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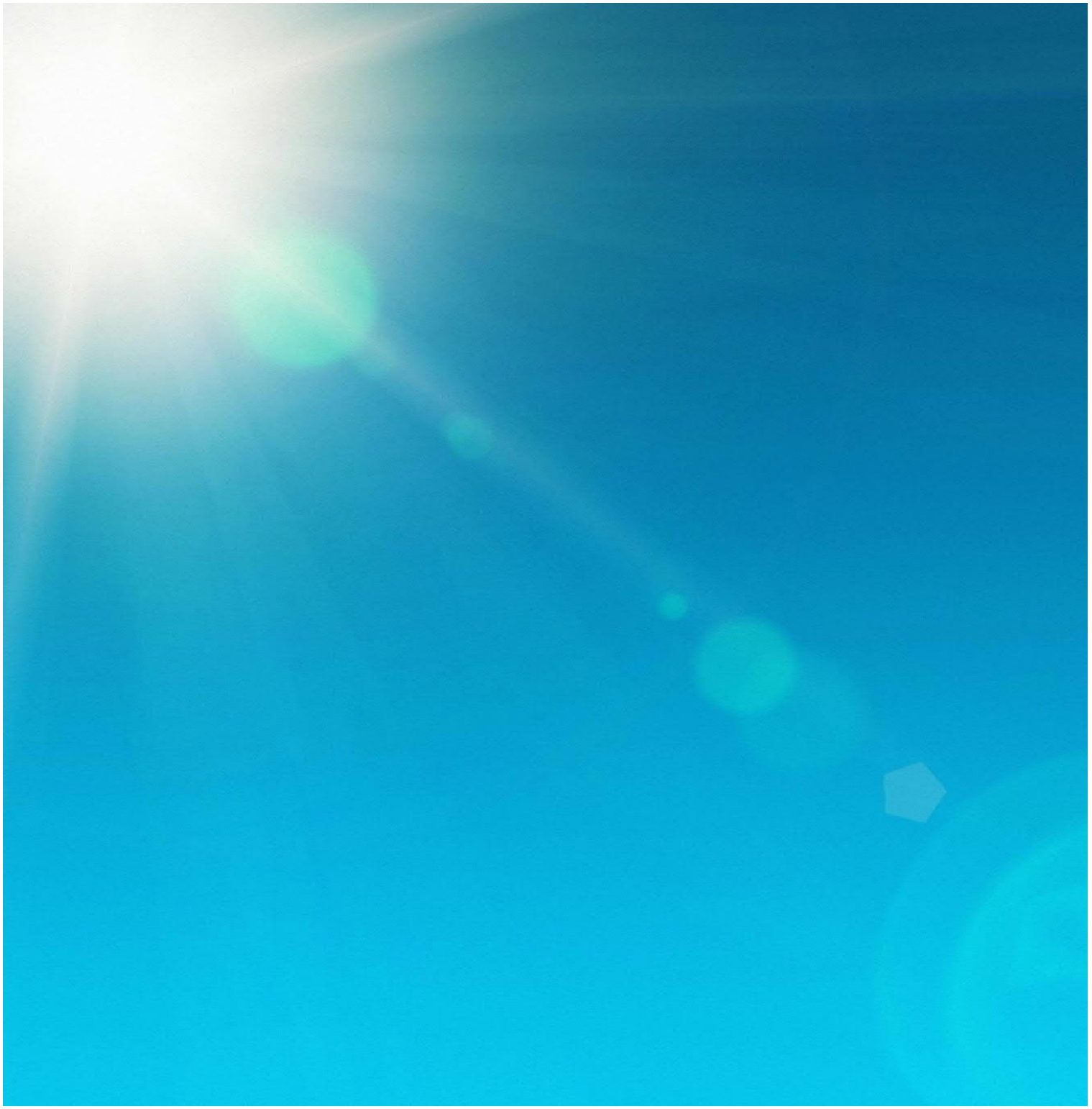
March 2022

Chapter 7 – Inland Water Environmental Quality

Australia-Asia PowerLink Environmental Impact Statement

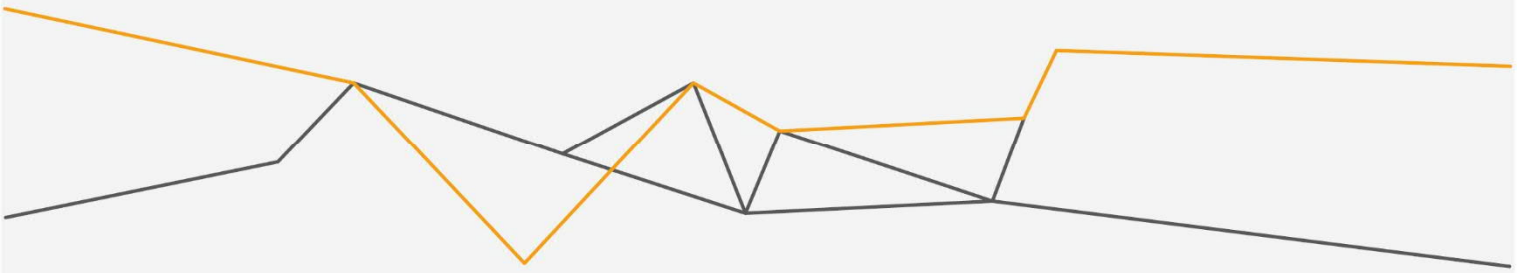


Chapter 7 – Inland Water Environmental Quality

Document ID: 198908

Revision history

Revision	Date	Purpose	Reviewed by	Approved by
0	18/03/2022	Draft EIS submission	Joe Sheridan	Mark Branson



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7 Inland Water Environmental Quality

The NT EPA's objective for the Inland water environmental quality factor is:

"Protect the quality of groundwater and surface water so that the environmental values including ecological health, land uses, and the welfare and amenity of people are maintained."

This chapter describes and assesses the significance of potential impacts to the quality of surface water and groundwater associated with the Australia-Asia PowerLink (AAPowerLink) proposal.

The potential impacts to water quality considered in this chapter were identified with reference to the EIS Terms of Reference (TOR) issued by the NT Environment Protection Authority (NT EPA) (Appendix A), issues raised by stakeholders, and professional judgement of the EIS team (Appendix D) based on their knowledge and understanding of the AAPowerLink components and activities described in Chapter 2 Proposal Description. Potential impacts were then assessed using the Environmental Impact Assessment (EIA) methods described in Chapter 3 Impact Assessment. This chapter presents the findings of the EIA process undertaken for the Inland water environmental quality factor.

The surface watercourses and groundwater aquifers present within and surrounding the AAPowerLink proposal footprint were identified and described earlier in Chapter 6 Hydrological Processes. This chapter considers the potential impacts to the water quality in these watercourses and aquifers, and the environmental values they maintain. Closely related environmental factors are covered elsewhere in this EIS - Chapter 8 Aquatic ecosystems considers impacts to those systems from changes to hydrological regimes and/or water quality, and Chapter 9 Marine Environmental Quality addresses impacts to water quality in the marine environment as a result of the proposal activities in the sea and on land.

7.1 Information sources

The information within this chapter is based on review of existing studies and information available in relation to the water resources present within and proximate to the proposal footprint, and observations made during field surveys undertaken for the ecological studies (see Appendix O and P). The sources of potential impacts to water quality associated with the AAPowerLink are limited mainly to the construction phase and as such, a desktop assessment of water quality was considered adequate for the purpose of informing the EIA. Key information sources used to describe the current conditions of watercourses and supported environmental values are summarised below.

Watercourse conditions have been described based on aerial imagery and watercourse data from the Northern Territory Government's database, available on NR Maps (DEPWS 2021a). Baseline water quality sampling has not been undertaken as the proposal does not involve activities that are likely to significantly alter surface water quality from current conditions. The Northern Territory Government Water Data Portal provides publicly available stream and groundwater data, including some water quality data (DEPWS 2021b). Data are limited in the vicinity of the proposal footprint; however, available data has been summarised where relevant.

Groundwater aquifers were described with reference to previous regional studies undertaken around the Solar Precinct (de Caritat et al. 2019) and Murrumujuk, Gunn Point where the Darwin Converter Site and Cable Transition Facilities are located (Woltmann 2020). The location of registered groundwater bores was extracted from NR Maps, along with bore reports which detail available data on depth to groundwater and, where available, groundwater quality at the time that the bore was drilled and developed.

Journal articles and studies were also used to determine water quality in the region, including studies on Lake Woods, and the main tributary of Lake Woods, Newcastle Creek. Northern Territory Government reports have been reviewed and summarised, including reports on the water quality of the Daly Catchment, Gunn Point and Darwin Harbour. These are referenced throughout.

Erosion hazard and risks associated with impacts to water quality from erosion and sedimentation was assessed based on the *Best Practice Erosion and Sediment Control (BPESC) Guidelines* (International Erosion Control Association 2008 [IECA]). The Erosion Hazard Assessment (Appendix M) details erosion hazard and risk for each of the proposal footprints, which is summarised in Chapter 4 of this EIS. This information has been used to inform assessment of potential water quality impacts associated with off-site movement of sediments from the disturbance footprint.

7.2 Relevant policies and guidelines

The *National Water Quality Management Strategy* provides national plans and resources for managing water quality across Australia. This includes the:

- Australian and New Zealand guidelines for fresh and marine water quality (ANZG 2018)
- Guidelines for Groundwater Quality Protection in Australia (Australian Government 2013)

Other guidelines and standards relevant to this chapter are as follows:

- Australian and New Zealand Standard 1547:2012 On-site domestic wastewater management
- Australian Standard 1940:2017 The storage and handling of flammable and combustible liquids
- Australian Dangerous Goods Code
- Best Practice Erosion and Sediment Control Guidelines (IECA 2008)
- Code of Practice for Wastewater Management (DoH 2020)
- Darwin Harbour Water Quality Objectives (DEPWS 2022)
- Northern Territory Land Clearing Guidelines (DEPWS 2021)
- National Standard NOHSC: 1015 (2001) Storage and Handling of Workplace Dangerous Goods.

7.3 Environmental values

This section describes the surface and groundwater quality of watercourses and groundwater aquifers within the proposal footprint and the surrounding and downstream areas which could be indirectly impacted (area of influence), and the environmental values maintained by these.

7.3.1 Solar Precinct

The Solar Precinct site is located in the Barkly region in the Lake Woods catchment and overlies the Cambrian Limestone (groundwater) Aquifer.

7.3.1.1 Surface water

There are no defined drainage lines within the Solar Precinct footprint, although a number of drainage depressions were mapped during the land type survey (Figure 7-1). These drainage depressions receive overland flow from the surrounding area following rainfall and hold water for a period during the wet season. They do not feed watercourses, but rather would be sites of infiltration into the soil, and evaporation (evaporative losses are high based on average annual evaporation of ~3,000 mm per year; BoM 2021).

The access road corridors to the Solar Precinct do cross defined drainage lines, including (from west to east) Gleeson Creek, Billy Creek, Bull Creek, and unnamed tributaries of Powell Creek (see Figure 7-1). These creeks drain to the north, discharging into the floodplain environment surrounding Lake Woods, the usual extent of which is >10 km north of the Solar Precinct and access roads.

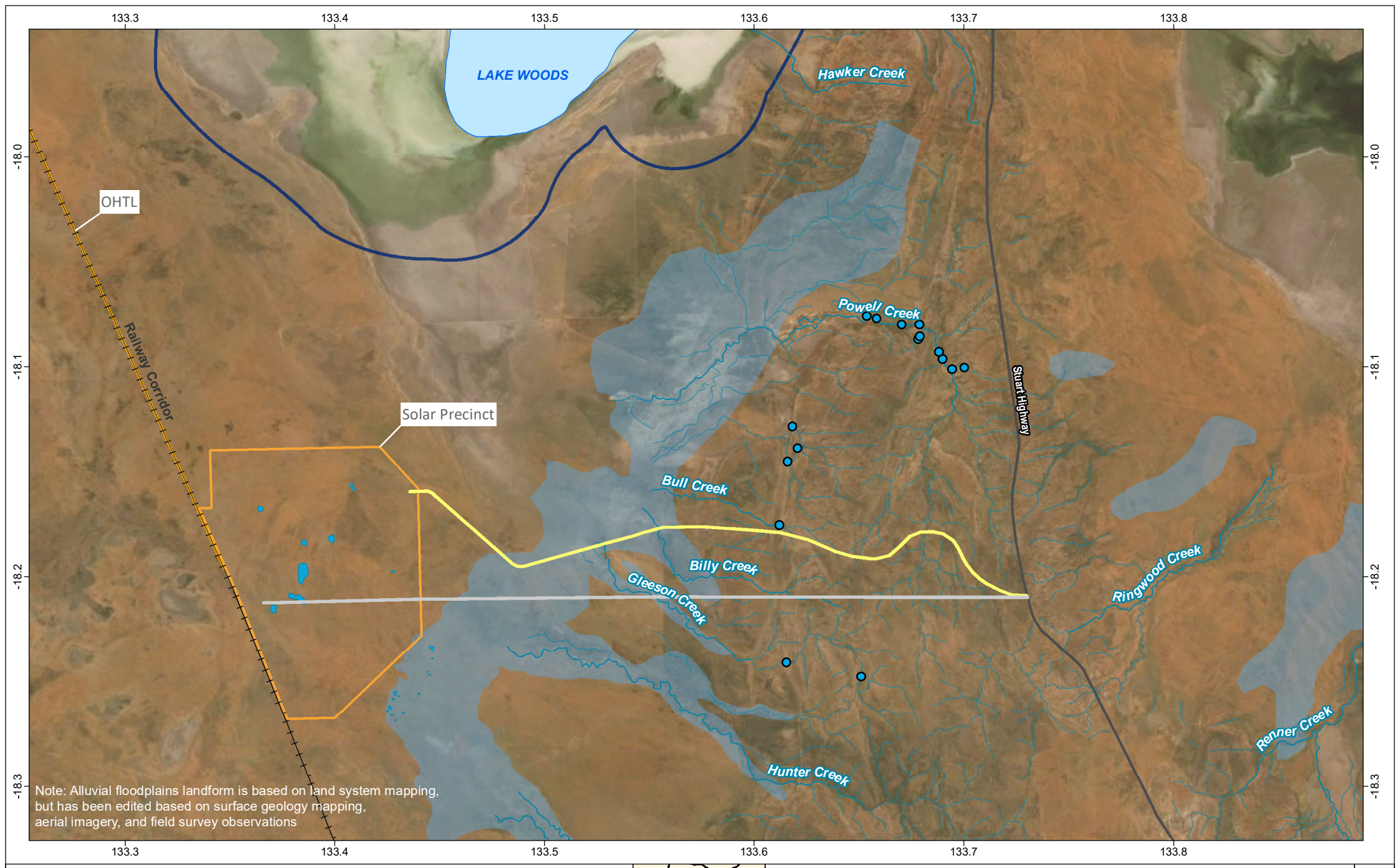
Springs (i.e., areas of permanent or near-permanent water which are groundwater fed) have been identified along the watercourses crossed by the access roads – see Chapter 6 Section 6.3.1.2. No springs occur within the proposal footprint; the closest spring (on Bull Creek) is >800 m downstream of the access road crossing. All other springs are >3 km away from the access roads. The springs are unlikely to be affected by water quality impacts associated with the construction and operational use of the access roads as they are a significant distance from the access road corridors, and there are no major water quality risks associated with the access roads. The proposal also does not involve any activities which are likely to impact groundwater quality which, in turn, could impact the water quality in the springs.

Lake Woods is the most prominent surface water feature in the region and although not a permanent water body, it does have a high ecological value and provides diverse wetland habitat for large numbers of birds. Details of these surface water features are provided in Chapter 6 Hydrological Processes, and the associated terrestrial and aquatic environmental values are considered in Chapter 5 Terrestrial Ecosystems and Chapter 8 Aquatic Ecosystems.

Due to the semi-arid climate, ephemeral nature of the watercourses, and remoteness of the region, few studies have been undertaken on surface water quality. The two studies undertaken that have publicly available results are summarised below.

Townsend (2002) measured the water quality of the perennial Longreach Waterhole within Newcastle Creek (the main creek feeding into Lake Woods) from April to October during four years between 1985 and 1993. The waterbody was well oxygenated, although oxygen concentrations tended to decline towards the end of the dry season. Turbidity was high, comprising mainly colloidal clay and silica minerals. Evaporative concentration – inferred from increased conductivity and observed reductions in water level – increased the concentration of total solids, phosphorus, nitrogen and reduced euphotic depth throughout the dry season. This waterbody is likely to represent water quality in pools and springs around the region and indicates that water quality is generally good but is impacted by evapo-concentration throughout the dry season, which results in naturally poor water quality particularly toward the end of the dry.

A study of the groundwater of the Lake Woods region included the collection of two surface water samples in the late dry season of 2013; one from Lake Woods and one from Newcastle Waters Creek (see de Caritat et al. 2019). Both samples exhibited the effects of significant evaporation and resultant concentration of minerals and salts. However, the water quality data indicates neutral to slightly alkaline pH (the alkalinity is likely due to the concentration of bicarbonates due to evaporation), low to moderate DO and moderate EC – noting that these parameters would also be impacted by evapo-concentration. Metals were analysed for both surface waters, and most metals concentrations were below the ANZG 2018 default guideline values (DGV) for 99% species protection in freshwater, with some exceptions such as arsenic and copper, which slightly exceeded the DGV. It should be noted that metals concentrations would also be impacted by evapo-concentration, and so would be expected to be significantly lower during periods of flow following rainfall events.

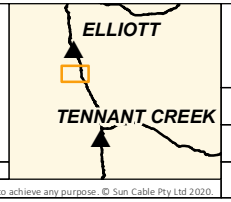


Legend

- AAPowerLink infrastructure
- Main access road (sealed)
- All-weather access road (unsealed)
- Inferred spring locations

Landform class

- alluvial floodplains
- Watercourses
- Shallow depressions (revised from fieldwork)
- Lake Woods
- Lake Woods SOCS
- Railway
- Principal road



Source: Sun Cable, EcOz, NTG (NR Maps)

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Figure 7-1: Map of surface water features within the area of influence of the Solar Precinct and access corridors

Project: Australia-Asia PowerLink	Reference: M-Files ID 198908	Revision: 1	N
Projection: GDA2020	Date: 9/03/2022		
0 2 4 6 8 10 Kilometres	Scale: 1:250,000	A4	SUN CABLE

Two stream gauging stations are located on Newcastle Creek, between the Stuart Highway and Lake Woods: G0280125 and G028005. Very limited water quality data is available, with one water sampling event from March 1993 at G0280125. pH and EC were measured in the field, and results indicate freshwater (i.e., not influenced by evapo-concentration), with a relatively low EC of 46 µS/cm and neutral pH of 6.5. There is a stream gauging station on Powell Creek, approximately 11 km north of the unsealed all weather access road corridor (i.e., the northern most project component); no water quality data is available for this station, and level data is limited (DEPWS 2021b).

Based on the existing data and the hydrology of the region, surface water quality in the watercourses crossed by the access roads to the Stuart Highway is expected to be largely reflective of rainfall. Turbidity would be high following rainfall events due to flushing of soils into the watercourses and disturbance of sediments within watercourses, but other parameters would be expected to meet relevant guideline values as there are no sources of contamination in the catchment. Following rainfall, as waters recede, evapo-concentration impacts on water quality with salts, minerals and metals increasing in concentration. Toward the end of the dry season, water quality is likely to be naturally poor.

Pastoral and stock activities on Powell Creek and surrounding stations are supported by groundwater; as surface water is unreliable. There are no surface water extraction licences granted for the region surrounding the Solar Precinct (DEPWS 2021a). Lake Woods and the springs along Newcastle Waters are culturally significant to the Warlmanpa and other Aboriginal groups who visit the area for ceremony, resources, and trading (see Heritage Impact Assessment Appendix V). Tourist camping was permitted at Longreach Waterhole on Newcastle Creek but has since been prohibited due to concerns of environmental degradation from traditional owners and pastoralists (Barkly Tourism 2022). Lake Woods and surrounding waterholes are a bird spotting tourism attraction, particularly during periods of inundation.

7.3.1.2 Groundwater

The Solar Precinct overlies the Cambrian Limestone Aquifer, within the Wiso Basin, a fractured and karstic rock aquifer. The access roads traverse two other aquifers within the Tennant Creek geological region; a relatively narrow band of the Kalkarindji Province, and then the Tennant Creek Block to the Stuart Highway. Details of the hydrogeology are provided in Chapter 6 Section 6.3.1.3. Depth to groundwater underlying Powell Creek station is between 36 mbgl and 60 mbgl (DEPWS 2021a).

There are a number of registered bores in the region surrounding the Solar Precinct, and bore reports are available on NR Maps (see DEPWS 2021a). Some bore reports have basic water quality data available, with water quality usually analysed for potable purposes. From a review of bore reports, the majority of the bores on Powell Creek Station yield water suitable for consumption, although total hardness is frequently elevated.

De Caritat et al. (2019) collected groundwater samples from 35 bores surrounding Lake Woods in the late dry season (August to September) of 2013. The majority of bores sampled were located north of Lake Woods, although three were located south, between the Solar Precinct site and Lake Woods. In general, water quality in bores was good, and reflective of rainfall influenced by evapotranspiration and also the geology of the aquifers (e.g., dissolution of carbonates). Median water quality from the bores indicates neutral pH and moderately high EC (922 µS/cm). Anions and cations indicate influence of evapotranspiration during groundwater recharge, and interactions with the geology, e.g., presence of calcium, magnesium, and bicarbonate due to dissolution of dolomite. The samples were analysed for metals, and the median concentration for nearly all analytes was below the ANZG 2018 default guideline values (DGV) for 99% species protection in freshwater (i.e., most conservative guideline values). Only chromium and zinc concentrations exceeded the DGV; the median zinc concentration was approximately 10 times the DGV, while the chromium concentration only just exceeded the DGV, and was below the DGV for 95% species protection. These concentrations are assumed to be reflective of natural groundwater conditions, as there are no known sources of contamination in the area.

In relation to existing water users, the majority of bores within the proposal footprint and surrounding area are production bores for pastoral use (e.g., stock watering). The potable water for Elliott is supplied from

groundwater bores within the Georgina Basin aquifer (i.e., different aquifer to those underlying the proposal footprint), and over 60 km north of the Solar Precinct and access tracks. The nearest groundwater extraction licences are at Elliott; granted to Power and Water for the purposes of extraction for potable water supply for the town (NR Maps). See Figure 6-7 in Chapter 6, which shows the aquifers, bores and water extraction licences in the region surrounding the Solar Precinct.

As discussed in the previous section, springs and permanent/semi-permanent water bodies do occur in the watercourses crossed by the access roads, which are considered groundwater dependent ecosystems (refer to Chapter 5 and Chapter 8). Groundwater quality is not expected to be impacted by the proposal, and therefore impacts to water quality feeding the springs is unlikely to occur.

7.3.2 Overhead Transmission Line

The Overhead Transmission Line (OHTL) corridor traverses over 788 km from the Solar Precinct to Darwin, crossing numerous surface watercourses and groundwater aquifers.

7.3.2.1 Surface water

The OHTL traverses a number of river basins – from south to north – the Wiso, Roper, Daly, Mary, Adelaide, Darwin/Blackmore, and the Finniss/Elizabeth/Howard River basins. In the south of the OHTL route, watercourses are typically ephemeral and episodic; the north is a combination of ephemeral and perennial watercourses. As detailed in Chapter 6 Hydrological Processes, the OHTL footprint crosses four major perennial rivers (Katherine, Edith, Fergusson, and Adelaide rivers), 24 creeks of stream orders three and four, and a large number of intermittent streams and drainage lines (see Figure 7-2 and Figure 7-3). The total number of watercourse crossings is 154. The water quality for each of these watercourses varies (e.g., due to differences in their supply sources, catchment inputs, flow regimes and ecosystem processes), and most watercourses have little water quality data available.

Across the majority of the proposal footprint there are no industrial land uses that are likely to affect water quality, except around the Katherine region where water quality is impacted by per- and poly-fluoroalkyl substances (PFAS) contamination from the Tindall RAAF Base, and the Edith River is impacted by discharges from Mount Todd mine. Baseline water quality in some areas is impacted by land clearing and development that contribute to elevated turbidity and nutrients. Water quality in each of the major watercourses crossed by the OHTL is summarised briefly below.

Katherine River

The Katherine River is a large perennial river, which is crossed by the OHTL at ~KP456. The river has connectivity with the underlying Tindal Limestone Aquifer, recharging the aquifer during the wet season, which in turn feeds the Katherine River during the dry season. Water quality is generally good, as the majority of the catchment upstream of Katherine is undeveloped; however, the river does receive inputs from agricultural and industrial land uses, as well as urban (including treated wastewater) discharges from Katherine township (Schult and Townsend 2012). The water quality reflects seasonal input changes, i.e., fresh rainwater during the wet season, and then groundwater (including alkaline and high conductivity water from the Tindall Limestone Aquifer) in the dry season. Katherine River's water quality is impacted by nutrients (nitrate and reactive phosphorus), possibly from agricultural land uses within the catchment, as well as PFAS contamination from the Tindall RAAF Base, south of Katherine (Schult and Townsend 2012; NTG 2019). The Katherine Wastewater Treatment Plant discharges treated effluent into the Katherine River just south (downstream) of the proposed OHTL crossing.

The river is used to supply 90% of Katherine's drinking water (PWC 2021), as well as many agricultural and industrial uses in the region. A number of groundwater fed springs provide important habitat, and also recreational swimming; the Katherine Hot Springs is located upstream of the OHTL crossing. Recreational swimming and fishing are supported along sections of the Katherine River. Numerous groundwater and surface water extraction licences have been granted along the Katherine River, and from the Katherine Tindall

Limestone Aquifer (see NR Maps), including downstream of the OHTL crossing. Water uses include agricultural, horticultural, and industrial applications (pastoral uses are also supported, but do not require a water extraction licence).

Edith River

The Edith River is a perennial tributary of the Fergusson River, which is crossed by the OHTL at ~KP498. The catchment of the Edith River is largely undeveloped and includes Nitmiluk National Park. However, the Mt Todd Gold Mine discharges into the Edith River, and impacts of acidic and metalliferous drainage (AMD) have occurred in the past, with fish kills in the river attributed to Mt Todd mine water discharges (Schult and Townsend 2012). Wet season discharges from Mt Todd are permitted under a Waste Discharge Licence under the *Water Act* 1992, regulated by the NT EPA, which aims to minimise impacts on water quality and aquatic ecosystem health in the receiving waters. When assessed in 2012, water quality within the Edith River complied with the ANZECC[1] Guideline Values, except for copper and zinc, which were both present in concentrations exceeding the applicable guideline value (which was attributed to Mt Todd mine impacts; see Schult and Townsend 2012).

There are two surface water extraction licences permitting water extraction from the Edith River for irrigated agriculture; both are >13 km downstream of the OHTL crossing.

Fergusson River

The Fergusson River is a perennial watercourse, crossed by the OHTL at ~KP513. The Pine Creek township is located within the Fergusson River catchment, and a number of legacy mine sites (gold mines) are scattered throughout the catchment. The majority of the catchment is, however, undeveloped, and water quality is generally good. When assessed in 2012, all water quality parameters met the applicable ANZECC guideline values, except for copper and zinc within the Edith River, as discussed above (Schult and Townsend 2012).

Adelaide River

The Adelaide River is crossed by the OHTL at ~KP657. At the point where the OHTL crosses the Adelaide River (near the township of Adelaide River), the river is perennial although flows (and river height) are significantly higher in the wet season. Water quality data for Adelaide River is limited. The stream gauging station at the Adelaide River Railway Bridge (G8170002) – where the OHTL will cross the river – has water quality data from one sampling event in July 1992, which indicates neutral pH and low (117 µS/cm) EC (DEPWS 2021b).

Land uses within the Adelaide River catchment include pastoral, conservation, recreation, tourism, horticultural and aquaculture, as well as cultural and Indigenous. All of these land uses are supported by the Adelaide River, including water quality. There are surface water extraction licences granted along the Adelaide River downstream of the OHTL crossing for industry and agricultural uses. The coastal floodplains of the Adelaide River are a SOCS, which supports aquatic ecosystems and provides habitat for large numbers of species including waterbirds (McGuire et. Al. 2009). The SOCS boundary commences approximately 50 km downstream of the OHTL crossing.

Elizabeth River

The upper reaches of the Elizabeth River are crossed by the OHTL at ~KP728. The river is a stream order three at the point of the OHTL crossing, and is ephemeral (i.e., does not flow in the dry season) at the crossing location (see Section 6.3.2.2 of Chapter 6). Although the river ceases to flow at the crossing location, it is a

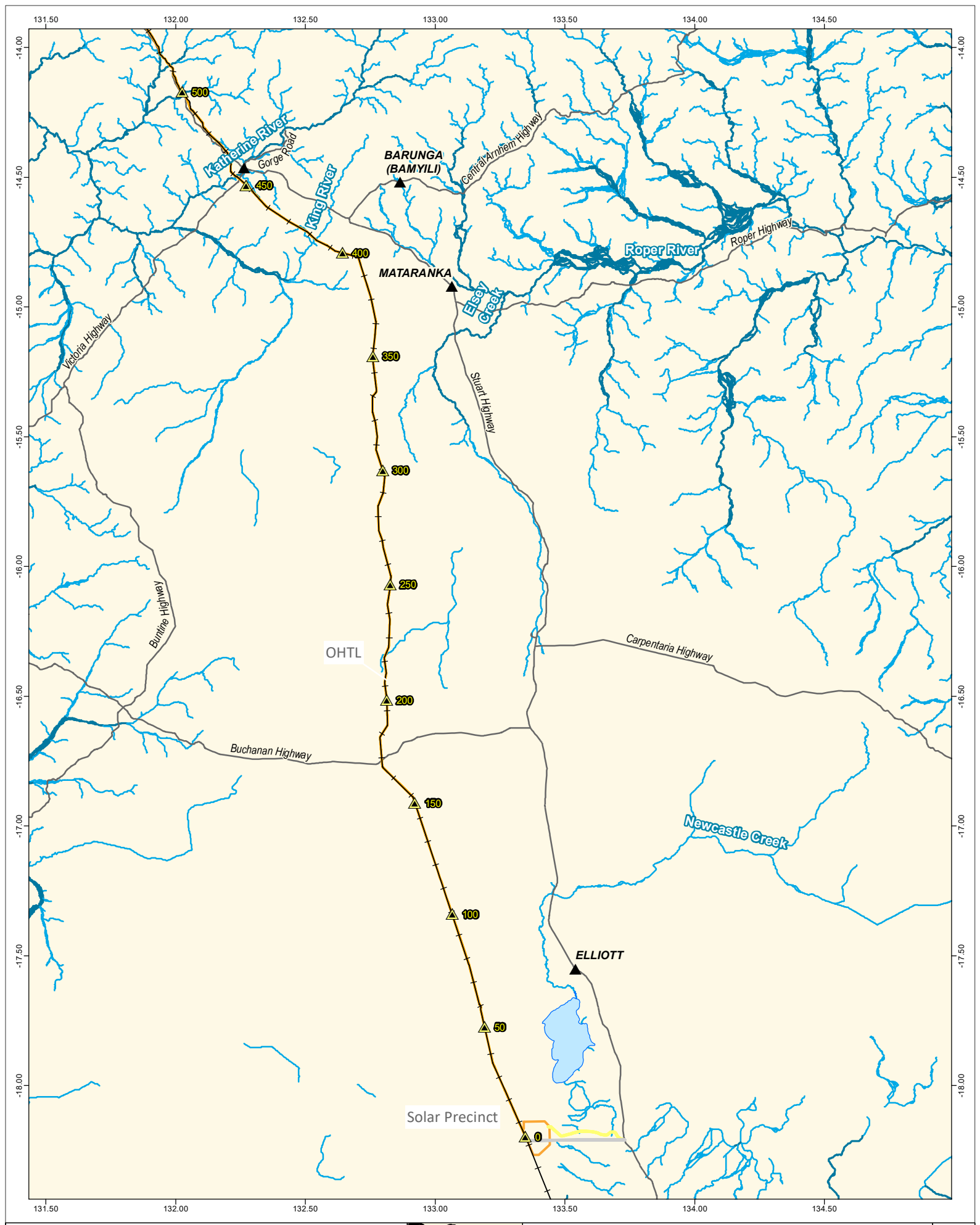
[1] The Australian and New Zealand Environment Conservation Council (ANZECC) published the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* in 2000. These were revised and updated in 2018, and are now referenced as the ANZG 2018.

major tributary of Darwin Harbour, with numerous supported values. The Elizabeth River is also the largest watercourse crossed by the OHTL within the Utilities Corridor (i.e., where the OHTL deviates from the railway corridor at ~ KP722).

The Elizabeth River is not a major water supply, with no surface water extraction licences along the river (DEPWS 2021a). Catchment land uses include agriculture, rural residential, and developments in the Darwin region (e.g., urban areas, industry, and intensive use); industry such as the Ichthys Onshore LNG Processing Facility is located at Bladin Point at the mouth of the Elizabeth River (Drewry et. A. 2010). The Elizabeth River supports mangroves in the tidal zones which provide a range of ecosystem functions. Recreational uses include fishing, with a boat ramp near the Elizabeth River mouth.

A stream gauging station is located where the Stuart Highway crosses the Elizabeth River (station G8150018; see DEPWS 2021b). Turbidity[2] data is available from 2015-2020, which shows clear seasonal patterns in turbidity; turbidity is generally highest at the start of each wet season and lower toward the end of the wet season, with spikes presumably following rain events. The maximum turbidity recorded was ~375 NTU in November 2017. In general water quality within the Elizabeth River estuary (downstream of the OHTL crossing and the stream gauging station) is good as reported in the annual Darwin Harbour Report Cards (DEPWS 2021c). The Elizabeth River estuary has been graded as 'A' for the majority of the reporting years, 2009-2020. Within the estuary, pH is neutral to slightly alkaline (typical of seawater), while indicators such as turbidity, chlorophyll-a and nutrients were all below the Darwin Harbour Water Quality Objectives (WQOs).

[2] There is little data available for other water quality parameters at G8150018, hence only turbidity is discussed.



Legend

- AAPowerLink infrastructure
- OHTL Kilometre Points
- Towns
- Roads
- Railway
- Main access road (sealed)
- All-weather access road (unsealed)
- Major watercourse (stream order 5+)
- Minor watercourse (stream order 3-4)
- Lake Woods

Source: Sun Cable, EcOz, NTG (NR Maps)

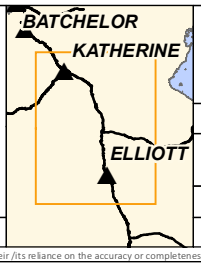


Figure 7-2: Map of major watercourses crossed by the OHTL - southern end

Project: Australia-Asia PowerLink

0 20 40 60 Kilometres

Reference: M-Files ID 198908

Date: 09/03/2022 | Revision: 1

Scale: 1:2,000,000

Coordinate System: GDA2020 | A4

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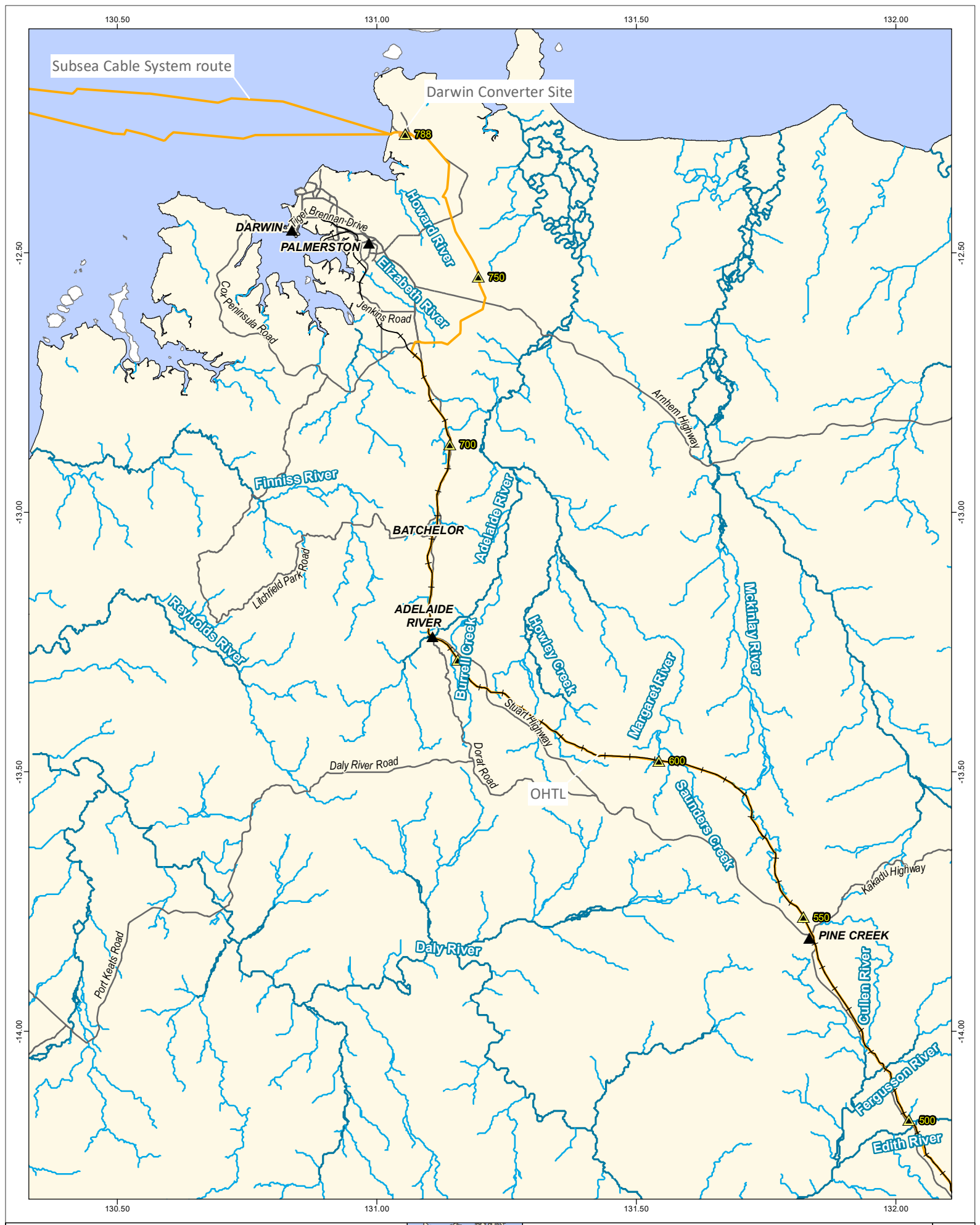

Legend

- AAPowerLink infrastructure
- OHTL Kilometre Points
- Towns
- Railway
- Roads
- Watercourses (stream level 5+)
- Watercourses (stream level 3-4)

Source: Sun Cable, EcOz, NTG (NR Maps)

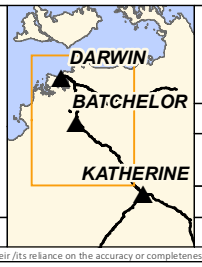

Figure 7-3: Map of major watercourses crossed by the OHTL - northern end

Project: Australia-Asia PowerLink

0 15 30 Kilometres

Reference: M-Files ID 198908

Date: 09/03/2022 | Revision: 1

Scale: 1:1,000,000

Coordinate System: GDA2020 | A4

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7.3.2.2 Groundwater

The OHTL overlies a number of aquifers, including those within the Daly Roper Beetaloo Water Control District (WCD) and the Darwin Rural WCD. Major water yielding aquifers traversed by the OHTL include the Katherine Tindall Limestone Aquifer, Mataranka Tindall Limestone Aquifer, Oolloo Dolostone Aquifer, and the Howard Koolpinyah Dolostone Aquifer. Groundwater quality varies based on the geology of the formation, and potential inputs from land uses (e.g., agricultural land uses can result in elevated nutrients in the underlying groundwater, while mining can result in elevated metals concentrations). There are also areas of groundwater-surface water interaction proximate to the OHTL, for example Lake Woods, the springs along Powell Creek, springs along the Katherine River and the springs in the Darwin Rural area (Howard Springs, Black Jungle, and various small swamps within the Koolpinyah region).

The construction and operation of the OHTL is unlikely to have impacts on groundwater quality (as discussed in Section 7.4) and as such, groundwater quality in aquifers underlying the OHTL is not described in detail.

7.3.3 Darwin Converter Site and Cable Transition Facilities

The Darwin Converter Site and Cable Transition Facilities are located at Murrumujuk, on the base of the Gunn Point Peninsula approximately 31 km northeast of Darwin.

7.3.3.1 Surface water

There are no defined drainage lines within the Darwin Converter Site and Cable Transition Facilities footprints. Rainfall/runoff produces overland flows that discharge towards the south and west entering localised depressions (seasonal swamps) and the floodplains and coastal creeks within the Shoal Bay and Tree Point Conservation Areas.

Drainage from the Darwin Converter Site will flow, via overland flow, to the south into adjacent vegetated areas, and towards the seasonal swamp located to the south-west of the proposal footprint (see Figure 7-4). The swamp fills during the wet season and discharges to the south-west into a minor drainage line that flows into the coastal floodplains in Tree Point Conservation Area, approximately 1.5 km south-west of the Darwin Converter Site. It is possible that land disturbance during construction of the Darwin Converter Site will result in impacts to water quality in the seasonal swamp due to erosion and sedimentation, although ESCP's will be implemented to mitigate this risk (see Section 7.4.2.1).

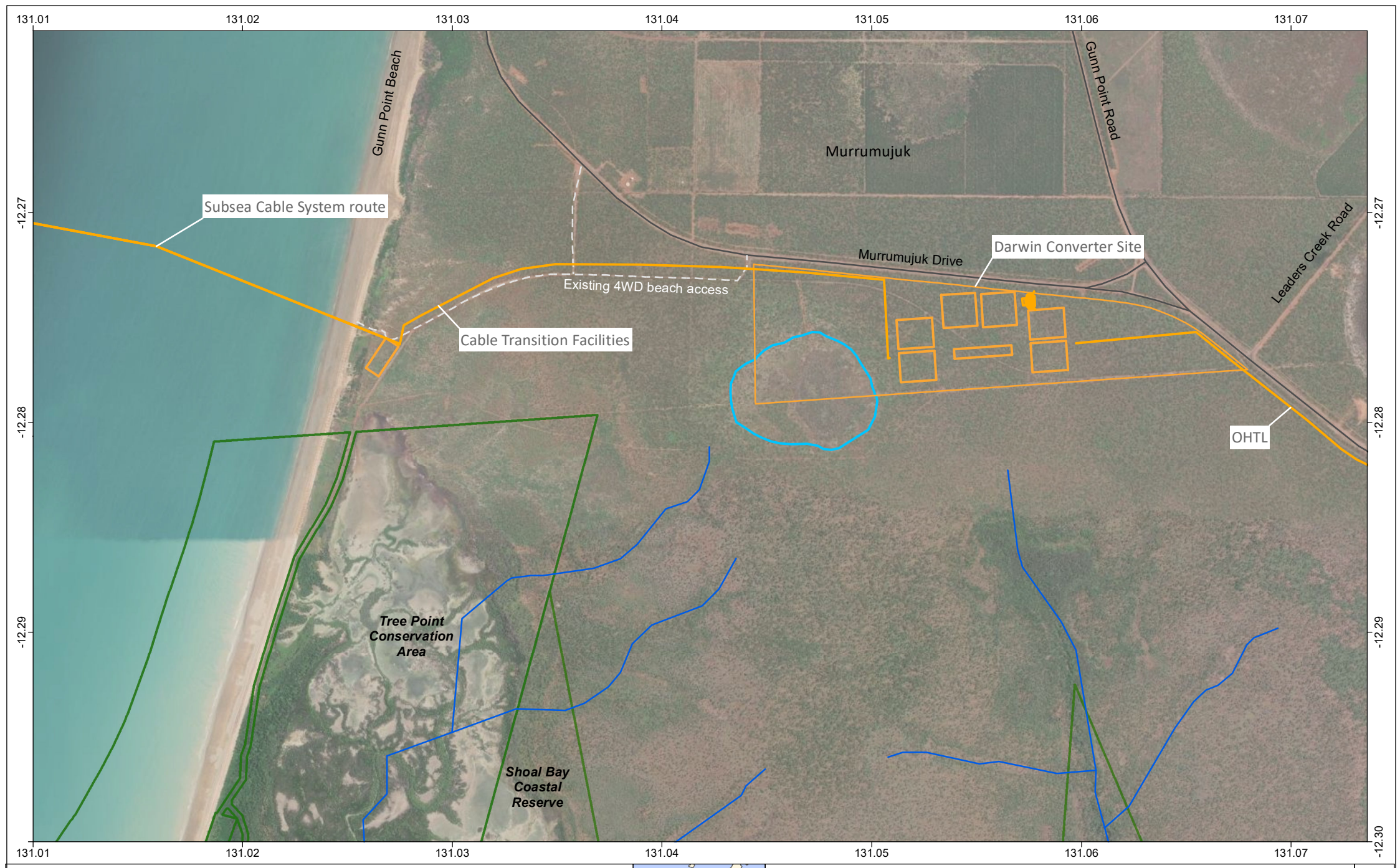
There is no water quality data available for the seasonal swamp, however studies have been undertaken on seasonal and perennial wetlands in the Darwin Rural Area (see, for example, Lloyd 1999, Lamche and Schult 2012, Welch and Schult 2005). In general, water quality in the wetlands of the Darwin region is good during the wet season and early dry season and deteriorates over the dry season due to evapo-concentration, stagnation, and factors such as agitation of sediment by water birds as water becomes shallower (Welch and Schult 2005). In the wet season and early dry season, water quality is characterised by neutral to slightly acidic pH (consistent with rainfall in the Darwin region which is known to be slightly acidic), low EC, low turbidity, and low concentrations of nutrients (nitrogen and phosphorus) and chlorophyll-a (an indicator of algal growth). Throughout the dry season, EC, turbidity, nutrients, and chlorophyll-a generally increase (i.e., water quality declines) due to the factors mentioned above. Based on the previous studies, it is likely that water quality within the seasonal swamp south-west of the Darwin Converter Site is good during the wet season, reflective of fresh rainfall, and deteriorates as water evaporates through the dry season, until it eventually dries up.

Drainage from most of the Cable Transition Facilities footprint will report to adjacent vegetated areas. Drainage from the Shore Crossing Site will report directly to the beach and intertidal areas of Shoal Bay, via erosion and sediment controls. Water quality impacts to the marine environment are addressed in Chapter 9.

7.3.3.2 Groundwater

The Darwin Converter Site and Cable Transition Facilities overlie the central portion of the Howard Groundwater system. Values and uses associated with the Howard Groundwater system are detailed in Chapter 6. The Mapping the Future project included an investigation of groundwater resources at Gunn Point (see Woltmann 2020). There are two main aquifers underlying Gunn Point: an upper (shallow) seasonal lateritic aquifer, and a lower productive aquifer mostly within the Koolpinyah Dolostone formation. The lower aquifer is considered the main resource aquifer for water supply. The lower aquifer is confined underlying the DCS and Cable Transition Facilities, and so water quality impacts to this aquifer would not occur at the proposal footprint.

Groundwater quality (as presented in Woltmann 2020) within the upper shallow aquifer is similar to rainwater, with low EC (18-94 µS/cm i.e., 'fresh') and slightly acidic pH (4.2-6.3). Groundwater quality in the lower productive aquifer varies and is brackish and saline impacted underlying the western portion of the Darwin Converter Site and Cable Transition Facilities (EC contours show EC ~ 1,500 µS/cm). The eastern portion of the Darwin Converter Site overlies fresh water (EC <1,000 µS/cm), but with minimal recharge (i.e., limited resources).



Legend

- AAPowerLink Infrastructure
- 4WD beach access
- Road
- Streams
- Seasonal swamp
- NT Parks and Reserves
- Howard Water Allocation Plan (inset)

Figure 7-4: Map of water features within the area of influence of the Darwin Converter Site and Cable Transition Facilities

Project: Australia-Asia PowerLink | Reference: M-Files ID 198908 | Revision: 2

Coordinate System: GDA2020 | Date: 09/03/2022

0 1 Kilometres | Scale: 1:25,000 | A4

N

SUN CABLE

Source: Sun Cable, EcOz, NTG (NR Maps)

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7.4 Potential impacts

The potential impacts to surface water and groundwater quality, and supported environmental values, associated with construction and operation of the AAPowerLink have been assessed using the EIA methodology described in Chapter 3 – Impact Assessment. The EIA identified and assessed the following impacts that could occur during construction and/or operations:

- Increased turbidity in surface waters from erosion and sedimentation caused by soil disturbance
- Contamination of surface water or groundwater by spills/leaks from storage and handling of fuels and hazardous materials
- Contamination of surface water or groundwater from waste storage and disposal
- Contamination of surface water or groundwater by sewage from camps and ablutions.

The EIA considered the impact avoidance and mitigation measures detailed in Section 7.5 and assessed the residual impacts to water quality assuming these measures are effectively implemented. A residual impact rating was then assigned taking into consideration the scale, magnitude and duration of the impacts, the presence/absence of environmental values and/or sensitive receptors and the level of certainty with respect to the intensity of the impact and the effectiveness of the mitigation measures. The residual impact ratings adopted in the assessment are provided in Table 7-1.

The outcomes of the EIA are summarised in Table 7-2 and Table 7-3 from the Impact Assessment Registers provided at Appendix E and discussed in the subsequent sections.

Table 7-1. Residual impact ratings adopted for the AAPowerLink EIA

Ratings and Description
Minor: A minor residual impact is unlikely to be significant.
A minor impact generally has two or more of the following characteristics: Scale: Limited/Localised Magnitude: Negligible/Minor Duration: Short-term/ Medium-term/Reversible. **OR** there are no sensitive receptors or land uses present, and the environment does not contain any aspects that are valuable or otherwise important or unique (i.e., Very Low/Low rating), and there is moderate to high degree of certainty about the likelihood and intensity of the impact, and the effectiveness of proposed mitigation measures.
Moderate: A moderate residual impact has potential to be significant. The significance depends on the acceptability of the impacts and the effectiveness of mitigation measures.
A moderate impact generally has two or more of the following characteristics: Scale: Localised/Regional Magnitude: Moderate Duration: Medium-term/Long-term **AND/OR** There are sensitive receptors or land uses present, or environmental aspects that are valuable or otherwise important or unique (i.e., Medium-High value rating), and there is a low degree of certainty about the impact, and the effectiveness of proposed mitigation measures.
Major: A major residual impact is likely to be significant. The level of acceptability will depend on offsets or benefits compensating for the impact.
Impact generally has two or more of the following characteristics: Scale: Regional/ Widespread Magnitude: Moderate/Major Duration: Long-term/Permanent **AND** There are sensitive receptors or land uses present, or environmental aspects that are valuable or otherwise important or unique (i.e., Medium-High value rating).

Table 7-2. Summary of EIA results - Inland water environmental quality factor – Construction

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual impact
Increased turbidity in watercourses caused by soil disturbance and erosion Section 7.4.2.1	Solar Precinct	**Possible** Access roads will cross ephemeral watercourses and will disturb bed and banks, which increases erosion risk and potential for increased turbidity.	**Limited** Water quality may be impacted for several hundred metres downstream of crossings.	**Short-term** Water quality impacts would only occur for days immediately following a rainfall event.	**Minor** Watercourses are naturally turbid, particularly following rainfall and runoff events.	**Medium** Water quality supports values such as aquatic ecosystem health, pastoral, agricultural, cultural, social and amenity.	**High** Erosion hazard assessment and ESCP in accordance with IECA guidelines.	**Minor**
	Overhead Transmission Line	**Possible** OHTL crosses 154 water courses. Works will disturb soils, which may erode along the OHTL and increase turbidity in watercourses.	**Limited** Water quality may be impacted for a several hundred metres downstream of crossings.	**Short-term** Water quality impacts would only occur for days immediately following a rainfall event.	**Minor** Watercourses are naturally turbid, particularly following rainfall and runoff events.	**Medium** Water quality supports values such as aquatic ecosystem health, pastoral, agricultural, cultural, social and amenity.	**High** Erosion hazard assessment and ESCP in accordance with IECA guidelines.	**Minor**
	Darwin Converter Site	**Possible** Construction works will disturb soils in an area of high seasonal rainfall, which could erode and result in turbid runoff into the swamp.	**Localised** Water quality impacts may occur in the swamp, but not further downstream.	**Short-term** Water quality impacts could occur following rainfall, and last for days to weeks.	**Moderate** Turbidity is naturally low in similar swamps and lagoons, except when water levels are low as it dries up.	**Medium** Water quality in swamp supports aquatic ecosystem health.	**Low** Erosion hazard assessment and ESCP in accordance with IECA guidelines. However, swamps proximity to the proposal footprint and location in a high erosion risk area	**Moderate**

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual impact
							mean impact could still occur.	
	Cable Transition Facilities	**Unlikely** Footprint is small, there are no watercourses present and the area is outside of storm surge zone.	**Limited** Any runoff from the footprint could be turbid but would be discharged to vegetated area in immediate surrounds.	**Short-term** Construction activities will take place over a single dry season.	**Negligible** Lack of watercourses mean water quality impacts are negligible.	**Low** No watercourses or surface water features within area of influence.	**High** Works will be undertaken over a single dry season, footprint will be reinstated, and controls as per ESCP in accordance with IECA guidelines.	**Minor**
Contamination by release of fuels and hazardous chemicals Section 7.4.2.2	All components	**Unlikely** Small volumes of fuels and hazardous substances will be stored and used.	**Limited** Spills may occur but storage and handling procedures mean a spill will be limited to ground around spill and will not enter a watercourse or groundwater aquifer.	**Short-term** Spills to ground will occur intermittently. Spills will be detected and remediated immediately.	**Negligible** No change in water quality as a result of spills.	**High** Water quality in watercourses and groundwater is sensitive to contamination and supports numerous beneficial uses.	**High** Australian Standards are established and proven effective for mitigating risk. No underground storage, or storage within 200 m of a watercourse.	**Minor**
Contamination from waste storage and disposal areas Section 7.4.2.3	All components	**Unlikely** Inert and putrescible waste will be disposed of onsite at Solar Precinct. All other waste will be temporarily stored and disposed at a licenced facility.	**Limited** Any contamination from waste storage and disposal will be limited to soil in immediate surrounds.	**Long-term** Waste will be stored at Darwin Converter Site and stored and disposed at Solar Precinct for construction and operation phases. Short term storage within OHTL.	**Negligible** No change in water quality as a result of waste storage and disposal.	**Low** No watercourses or groundwater proximate to waste storage and disposal areas.	**High** Compliance with NT guidelines and regulations proven effective for mitigating risk.	**Minor**

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual impact
Contamination by wastewater from camps and ablutions Section 7.4.2.4	All components	**Unlikely** Onsite wastewater management systems will be established at the Solar Precinct, along the OHTL at fly camps, and at the Darwin Converter Site.	**Limited** Wastewater will be treated and disposed of to land in a controlled and spatially limited area. .	**Long-term** Wastewater management systems will be used for construction and operation phases at Solar Precinct and Darwin Converter Site but will be temporary at OHTL fly camps.	**Negligible** No change in water quality as a result of wastewater management.	**Medium** Some watercourses or shallow groundwater may be proximate to Darwin Converter Site and OHTL systems, which support numerous beneficial uses.	**High** Compliance with NT guidelines and regulations proven effective for mitigating risk.	**Minor**

Table 7-3. Summary of EIA results - Inland water environmental quality factor – Operations

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual impact
Increased turbidity in watercourses caused by soil disturbance and erosion Section 7.4.3.1	Solar Precinct	**Possible** Minor occurrences of erosion at Solar Precinct access road watercourse crossings could increase turbidity in watercourses.	**Limited** Water quality may be impacted for a several hundred metres downstream of crossings.	**Short-term** Erosion will be identified and rectified, and water quality impacts would only occur for days immediately following a rainfall event.	**Minor** Watercourses are naturally turbid, particularly following rainfall and runoff events.	**Medium** Water quality supports values such as aquatic ecosystem health, pastoral, agricultural, cultural, social and amenity.	**High** ESCP in accordance with IECA guidelines, and ongoing monitoring and maintenance.	**Minor**
	Overhead Transmission Line	**Possible** OHTL crosses 154 water courses. Maintenance of a cleared 6 m wide access along a long linear footprint could result in erosion and turbidity in watercourses.	**Limited** Water quality may be impacted for a several hundred metres downstream of crossings.	**Short-term** Erosion will be identified and rectified, and water quality impacts would only occur for days immediately following a rainfall event.	**Minor** Watercourses are naturally turbid, particularly following rainfall and runoff events.	**Medium** Water quality supports values such as aquatic ecosystem health, pastoral, agricultural, cultural, social and amenity.	**High** ESCP in accordance with IECA guidelines, and ongoing monitoring and maintenance.	**Minor**
	Darwin Converter Site	**Possible** Erosion at the Darwin Converter Site could result in increased turbidity and sedimentation of the seasonal swamp.	**Localised** Water quality impacts may occur in the swamp, but not further downstream.	**Short-term** Erosion will be identified and rectified. Water quality impacts could occur following rainfall, and last for days to weeks.	**Moderate** Turbidity is naturally low in similar swamps and lagoons, except when water levels are low as it dries up.	**Medium** Water quality in swamp supports aquatic ecosystem health.	**Low** ESCP in accordance with IECA guidelines and ongoing monitoring and maintenance. However, the swamps proximity to the proposal footprint and location in a high	**Moderate**

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual impact
							erosion risk area mean impact could still occur.	
	Cable Transition Facilities	**Unlikely** No operational activities in footprint. Some minor erosion could occur in reinstated footprint.	**Limited** Any runoff from the footprint could be turbid but would report to vegetated areas.	**Short-term** Any erosion will be identified and rectified.	**Negligible** Lack of watercourses mean water quality impacts are negligible.	**Low** No watercourses or surface water features within area of influence.	**High** ESCP in accordance with IECA guidelines, and ongoing monitoring and maintenance.	**Minor**
Contamination by release of fuels and hazardous chemicals Section 7.4.3.2	All components	**Unlikely** Generally minor volumes of fuels and hazardous substances will be stored and used. A large above-ground storage will in place at the Solar Precinct airfield.	**Limited** Spills may occur but storage and handling procedures mean a spill will be limited to ground around spill and will not enter a watercourse or groundwater aquifer.	**Short-term** Spills to ground will occur intermittently. Spills will be detected and remediated immediately.	**Negligible** No change in water quality as a result of spills.	**High** Water quality in watercourses and groundwater is sensitive to contamination and supports numerous beneficial uses.	**High** Australian Standards are established and proven effective for mitigating risk. No underground storage, or storage within 200 m of a watercourse.	**Minor**
Contamination from waste storage and disposal areas Section 7.4.3.3	Solar Precinct and Darwin Converter Site	**Unlikely** Inert and putrescible waste will be disposed of onsite at Solar Precinct. All other waste will be temporarily stored and disposed at a licenced facility.	**Limited** Any contamination from waste storage and disposal will be limited to soil in immediate surrounds.	**Long-term** Waste will be stored at Darwin Converter Site and stored and disposed at Solar Precinct for operational phase (70 years).	**Negligible** No change in water quality as a result of waste storage and disposal.	**Low** No watercourses or groundwater proximate to waste storage and disposal areas.	**High** Compliance with NT guidelines and regulations proven effective for mitigating risk.	**Minor**

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual impact
		No waste stored at OHTL or Cable Transition Facilities.						
Contamination by wastewater from camps and ablutions Section 7.4.3.4	Solar Precinct and Darwin Converter Site	**Unlikely** Onsite wastewater management systems will be established at the Solar Precinct and at the Darwin Converter Site.	**Limited** Wastewater will be treated and disposed of to land in a controlled and spatially limited area. .	**Long-term** Wastewater management systems will be used for operation phase (70 years).	**Negligible** No change in water quality as a result of wastewater management.	**Medium** The seasonal swamp and shallow groundwater are proximate to Darwin Converter Site system, which support numerous beneficial uses.	**High** Compliance with NT guidelines and regulations proven effective for mitigating risk.	**Minor**

7.4.1 Areas of potential impact

7.4.1.1 Proposal footprint (direct disturbance)

The area within which water quality and supported values may be directly impacted is limited to locations where the proposal footprint intersects surface water features and areas of groundwater-surface water interaction (e.g., springs). At the Solar Precinct the direct disturbance footprint encompasses several drainage depressions that hold water after wet season rains, and several seasonal watercourses which are crossed by the access roads (see Figure 7-1). Groundwater underlying the Solar Precinct is deep and groundwater quality is unlikely to be impacted by proposal activities. There are no springs or areas of groundwater expression within the direct disturbance footprint.

Along the OHTL corridor numerous rivers, creeks and minor drainage lines are crossed, some of which are known or highly likely to be areas of groundwater expression (see Figure 7-2 and Figure 7-3; discussed further in following section). At the Darwin Converter Site and Cable Transition Facilities, there are no surface watercourses present within the direct disturbance footprint, but groundwater levels are close to the surface in the shallow aquifer during the wet season.

The remainder of the proposal footprint does not directly impact surface water features or groundwater aquifers.

7.4.1.2 Area of influence (indirect disturbance)

Construction and operational activities could indirectly impact water quality downstream of the proposal footprint. For turbidity impacts, the area of influence is predicted to be localised to areas immediately downstream of watercourse crossings along the Solar Precinct access routes and OHTL corridor (locations shown on Figure 7-1 to Figure 7-3). It is predicted that any water quality impacts may occur for several hundred metres downstream. At the Darwin Converter Site, turbidity impacts may occur to the seasonal swamp located ~150 m south-west (location shown on Figure 7-4).

For chemical contamination from spills or leaks, the area affected would be dependent on the location of any incident and its proximity to a watercourse, as well as rainfall and flow conditions at the time of the event, which would dictate the extent to which any contaminants (for example) would be transported away from the proposal footprint. Given the proposed activities (as described in Chapter 2), and the environmental values and features (e.g., climate, lack of watercourses within Solar Precinct or Darwin Converter Site footprints), the area of influence to water quality is expected to be localised.

Areas of surface-groundwater interaction (e.g., springs) do occur along the watercourses crossed by the Solar Precinct access roads, and along the OHTL. However, the groundwater aquifers at these locations are not considered to be within the area of influence as proposal activities are unlikely to impact surface water quality to the extent that groundwater quality would also be impacted. Works within flowing watercourses will be avoided, only minor volumes of chemicals and hazardous substances will be used and stored along the access roads and OHTL during construction (and none during operations) and controls and mitigation measures reduce the risk of spills impacting water quality. Additionally, the shallow aquifer underlying the Darwin Converter Site is unlikely to be impacted as proposal activities do not involve storage or handling of hazardous substances in large quantities and controls and mitigations will contain any minor spills or leaks.

7.4.2 Construction

Potential impacts to water quality will be greatest during the construction phase, when there is a higher likelihood of erosion and turbid runoff from disturbed areas[3], larger volumes of fuels and chemicals will be stored and handled in temporary facilities, and the volume of sewage wastewater being generated will be at a maximum due to facilities supporting a large construction workforce.

7.4.2.1 Increased turbidity in watercourses caused by soil disturbance and erosion

During the construction phase, land clearing and earthworks will result in the disturbance of soils, which increases the risk of erosion. It is possible that erosion during construction will result in impacts to surface water quality due to increased turbidity, sedimentation, and potential transport of contaminants (e.g., metals, nutrients) bound to sediments. These impacts are being assessed because significant sedimentation can smother macrophytes[4] and aquatic ecosystems, and impact aquatic ecosystem health. The potential for increased turbidity is directly related to erosion hazard and risk, which is discussed in Chapter 4 Terrestrial Environmental Quality. The sections below consider the impacts that could occur within the direct disturbance footprint (i.e., in surface water features intersected by the proposal footprint) and area of influence.

Solar Precinct

Construction works within the Solar Precinct will expose the land and soils, which may result in turbid runoff from the areas during rainfall events. There are several drainage depressions within the proposal footprint that are likely to receive turbid runoff during construction; however, these areas are likely to be filled during construction and so water quality impacts are of less concern[5]. The Solar Precinct stormwater drainage design (refer Chapter 2 Figure 2-16) includes controls to minimise erosion and remove sediments from the water at discharge locations prior to discharge into surrounding vegetation. With these measures in place, impacts to water quality are unlikely to occur because most sediment will be removed from stormwater flows and the remaining sediment will settle in vegetated areas where there are no watercourses present.

Construction of the access roads into the Solar Precinct will involve disturbance of the bed and banks of several watercourses where there is a high risk of erosion. The roads will be designed with reference to accepted engineering design standards and will incorporate erosion and sediment controls suited to the local land and climatic conditions. As the watercourses flow only after rainfall, assuming construction occurs only during the dry season, the watercourses will be dry and there will be no pathway for transport of sediments downstream. The key risk to water quality will be in the first wet seasons after construction, when erosion could occur at the recently completed crossings, and cause pulses of increased turbidity for a short distance (and short period of time) in the downstream watercourse.

Measures that will be implemented to minimise the likelihood and severity of erosion during construction of the Solar Precinct and access roads will be provided in Erosion and Sediment Control Plans (ESCP) prepared in accordance with the BPESC Guidelines (IECA 2008). In addition to road design standards, ESCP's will provide specific controls for watercourse crossings and reinstating the beds and banks of watercourses prior to the onset of wet season rains. With these measures in place, occurrences of erosion are predicted to be localised and only small volumes of sediment will be mobilised following significant rainfall events. Watercourses in the

[3] Erosion hazard and risk calculations for each component of the proposal footprint are provided in Appendix M and were calculated using the *Best Practice Erosion Control Association Guidelines* (IECA 2008).

[4] Macrophytes are aquatic plants, and include plants that are submerged and emergent.

[5] Impacts associated with the loss of these features are further discussed in Chapter 6 Hydrological Processes.

region are naturally turbid following rainfall (as indicated by water quality data in Section 7.3.1.1), and therefore any short-term elevated turbidity that occurs for a short distance (several hundred metres) downstream of the watercourse crossings is unlikely to affect aquatic ecosystems which are also limited due to the seasonal or ephemeral nature of the watercourses.

Overhead Transmission Line

The OHTL crosses 154 watercourses, including major perennial rivers. The construction footprint is up to 22 m wide, and clearing may occur through minor watercourses and wetland/floodplain features, where flows are ephemeral or episodic. Within the Railway Corridor, the existing maintenance access track crosses minor watercourses and these will be used for OHTL construction access where available. Where the OHTL is within the Utilities Corridor (from KP722 to Murrumujuk), clearing will be required for construction access. The ecological field surveys identified 10 features (watercourses or swamps) which would have surface water present during the wet season, and which support riparian vegetation or aquatic ecosystems (see Chapter 5, Section 5.3). At all locations, no works will occur in flowing watercourses.

For major perennial watercourses, tracks will be cleared to access either side, and the OHTL infrastructure will span the watercourses[6], avoiding disturbance of beds and banks and riparian vegetation. Some selective pruning may be required if riparian vegetation (i.e., trees) is higher than the required clearance under the line. This will be minimised through micro-siting poles and infrastructure (see Chapter 2 Section 2.5.2.3). It is possible that erosion will occur during construction, and in the first year following construction (after reinstatement but prior to ground cover being established). Increased turbidity may occur in watercourses crossed by the OHTL for a short distance (several hundred metres) downstream following rainfall event. Any impacts would be short-term (hours to days). Watercourses in the region are naturally turbid following rainfall, as indicated by water quality data in Section 7.3.1.1, and therefore any short-term elevated turbidity that occurs downstream of the watercourse crossings is unlikely to affect aquatic ecosystems.

Measures that will be implemented to minimise the likelihood and severity of erosion during construction will be provided in Erosion and Sediment Control Plans (ESCP) prepared in accordance with the BPESC Guidelines (IECA 2008). ESCP's will provide specific controls for watercourse crossings and reinstating the beds and banks of watercourses prior to the onset of wet season rains. These measures are predicted to ensure that occurrences of erosion are localised, and only small volumes of sediment are mobilised following significant rainfall events.

Darwin Converter Site and Cable Transition Facilities

Construction works within the Darwin Converter Site will expose the land and soils, which may result in turbid runoff from the proposal footprint during wet season storm events. Water quality impacts due to increased turbidity and sediment may affect the seasonal swamp located ~150 m south-west of the proposal footprint. There is an existing stormwater drain that discharges from Murrumujuk Drive towards the swamp, which could also contribute to sediment loads. The swamp discharges into the Tree Point Conservation Area via a minor drainage line, and also has value as an aquatic ecosystem (see Chapter 8).

Measures that will be implemented to minimise the likelihood and severity of erosion during construction of the Darwin Converter Site and Cable Transition Facilities will be provided in Erosion and Sediment Control Plans (ESCP) prepared in accordance with the BPESC Guidelines (IECA 2008). Run off from disturbed areas will occur as overland flows and/or will be captured in the site stormwater drainage channels as they are constructed. Erosion and sediment controls will be installed at discharge points around the site boundary and in the stormwater drainage network as required to minimise erosion and remove sediments from the water prior to discharge into surrounding vegetation. No direct discharge to the swamp will occur. With these measures in place, the volume of sediments being discharged in stormwater flows will be minimised, and any

[6] Maximum span between poles is 450 m

water quality impacts in the swamp are expected to be short-term. However, the Darwin Converter Site is located in an area of high rainfall and erosion risk, and the proximity of the swamp and expected water quality (i.e., naturally clear) mean that it may be susceptible to turbidity and sediment impacts. Therefore, the precautionary principle has been applied in the impact assessment.

There are no watercourses in the Cable Transition Facilities footprint and therefore impacts to water quality are unlikely to occur. Erosion and sediment controls will be installed that will minimise the amount of sediment present in stormwater flows discharging from the disturbed areas and the construction footprint will be reinstated prior to the onset of the wet season. Erosion and sediment controls will discharge to surrounding vegetated areas; no discharges to water will occur.

The Shore Crossing Site has a high erosion hazard rating due to the presence of steep slopes and unconsolidated sandy soils. Any turbid runoff from this area could discharge into the marine environment and is considered in Chapter 9 Marine Environmental Quality.

7.4.2.2 Contamination by release of fuels and hazardous chemicals

It is unlikely that surface water or groundwater quality will be impacted by contamination due to storage and handling of fuels and hazardous chemicals. Dangerous goods, hazardous chemicals, and associated wastes (i.e., waste oils, containers etc) will be stored at various locations during the construction phase. Storages will be located at the Solar Precinct, OHTL fly camps and Darwin Converter Site, and mobile refuelling will occur. The substances stored in largest volumes will be diesel, used for fuelling vehicles, equipment and running construction camps, and break/hydraulic fluids, oils and lubricants for vehicle and equipment maintenance. Transport, storage, and handling will be in accordance with accepted guidelines and Australian standards.

Adoption of Australian Standards is proven to be an effective way to minimise workplace and environmental risks associated with storage and handling of dangerous goods and hazardous chemicals and as a result any spills or leaks that do occur are predicted to be limited to small volumes. In the event of a spill or leak, soils may become contaminated in the vicinity of the spill. Additionally, if a spill occurred during a rainfall event, then surface water runoff could become contaminated and result in contamination of downstream land. Given there are no watercourses within or immediately downstream of the Solar Precinct, it is unlikely that a spill at the Solar Precinct would result in impacts to downstream water quality. Along the OHTL, storages would be located at least 200 m from a watercourse, and so minor spills which may occur would be unlikely to impacts on surface water quality. At the Darwin Converter Site, spills would report to land; no watercourses are within the direct disturbance footprint and the seasonal swamp is located ~150 m away from the westernmost components of the proposal footprint. In all instances, any spills would be identified, and spill response measures implemented to contain and clean-up the spill.

Groundwater is unlikely to become contaminated due to a spill as there will be no underground storage, all fuels and chemicals will be bunded, and the risk of large spills/leaks that would pass through soils into groundwater is inherently low due to the minor volumes being stored and handled at each location. The productive aquifers under the Solar Precinct and Darwin Converter Site are deep (and confined under the Darwin Converter Site) and are therefore highly unlikely to become contaminated by a spill. Along the OHTL, shallow groundwater does occur, particularly near major perennial watercourses such as the Katherine River, which is an area of groundwater surface-water interaction. Wetlands and other areas of groundwater expression do also occur within and proximate to the OHTL. However, the above-mentioned controls (minor volumes, bunding as required by Australian Standards, and no storage within 200 m of a watercourse, wetland or groundwater bore) mitigate the risk associated with contamination of shallow groundwater along the OHTL.

Assuming effective implementation of these controls, impacts from spills/and leaks are predicted to be limited to contamination of soil, which is addressed in Chapter 4 Terrestrial Environmental Quality.

7.4.2.3 Contamination from waste storage and disposal areas

It is unlikely that water quality will be impacted due to contamination from waste storage and disposal during construction. Volumes and types of wastes expected to be generated during construction of the proposal, and details of storage and disposal are provided in Chapter 2. At all construction locations, listed hazardous wastes and recyclable wastes will be temporarily stored in designated onsite waste storage areas, prior to scheduled removal from site by a licenced waste contractor for disposal at a suitably licenced facility. A landfill will be established at the Solar Precinct for disposal of inert solid wastes and putrescible wastes produced at the site that cannot be reused or recycled. For the OHTL and Darwin Converter Site, all wastes will be temporarily stored at construction fly camps or at the Darwin Converter Site before being disposed of at a licenced facility.

Waste management will be in accordance with best practice guidelines (e.g., separation of waste, covering, bunded storage areas), and the requirements of the *Waste Management and Pollution Control Act 1998,* and supporting regulations. The location, design and management of the landfill will comply with the *Guidelines for Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory* (NT EPA 2003). Compliance with the regulatory requirements and guidelines is proven effective and it is unlikely that there will be impacts to water quality from waste storage and disposal facilities.

7.4.2.4 Contamination by wastewater from camps and ablutions

Wastewater (sewage and greywater) will be managed in accordance with the NT *Code of Practice for Wastewater Management* (DoH 2020). Wastewater produced from ablutions at the Solar Precinct and Darwin Converter Site where large construction workforces will be based, will be captured, and treated by onsite wastewater management systems, which will remain in place to service the operations workforce. Fly camps along the OHTL will have mobile wastewater treatment plants which will be removed as fly camps are decommissioned and removed. Systems that are sited, designed, and operated in compliance with the Code of Practice are unlikely to cause any measurable impact to surface water and groundwater quality.

7.4.3 Operations

During operations, the likelihood of impacts to water quality is further reduced. Turbid runoff is less likely to occur as the soils disturbed during construction are now either under infrastructure or have been reinstated and allowed to revegetate, and stormwater management systems are constructed and operational, removing sediments from stormwater prior to discharge. Volumes of fuel and hazardous chemicals stored and used will be significantly reduced because the Solar Precinct and Darwin Converter Site will operate off solar power. The sources of potential impact to water quality during operations identified through the EIA process are discussed below and include isolated occurrences of erosion and turbid runoff, leaks/spills of fuels and oils from minor storages and electrical infrastructure at the Solar Precinct and Darwin Converter Site, and operation of onsite waste storage and disposal facilities and wastewater management systems.

7.4.3.1 Increased turbidity in watercourses caused by soil disturbance and erosion

It is possible that erosion could occur during operations which could result in isolated and short-term impacts to water quality. The erosion hazard assessments undertaken for each component of the project footprint indicate that post-construction erosion hazard (soil loss risk) is very low or low for all components, excepting the Land Sea Joint Station where the risk remains high due to steeper slopes and unconsolidated soil conditions[7]. The majority of the proposal footprint will be covered by infrastructure or hardstand and any areas cleared and not required for operations will be reinstated in accordance with a Reinstatement Plan prepared for the works with the objective of stabilising the soils and encouraging regeneration of native

[7] Refer the Erosion Hazard Assessment in Appendix M, and Chapter 9 for a discussion of marine water quality impacts from erosion at the Land Sea Joint Station.

vegetation. Numerous site-specific ('progressive') erosion and sediment control plans will be developed for proposal components, which will stipulate requirements for reinstatement, permanent or ongoing controls, and monitoring and management requirements post-construction. This includes those areas with a high risk of ongoing erosion, i.e., at the Land Sea Joint Station and Shore Crossing Site.

Key site selection and design criteria that contribute to avoiding and minimising erosion impacts are provided in Chapter 2 and summarised below:

- The Solar Precinct is located on flat ground, above the maximum modelled flood extent of 0.1% AEP (1-in-1000-year event). The Darwin Converter Site is located on flat ground, away from watercourses, and outside of mapped storm surge zones. The topography means that runoff conditions are slow.
- The 12,000-ha area of exposed soils beneath the solar fields will be protected by the infrastructure, and it is predicted that rainfall runoff from the panels will rapidly infiltrate the soils underneath.
- Stormwater drainage system design at the Solar Precinct and Darwin Converter Station will minimise the risk of localised flooding by managing overland flows in wide open drain lines and basins designed to deal with peak rainfall events, such that surface water discharges from the sites will be at rates similar to pre-development conditions.
- Permanent drainage, erosion and sediment controls will be installed throughout operational footprints as required, and at stormwater discharge locations to remove sediments prior to discharge as overland flows into surrounding vegetation. There will be no direct discharge to watercourses.
- Roadside drainage and culverts will be installed along the access roads and any access tracks in accordance with accepted road design standards.
- The OHTL design avoids placement of poles in watercourses, with the cables able to span up to 450 m to avoid disturbing watercourses. Only minor watercourses will be crossed by the maintenance access track.

With the above measures in place, isolated occurrences of erosion will possibly occur each wet season but will be identified and remediated as part of routine inspection and maintenance activities. This is predicted to be an effective approach to minimise impacts to water quality and to adjacent land uses and infrastructure as discussed in Chapter 4. Sediments could be mobilised into surface waters and elevate turbidity, but this would be limited to where the project infrastructure crosses minor seasonal or ephemeral watercourses along the Solar Precinct access roads and OHTL corridor, and possibly the seasonal swamp near the Darwin Converter Site. At these locations, minor volumes of sediments may be mobilised following significant rainfall events, especially in the first two years following construction whilst the disturbed areas are stabilising.

At the Solar Precinct and along the OHTL, watercourses are naturally turbid following rainfall (as indicated by water quality data in Section 7.3.1.1), and short-term elevated turbidity is unlikely to affect aquatic ecosystems which are also limited due to the seasonal or ephemeral nature of the watercourses. The seasonal swamp near the Darwin Converter Site could be sensitive to any sediment deposition that occurs over time and therefore the performance of the stormwater management system in removing sediments prior to discharge of water towards the swamp will be monitored and subject to adaptive management as described in Section 7.5.

7.4.3.2 Contamination by release of fuels and hazardous chemicals

It is unlikely that water quality will be contaminated due to spills or release of fuels or hazardous chemicals. Dangerous goods and hazardous chemicals and associated wastes (i.e., maintenance wastes and containers etc) will be stored at designated storage locations at the Solar Precinct and Darwin Converter Site. The materials that will be stored are detailed in Chapter 2 Section 2.4.2.4 and Section 2.6.2.5 and include quantities of fuels, oils/lubricants, synthetic ester, chlorine for water treatment, glycol, cleaning chemicals, herbicides, and pesticides. There will be bulk storage tanks at the Solar Precinct for storage of aviation fuel. Insulating oils used in the electrical infrastructure will be biodegradable varieties that pose a low risk of environmental harm and will be contained inside sealed sections of the transformers on concrete bunded foundations, with

interceptors installed to capture any spills/leaks that occur during rainfall. Along the OHTL corridor, no fuels, chemicals, or hazardous substances will be stored and therefore impacts are limited to minor spills of fuels, oils/lubricants or herbicides used in maintenance activities. Transport, storage, and handling will be in accordance with accepted guidelines and standards, which is proven to be an effective way to minimise workplace and environmental risks.

In the event of a spill or leak, soils may become contaminated in the immediate vicinity, or if the spill occurs during rainfall, contaminants could enter the stormwater drainage system. Given there are no watercourses within or immediately downstream of the Solar Precinct, it is unlikely that a spill would result in impacts to downstream surface water quality. Along the OHTL corridor it is unlikely that a spill during maintenance activities would impact surface water quality due to the small volumes involved and because the poles are located away from watercourses. The main risk to surface water will be at the Darwin Converter Site, where any contaminants entering the stormwater system could discharge to the nearby seasonal swamp. An Environmental Emergency and Spill Response Plan will be in place adopting routine controls and procedures which are proven effective in limiting the transport of contaminants away from the site of an incident and interceptors will ensure any diffuse pollution is captured and does not leave the site.

Groundwater is unlikely to be contaminated by leaks or spills at any location because the main storages are above-ground and located on concrete hardstand areas, and spills/leaks are not predicted to be in volumes that would pass through soils into groundwater. Productive groundwater aquifers are generally deep and/or confined underlying the Solar Precinct and Darwin Converter Site. The same controls which minimise the risk of impacts to surface water (discussed above) are relevant in relation to minimising the likelihood of impacts to groundwater quality.

Assuming the facilities design and operation comply with Australian Standards, impacts from spills/and leaks are predicted to be limited to minor contamination of soil, which is addressed in Chapter 4 Terrestrial Environmental Quality, and water quality in unlikely to be impacted.

7.4.3.3 Contamination from waste storage and disposal areas

It is unlikely that water quality will be impacted due to contamination from waste storage and disposal during operations. Types of wastes expected to be generated during routine operations and details of storage and disposal are provided in Chapter 2. The landfill established at the Solar Precinct site will be used to dispose of inert solid waste and putrescible wastes over the life of the proposal. At the Darwin Converter Site, all wastes will be temporarily stored in designated locations at site before being disposed of at the Shoal Bay Waste Management Facility. At all locations, listed hazardous wastes and recyclable wastes will be temporarily stored in designated onsite waste storage areas, prior to scheduled removal from site by a licenced waste contractor for disposal at a licensed facility.

All waste management will be in accordance with the *Waste Management and Pollution Control Act 1998 and* supporting regulations. The location, design and management of the landfill will comply with the *Guidelines for Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory* (NT EPA 2003). Specific requirements include appropriate design of the landfill to contain waste, separation of waste storage areas, covering of waste and landfill, and bunded storage areas. Compliance with the regulatory requirements and guidelines is proven effective and it is unlikely that there will be impacts to water quality from waste storage and disposal facilities.

Waste storage and disposal requirements associated with major maintenance and decommissioning activities are addressed in Chapter 2. When major components of the system, such as panels and batteries, are replaced or decommissioned, they will be removed from site for recycling and disposal. No waste material will be left at any site, which could result in impacts to water quality.

7.4.3.4 Contamination by sewage from camps and ablutions

Wastewater systems installed at the Solar Precinct and Darwin Converter Site during construction will be used to service the operational workforce. As detailed above in Section 7.4.2.4, wastewater (sewage and greywater) will be managed in accordance with the NT *Code of Practice for Wastewater Management* (DoH 2020). Systems that are sited, designed, and operated in compliance with the Code of Practice are unlikely to cause any measurable impact to surface water and groundwater quality.

7.5 Avoidance, Mitigation and Monitoring

Sun Cable is committed to applying the environmental decision-making hierarchy. Consistent with section 26 of the *EP Act* this involves applying the following approaches in order of priority:

1. Avoid – Ensure that actions are designed to avoid adverse impacts on the environment
2. Mitigate – Identify management options to mitigate adverse impacts on the environment to the greatest extent practicable.
3. Offset – if appropriate, provide for environmental offsets for residual adverse impacts on the environment that cannot be avoided or mitigated.

The environmental management framework that will be adopted for the construction and operation of the AAPowerLink is detailed in Chapter 17 Environmental Management. The framework comprises a Construction Environmental Management Plan (CEMP) and Operations Environmental Management Plan (OEMP) that sit within an overarching Environmental Management System (EMS).

For each of the potential impacts to water quality discussed in this chapter, Table 7-4 summarises the actions that will be taken to avoid environmental impacts (through site selection and design) and actions proposed to minimise impacts during construction, operation and decommissioning of the proposal. Relevant measures have been referred to in the above discussion of the likelihood and severity of potential impacts at each project location. The proposed controls are routine for developments and industrial operations and, assuming proper implementation and adaptive management, will be effective in ensuring no unacceptable impacts to water quality. The measures provided in this chapter, along with any additional measures required to address conditions of approvals, permits and licences, will be integrated into the CEMP and OEMP prepared for the AAPowerLink.

Table 7-4. Inland water environmental quality - Commitments

Impact	Avoidance	Mitigation	Monitoring	Reporting
Increased turbidity in watercourses caused by soil disturbance and erosion	Solar Precinct and Darwin Converter Site footprints located on flat land above the maximum modelled flood extent (1 %AEP/1-in-1000-year flood event) and outside of mapped storm surge zones. Solar Precinct and Darwin Converter Site footprints avoid watercourses. Progressive clearing, construction and reinstatement will be undertaken. OHTL poles will not be placed in watercourses or drainage lines. Only minor drainage lines will be crossed by the OHTL access track. Major drainages will be approached from either side to avoid the need for constructing crossings. Stormwater drainage will be installed to capture and manage runoff. Stormwater captured within facilities will discharge to land, via erosion and sediment controls. Roadside drainage and culverts will be installed in accordance with Austroads standards.	Watercourse crossings along access roads and OHTL will be installed during the dry season when no flow present. Drainage, erosion, and sediment controls will be installed and maintained in accordance with Erosion and Sediment Control Plans (ESCP) that align with the *Best Practice Erosion and Sediment Control Guidelines* (IECA, 2008). Develop and implement a Reinstatement Plan for post-construction reinstatement of works areas to stabilise soils and promote regrowth of native vegetation. Rectification of emerging erosion issues after each wet season.	During construction, visual inspections will be undertaken of disturbed areas and erosion and sediment controls as per ESCP (after significant rainfall events, at a minimum). Annual post wet season monitoring of reinstatement success until disturbed areas are stabilised. Visual inspections of drainage structures, discharge points and site boundaries following rain events. Visual inspections of seasonal swamp at Darwin Converter Site for evidence of sedimentation; implement water quality monitoring if required. Post-wet season inspections of all project locations and rectification of emerging erosion issues.	Internal records of ESCP inspections, as stipulated in ESCP's. Internal reporting on environmental performance. External reporting in accordance with environmental approval conditions.
Contamination by release of fuels and hazardous substances	During operations, solar power will be used as a power source, hence no requirement for bulk fuel storages. Dangerous Goods and Hazardous Substances will be stored and handled in accordance with regulated standards and codes of practice, and manufacturer's directions.	Dangerous Goods and Hazardous Substances Registers will be maintained at all storage and handling locations. An Environmental Emergency and Spill Response Plan will be in place and equipment provided	Routine visual inspections around storage locations and work areas.	Internal records of volumes used and stored in accordance with Workplace Health and Safety Regulations. Internal inspection records and notes. Internal records of water quality monitoring.

Impact	Avoidance	Mitigation	Monitoring	Reporting
	Dangerous Goods and Hazardous Substances will not be stored within 200m of a watercourse or groundwater bore, and mobile refuelling will not occur within 50m of a watercourse or groundwater bore.	at all storage and handling locations. Construction and operations staff will be trained in spill response.		Incidents of off-site pollution or nuisance reported to the NT EPA within 24 hours
Contamination from waste storage and disposal	Landfill will comply with the Guidelines for Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory (NT EPA 2003). No waste will be stored within 200m of a watercourse.	Waste management will be in accordance with best practice guidelines (e.g., separation of waste, covering, bunded storage areas), and the requirements of the *Waste Management and Pollution Control Act 1998*. All listed waste will be disposed of at a licenced waste management facility.	Routine visual inspections around landfill, waste storage locations and work areas.	Internal records of inspections. Incident reporting
Contamination by sewage from camps and ablutions	Onsite wastewater management systems to be designed and installed by suitably qualified person, in accordance with *NT Code of Practice for Onsite Wastewater Management*, plus other relevant standards and guidelines. System to be designed for projected wastewater loads, and appropriate for applicable climate.	Any issues identified with wastewater management system to be rectified by suitably licenced person.	Routine inspection and maintenance of wastewater management systems and land application areas, in accordance with the *NT Code of Practice for Onsite Wastewater Management*.	Internal records of maintenance works undertaken. Relevant notifications/applications and reporting to NT Department of Health, or DIPL.

7.6 Residual impact

As stated at the start of this chapter, the NT EPA's objective for the Inland water environmental quality factor is to:

'Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses, and the welfare and amenity of people are maintained'.

The residual impact of the AAPowerLink to inland water quality is summarised below, assuming the adoption of the impact avoidance, mitigation and monitoring measures described in this chapter.

Each impact to inland water quality was assigned a residual impact rating taking into consideration the scale, magnitude and duration of the impacts, the presence/absence of environmental values and/or sensitive receptors and the level of certainty with respect to the intensity of the impact and the effectiveness of the mitigation measures. The residual impact ratings adopted in the assessment were provided earlier in Table 7-1. The combined residual impact to inland water quality from all components of the AAPowerLink construction and operations is summarised in Table 7-5.

Table 7-5. Residual impact ratings for impacts to Inland water environmental quality

Impacts	Residual Impact Rating
Construction	
Increased turbidity in watercourses caused by soil disturbance and erosion	Moderate
Contamination by release of fuels and hazardous chemicals	Minor
Contamination from waste storage and disposal areas	Minor
Contamination by wastewater from camps and ablutions	Minor
Operations	
Increased turbidity in watercourses caused by soil disturbance and erosion	Moderate
Contamination by release of fuels and hazardous chemicals	Minor
Contamination from waste storage and disposal areas	Minor
Contamination by wastewater from camps and ablutions	Minor

The results of the EIA undertaken for the Inland water environmental quality factor indicate that the proposal could have Minor-Moderate residual impacts to surface water.

The Moderate residual impact rating applies only to the Darwin Converter Site where the seasonal swamp immediately south-west of the site could be impacted by erosion and increased turbidity. The Moderate residual impact rating for both the construction and operations phases acknowledges the sensitivity of the receiving environment at this location and the need for the site stormwater management system and site-specific ESCP's. With these measures in place, the residual impact may reduce to Low. Monitoring is proposed at the swamp to allow water quality issues to be identified and adaptive management to be implemented.

Across all other components of the footprint, the residual impact to water quality is assessed as Minor for both the construction and operations phases. In these areas, erosion and sedimentation impacts are predicted to be short-term and minor, and therefore likely to have only a localised impact to surface water quality. Storage of fuels and hazardous chemicals will occur in designated locations and in accordance with Australian Standards, which are proven effective in mitigating risks associated with these activities. Wastewater from camps and ablutions will be managed in accordance with the *NT Code of Practice for Onsite Wastewater Management*, plus other relevant standards, and guidelines, as regulated by Department of Health. The proposed controls are routine practice in land development and industrial projects and there is a high degree

of certainty that they will be effective in protecting water quality, and therefore the residual impacts will be Minor.

7.7 Cumulative impacts

The framework used to assess cumulative impacts is described in Chapter 3 Impact Assessment. The process involves considering the cumulative or combined impacts to terrestrial ecosystems associated with the residual impacts from the AAPowerLink, residual impacts from existing activities, and impacts associated with reasonably foreseeable developments described in Chapter 3.

The AAPowerLink is unlikely to contribute to cumulative impacts to environmental values or beneficial uses supported and maintained by surface water and/or groundwater quality. The EIA process summarised in this chapter has predicted that impacts from the proposal activities will be limited to isolated occurrences of minor short-term impacts to surface water quality during significant rainfall events. There are no major hazardous storage areas associated with the proposal and minor spills/leaks are unlikely to cause environmental contamination. Further, the majority of the proposal footprint does not contain any surface watercourses and the activities are unlikely to contaminate groundwater. There is not predicted to be any long-term residual impacts to water quality from the proposal activities and therefore limited potential for cumulative impacts to occur.

The Solar Precinct is located close to the Beetaloo Sub-basin where it is reasonably foreseeable that onshore gas development will occur. The Solar Precinct site is underlain by the regional scale Cambrian Limestone Aquifer (CLA) which forms the primary water resource in the Beetaloo Sub-basin. Cumulative impacts to water associated with hydraulic fracturing are of great concern to the community. The AAPowerLink is unlikely to impact groundwater quality (for example, there are no large storages of hazardous chemicals), and so is unlikely to contribute to cumulative impacts to water quality within the CLA.

7.8 Offsets

The EIA did not identify any significant residual impacts to surface water or ground water quality that require offsets.

7.9 References

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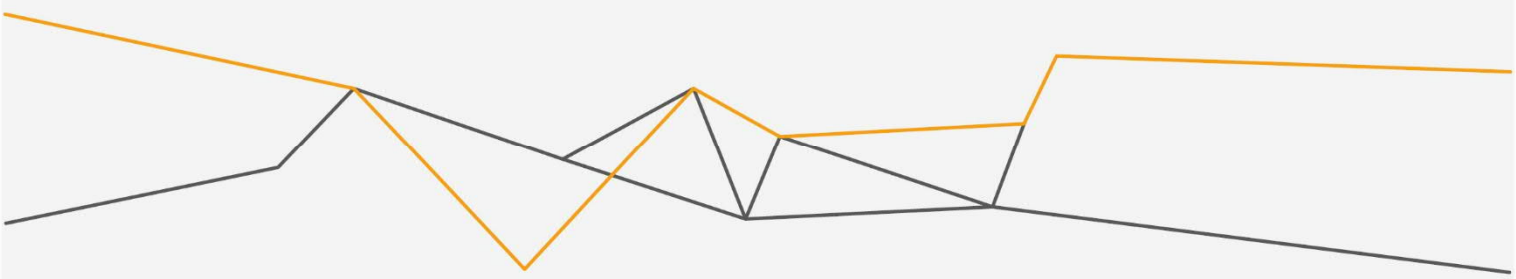

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