conducted utilising the MinesOnline (DNRM, 2016) mapping tool, to determine known mineral, coal, petroleum, natural gas and key resource areas (KRAs) within the Study Area.

16.4.4 Soils

The soils within the Project Site have been determined based on analysis of the CSIRO's Australian Soil Resource Information System tool (CSIRO, 2013), land system maps (DNRM, 2016), and Queensland Globe mapping (DEHP, 2016) for the Eastern Downs area of the Darling Downs region.

16.4.5 Contaminated land

Under the EP Act, contaminated land is defined as land which is impacted by a hazardous contaminant that may pose a potential risk to human health or the environment. Poor environmental management procedures, accidental spills, industrial activities and poor waste disposal procedures can all contribute to land contamination. To provide an understanding of the potential contamination status of the Project Site, the following methodology was undertaken:

- A desktop review of the current and historical land uses on properties within or adjacent to the Project Site
- Identification of historical land uses undertaken on the properties within the Project area that are considered to have the potential to cause contamination
- A review of available Queensland Government records to assess whether properties within the Project Site are recorded on the public access registers containing land use planning information, Environmental Management Register (EMR) or Contaminated Land Register (CLR)
- A desktop review of additional contamination sources with the potential to impact the Project Site, such as acid sulfate soil searches and unexploded ordinances search (UXO)
- A review of land potentially impacted by land contamination and the likelihood of impacts to the Project Site, based on proximity and contaminants of concern.

16.5 Description of environmental values

16.5.1 Topography

The Project is located within the Great Dividing Range, which extends along the eastern coast of Australia. The highest point in the vicinity of the Study Area is Mount Kiangarow (1,136 m AHD) which is located approximately 12 km south-east of the Project, in the Bunya Mountains National Park (see Figure 16.1, Volume 2).

The Study Area is characterised by a number of ridgelines, predominantly orientated in a north-west to westerly direction. Generally, the proposed wind turbines are located along these ridgelines to maximise exposure to the wind resource within the area. These ridgelines range in height from (855 m AHD) in the south-east of the Study Area, to (470 m AHD) in the north-west of the Study Area. Away from these ridgelines, properties within the Study Area are as low as 500 m AHD.

Slopes within the Study Area vary significantly, from very shallow to angles greater than 20°. Current access to some ridgelines within the Study Area requires traversing slopes of between 15% (to the south of the site) and 25% (in the central west of the site) (Coffey, 2008).

The topography of the site is compatible with the requirements of the Project.

16.5.2 Geology

Geological information for the Study Area shows that the Project site is predominantly underlain by Tertiary basalt bedrock (see Figure 16.2, Volume 2). Basalt is a dark, fine-grained, volcanic rock that was deposited as distinct layers of lava, varying in thickness from a few metres to almost 100 m. Basalt, although normally very strong in its fresh state, weathers relatively quickly (in geological time scales) to form dark brown and red clay soils. Basalt weathering processes often leave "corestones" or boulders of strong rock within a soil matrix. The rapid weathering, together with the mode of deposition in successive layers, can mean that terrain formed in basalt can have relatively weak material underneath strong rock. This is a situation that is largely unique to basalt terrains (Coffey, 2008).

Some parts of the Study Area, particularly in the north-east, are noted to be underlain by sedimentary rocks. Access to these areas was not available at the time of the site investigation.

The wind turbines will be founded on either rock anchored foundations or gravity type foundations, depending on the suitability of the underlying bedrock. The anchored foundation design requires that the near-surface materials must have appropriate strength and stiffness, and there must be suitable rock at depth over the bond length of the anchors, which would be at depths of more than 10 m below the base of the foundation (Coffey, 2008).

Challenges associated with basalt for anchored foundation systems relate to the potential for less-strong materials underlying the strong near-surface materials. Near-surface investigations undertaken by Coffey (2008) did not reveal these conditions, however there is still a possibility that these conditions exist in the Study Area.

Coffey (2008) states that suitable founding strata are likely to be present at most locations between 0.7 m and 1.5 m depth, and a gravity foundation could reasonably be designed for these ground conditions. The possible exceptions to this are deep clay soils on the ridge in the central-west portion of the Study Area, south of the intersection of Jarail Road and Niagara Road.

Sub-surface conditions throughout the Study Area will be confirmed during detailed design through a comprehensive geotechnical survey. Deeper drilling to provide a greater understanding of the geology of the successive lava flows associated with the basalt will be undertaken to make an assessment of the anchor bond zones for anchored foundations.

A quarry site for the Project is currently being investigated in the vicinity of the quarry site identified in the Preliminary Geotechnical Assessment: Coopers Gap Wind Farm (Coffey Geotechnics, 2008) (refer to Appendix C, Volume 3). Conditions at the potential quarry site are likely to be similar to those described in the Preliminary Geotechnical Assessment, with near surface materials comprising variably sized fragments of fresh, very high strength basalt. These conditions have formed through the collapse of large, joint defined “columns” of basalt which make up the adjacent hillside. Lava flows, from which the basalt was formed, often develop such continuous near vertical joints as they cool. At this location the adjacent creek appears to have undercut the base of the slope, exposing the columns and allowing collapse.

The geology of the site is considered to be compatible with the requirements of the Project.

16.5.3 Mineral resources and ore reserves

A search of the MinesOnline mapping tool shows that an Exploration Permit for Coal (EPC 2056) is located within the Project Site. The authorised holder of the EPC is COALBANK Limited. The EPC was granted on the 26 November 2010 and expires on 25 November 2020.

16.5.4 Soils

Interrogation of soil and land mapping available from the Australian Soil Resource Information System (ASRIS) (CSIRO, 2016), the DNRM and the DAF showed that the Project Site is predominantly comprised of fine textured grey and brown cracking clay soils.

Cracking clay soils are common in the Darling Downs region and commonly form on basalt bedrock and characterise alluvium plains, which are predominant in the Study Area. These are commonly considered good agricultural soils, particularly for cropping land, and are also specific to the Brigalow Belt bioregion. Lower lying areas, valleys and plateaus in the sub-region are characterised with great alluvial qualities, and often gravelly sands and loams can be found interspersed with brown and grey cracking clays. Many cracking clays are also self-mulching enhancing their water-holding capacity, and increasing their value as good agricultural soils (CSIRO, 2009). Parts of the Project Site occur on Marburg subgroup stratigraphic units (Geoscience Australia, 2012). Soil profiles in these areas can have sodic characteristics which, if disturbed, can rapidly erode.

Test pitting conducted in 2008 confirmed the presence of weathered basalt bedrock across the majority of the Project Ste with a hard gravelly clay or heavy clay B-horizon, and a medium to high plastic brown and red-brown clay A-horizon, characteristic of cracking clays.

Agriculture

The prominent land use throughout the Study Area is rural and much of the Study Area is mapped as Class A and Class B land under the Agricultural Land Classification (ALC). To achieve the State interest, Class A and Class B land should be protected from fragmentation, inappropriate development and land degradation.

The layout of the Project has been developed so that existing property owners can continue agricultural uses in conjunction with the development and ongoing operation of the Project. Owners of properties containing the wind farm infrastructure are willingly involved in the Project and will continue agricultural activities on their properties. The physical footprint of wind turbines and access road infrastructure is relatively minor and will not cause significant severance of productive land. In this manner, the Project supports the ongoing sustainable use of Class A and Class B lands. Wind farms are also temporary and reversible, allowing the land to be returned to former agricultural uses.

16.5.5 Contaminated land

The EP Act identifies land parcels (lots) based on the risk of contamination existing on those individual land parcels. The EMR lists those lots which have been used for a notifiable activity (Schedule 3 of the EP Act) and/or land that has been identified to contain a degree of contamination through a preliminary site investigation as detailed in the Guideline for Contaminated Land Professionals (DEHP, 2012). As such, land listed on the EMR is considered to pose a low risk to human health or the environment under the current land use.

Land parcels (lots) are recorded on the CLR when the extent of contamination following site investigation is deemed by DEHP to require remediation or management. Remedial action is required to reduce risk to human health and the environment, thereby preventing potential harm.

Digital Cadastral Database (DCDB) mapping of the Study Area was overlain with the Project Site to provide a focus area for the review. All lots included within the Study Area were searched on the Queensland EMR/CLR database. Twenty-eight (28) lots were identified in this manner. None of these lots were found to be listed on the EMR or CLR.

Land within the Study Area is predominantly used for agricultural purposes. In combination with the general remoteness of the Study Area, it is possible that potentially contaminating activities associated with agricultural land uses may be undertaken on the searched lots, but have so far avoided inclusion on the EMR/CLR database.

Potentially contaminating ‘Notifiable Activities’ (Schedule 3 of the EP Act), which could be carried out on rural agricultural properties on a small scale and have avoided inclusion on the EMR/CLR database, may relate to:

- Aerial spraying – operating premises used for:
    - Filling and washing out tanks used for aerial spraying; or
    - Washing aircraft used for aerial spraying.
- Livestock dip or spray race operations – operating a livestock dip or spray race facility.

A desk based review of the ASRIS found the Study Area to have a ‘low’ to ‘extremely low’ potential for acid sulfate soils to occur.

16.5.5.1 Unexploded ordnance mapping

UXO is military ammunition or explosive, which has failed to explode as intended. It includes sea mines or shells used by the Navy, mortar bombs, mines, artillery shells or hand grenades used by the Army; bombs, rockets or missiles used by the Air Force; and many other types of ammunition and explosives including training munitions. Military ammunition is designed to explode at the time it is used, but for a variety of reasons some of it fails to do so (Department of Defence website, accessed March, 2016).

In Queensland, DEHP works with the Department of Defence (Defence) in managing UXO contamination (Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland 1998). UXO is listed as a contaminant under Section 11 of the EP Act. Under the Commonwealth Policy on the Management of Land Affected by Unexploded Ordnance, Defence records all land in Queensland that has been identified and assessed by Defence as having been used by the military in a way that may result in residual UXO (DEHP website, accessed March 2016).

A review of Defence UXO mapping identified that the Project Site does not contain known UXO contaminated areas.

16.6 Potential impacts

16.6.1 Erosion and stability

Natural erosion processes are to be expected within the Project Site, particularly where topographical influences (such as slopes and fluvial basins) accelerate natural erosion processes. The erosion and stability impacts associated with the Project as detailed in this section do not include natural erosion processes, but are specifically related to the anthropogenic impacts from the Project.

As discussed in Section 16.5.4, the soil characteristics of the site include significant areas of cracking clays, much of which have medium to high plasticity. As such, these soils are prone to erosion, particularly where they are found to have sodic characteristics. Cracking clays are particularly vulnerable to accelerated erosion and dispersity when the horizon structure is disturbed.

Construction activities related to the Project are likely to have the greatest impact on the stability of the landscape. The removal and clearing of vegetation will expose topsoil to water and wind driven erosion, which may result in the degradation of the agricultural capability of the land post-construction. Removal of the topsoil layer and the disturbance of the horizons during any excavation activities also expose the site to erosion, particularly in wetter months where high rainfall events can be more frequent and more destructive.

Operational activities associated with the Project will include the maintenance and ongoing use of access roads and cleared areas adjacent to infrastructure. These areas are likely to be susceptible to increased erosion due to the lack of stabilising vegetation cover and the disturbance of the soil profile. Access roads will be particularly vulnerable to accelerated erosion due to the lack of protective (vegetative or hard engineered) cover.

The Project Site topography and geographic location is such that surface water run-off is likely to lead to ephemeral streams and local creeks and river systems. Where soil is disturbed and eroded, there is the potential for sediment to enter local waterways, which may impact water quality, downstream health and riparian and aquatic ecosystem function.

The pre-control risk of land clearing is therefore considered to be high, with unplanned clearing potentially exposing a large surface area of topsoil which could be eroded and discharged as sediment without proper pre-planning and control.

Control measures to manage and, where possible, avoid impacts from erosion and stability have been provided in Section 16.7.

16.6.2 Potential contamination impacts

Searches of the EMR, CLR and UXO mapping indicate that the Study Area contains no land parcels (lots) that are listed as being contaminated under the EP Act, or containing any known UXO potential. However, given the use of the land for agricultural purposes, there is the possibility that the Study Area is subject to potentially contaminating “Notifiable Activities” such as aerial spraying, livestock dip/spray race, and fertiliser manufacture.

Potentially contaminating ‘Notifiable Activities’ (Schedule 3 of the EP Act), which could be carried out on rural agricultural properties on a small scale and have avoided inclusion on the EMR/CLR database, may relate to:

- Aerial spraying – operating premises used for:
    - Filling and washing out tanks used for aerial spraying; or
    - Washing aircraft used for aerial spraying.
- Livestock dip or spray race operations – operating a livestock dip or spray race facility.

A desk based review of the ASRIS found the Study Area to have a ‘low’ to ‘extremely low’ potential for acid sulfate soils to occur.

The Project will include a number of activities that have a relatively high potential to cause contamination if not managed effectively. Construction and operational activities such as waste management, chemical and fuel handling and storage have the potential to release contaminants.

Project elements with an increased potential to cause land contamination include:

- Concrete batching plants
- Construction compounds

- Chemical stores.

Potential contamination impacts during Project operations may include spills of fuels, greases and lubricating oils which may cause localised contamination.

16.7 Mitigation measures

16.7.1 Erosion and stability

A site-specific ESCP will be prepared as part of an overarching CEMP prior to the commencement of construction. Particular issues that the ESCP will consider include:

- Surrounding terrain
- Scheduling of work activities to avoid, where possible, the exposure of soils during the wet season
- Temporary stockpiling of material within natural clearings until an on-site use is identified
- Stabilisation of exposed surfaces, post-construction and post-decommissioning
- Maintaining temporary erosion and sediment control measures in place, during and post-construction, until the site is stabilised.

Construction work activities within and/or adjacent to waterways will be minimised as much as feasibly possible to minimise disturbance to those waterways and adjacent riparian areas.

Any topsoil retained for rehabilitation activities will be stockpiled on site in a manner that conserves the native seedbank, soil structure and nutrient value. This will include instating a temporary cover crop on stockpiles that are to be stored for a significant period of time.

It is expected that implementation and maintenance of standard erosion and sediment controls will minimise the likelihood of material migrating off site.

On completion of construction activities, a land rehabilitation program will be established progressively to reinstate a suitable soil profile and vegetative cover in areas no longer required to be maintained as cleared as part of the operational footprint. Consideration will be given to the capability and co-land use opportunities for the Project Site. Operational monitoring of any erosion will be included as part of the overall site maintenance program.

Access tracks and other cleared areas susceptible to accelerated erosion will be designed in a manner that seeks to direct water flow away from the track or cleared footprint into local vegetated areas. Appropriate grading of footprints and access tracks will be conducted during construction to direct water flow, prevent ponding, and stabilise the cleared area surface. Maintenance of road surfaces and cleared footprints will be conducted prior to and immediately following rainfall events during the construction phase and throughout the life of the Project. This will reduce the potential for the mass movement of sediment from the Project Site.

Further studies related to soil and land stability will be conducted as part of the detailed design phase of the Project.

16.7.2 Contaminated land

Prior to the finalisation of a CEMP for the Project, a site visit will be undertaken to confirm the presence or absence of notifiable activities within the Project Site. Should any notifiable activity be identified through this site visit, the CEMP will be updated to ensure that potential issues associated with any contamination are appropriately dealt with.

The following measures will be in place to manage spills of contaminated fluids:

- Areas will be allocated for the storage of fuels, chemicals and other hazardous materials
- Facilities will be secured and bunded
- Spills or contaminated runoff will be captured and treated and/ or disposed of at a licensed facility
- Re-fuelling, wash down and preparation of construction materials will be undertaken in bunded areas to mitigate risks in relation to spills or leaks of fuels / oils or other hazardous onsite construction material

- The application of good practice in the storage and handling of dangerous and hazardous goods will provide appropriate practical responses to manage impacts on occupational health and safety and minimise the risk of a spill occurring
- Captured contaminants resulting from spills or leaks will be treated and disposed of at a licensed facility
- Any soil which has been contaminated with fuel, oils or other chemicals will be disposed as contaminated soil by a waste subcontractor.

16.8 Residual impacts

The Project's construction and operational activities will be carried out with the aim of minimising the amount of land disturbed at any one time. The Project will disturb approximately 360 ha of land during construction, however the construction workspace will be reduced to approximately 100 ha for operational activities. The construction workspace no longer required for the operational activities will be rehabilitated. Works will be progressive and staged, minimising the period of disturbance and the potential for harm to the environment.

With the implementation of standard mitigation and management measures, the disturbance of land due to the Project's construction and operational phases is not considered to result in a significantly increased potential for accelerated erosion. There is potential for some sediment-laden run-off to enter local waterways, even with the proposed mitigation measures, due to the erosive properties of the local soil type and the residual cleared areas. However, with the implementation of proposed mitigation measures, the volume of sediment anticipated to leave the Project site as a result of associated clearing activities is not expected to result in the degradation of local fluvial water quality or result in damage to adjacent ecosystem areas. As such, the residual impact to land based environmental values from erosion or loss of stability is considered to be low.

Impacts as a result of contamination incidents causing land degradation are considered to be unlikely with the application of standard mitigation and control measures. The residual impact to land based environmental values as a result of land degradation is therefore considered to be low.

16.9 Summary and conclusions

This chapter has outlined land based environmental values that may be affected by the Project. Due to the nature of the Project, existing environmental values pertaining to land use will be altered. Assessments were therefore carried out on a range land based topics to appropriately define the baseline environment and consider the likely impacts to the receiving environment.

Several broad, land based topics were considered. These included: geology; soils; potential land degradation and likelihood of contaminated land. The Project Site is suitable for both the Project and agricultural uses, with the surrounding land use being predominately pastoral and associated light agricultural industry. It is anticipated that the Project can co-function with existing agricultural practices.

An assessment into erosion risks as a result of the Project's activities considered that residual risks were low following the application of suitable mitigation and control measures.

The chapter demonstrated that although high risk activities will occur, which have the potential to impact on land based environmental values, the application of mitigation and control measures where appropriate reduces the residual risks to an acceptable level.

16.10 References

Coffey Geotechnics (2008) *Preliminary Geotechnical Assessment: Coopers Gap Wind Farm*. Report prepared for Investec Bank (Australia) Limited.

CSIRO (2016) *Australian Soil Resource Information System* http://www.asris.csiro.au/

DEHP (2012) Guideline for contaminated land professionals. Prepared by: Waste and Land Contamination Assessments, Department of Environment and Heritage Protection

Department of Defence (2016) http://www.defence.gov.au/uxo/where_is_uxo/where_is_uxo.asp

Queensland Government (2016) *Resource Mapping* https://minesonlinemaps.business.qld.gov.au

Queensland Government (2016) *Land Evaluation Schemes* https://www.qld.gov.au/environment/land/soil/soil-testing/types/#

Soil Quality (2016) http://www.soilquality.org.au/au/qld