4.0 Environmental Principles and Factors

4.1 Principles

The *Statement of Environmental Principles, Factors and Objectives* published by EPA (2018c) was used as the basis for the environmental impact assessment presented in this ERD. Section 4A of the EP Act also describes the principles of environmentally sustainable development. Table 4.1 presents an overview of how these principles have been considered in the context of the proposal.

Table 4.1: Consideration of *Environmental Protection Act 1986* principles (EPA 2018c).

Principle	Consideration
1. The precautionary principle *Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.* *In application of this precautionary principle, decisions should be guided by:* *a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and* *b) an assessment of the risk-weighted consequences of various options.*	Comprehensive biological surveys and technical studies have been undertaken by specialist scientists to inform the assessment of the proposal. The data yielded by these technical assessments have been used both in the refinement of the conceptual design of the proposal, and to reconfirm that the key impact mitigation incorporated in the original site selection process remains valid. Where residual environmental impacts have been identified, the risks of these impacts being significant has been evaluated and mitigation measures have been, and will continue to be, incorporated into the design and management of the proposal.
2. The principle of intergenerational equity *The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.*	The proposal is an excellent example of a renewable energy development that has the potential to provide significant environmental, social and economic benefits to future generations. It is one of the few cases where a development proposal has the potential in its own right to make a significant contribution to global-scale reliance on fossil fuel power and reduction in greenhouse emissions, with consequent climate change benefits. The proposal will make a major and sustained contribution to Western Australia's economy, within a setting that is currently unutilised for virtually any other economic land use. These intergenerational benefits can be delivered with the loss of less than 2% of the vegetation of the development envelope, including avoidance or effective mitigation of impacts on species and communities of conservation significance.
3. The principle of the conservation of biological diversity and ecological integrity *Conservation of biological diversity and ecological integrity should be a fundamental consideration.*	Broad-scale site selection took account of major ecological constraints, resulting in the avoidance of the majority of direct impacts that may have otherwise arisen. Comprehensive biological surveys and technical studies were then undertaken by specialists to inform the assessment of the proposal. The data yielded by these assessments have been used both in the refinement of the conceptual design of the proposal, and to reconfirm that the key impact mitigation incorporated in the original site selection process remains valid. This has included design modifications to avoid direct impacts on species and communities of conservation significance, and the development of a fire management framework to enhance biodiversity at the landscape scale.

Principle	Consideration
4. Principles relating to improved valuation, pricing and incentive mechanisms *(1) Environmental factors should be included in the valuation of assets and services.* *(2) The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement.* *(3) The users of goods and services should pay prices based on the full life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.* *Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.*	The proponent endorses the need for improved valuation, pricing and incentive mechanisms and has aimed to pursue these principles wherever practicable in the development of the proposal. This has included: • Environmental factors have played a central role in both the original site selection process and the refinement of the proposal conceptual design. • By its nature, the proposal will not generate intractable or large volume waste streams, with hydrocarbon and putrescible wastes management during construction and operations being the key considerations, which can be readily contained and managed through standard practices. • The cost of eventual closure and rehabilitation has been incorporated into the financial modeling for the proposal.
5. The principle of waste minimisation *All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.*	The proponent's approach to waste management and minimisation will follow the standard hierarchy, comprising: • avoid and reduce at waste stream sources; • reuse and recycle where practicable; and • treat and/or dispose of in accordance with regulated requirements.

4.2 Preliminary Key Environmental Factors

The preliminary key environmental factors for the ERD were identified by the EPA at the time of setting the level of assessment under Section 38 of the EP Act. These are:

- Benthic Communities and Habitats;
- Marine Environmental Quality;
- Marine Fauna;
- Flora and Vegetation;
- Terrestrial Fauna; and
- Social Surroundings.

4.3 Benthic Communities and Habitats

4.3.1 EPA Objective

The EPA objective for the Benthic Communities and Habitats factor is to protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.

4.3.2 Policy and Guidance

The following guidance and policy documents are relevant to the Benthic Communities and Habitats factor:

EPA Policy and Guidance

- Instructions on how to prepare an Environmental Review Document (EPA 2017);
- Statement of Environmental Principles, Factors and Objectives (EPA 2015);
- Environmental Factor Guideline: Benthic Communities and Habitats (EPA 2016e);
- Technical Guidance - Protection of Benthic Communities and Habitats (EPA 2016f); and
- Technical Guidance - Protecting the Quality of Western Australia's Marine Environment (EPA 2016g).

Other Policy and Guidance

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000);
- A Directory of Important Wetlands in Australia (Department of the Environment 2000);
- Eighty Mile Beach Marine Park Management Plan 80 2014 – 2024 (Department of Parks and Wildlife 2014);
- Western Australian Marine Science Institute Dredging Science Node Reports (https://www.wamsi.org.au/dredging-science-node/dsn-reports);
- WA Environmental Offsets Policy (Government of Western Australia 2011);
- WA Environmental Offsets Guidelines (Government of Western Australia 2014);
- EPBC Act Environmental Offsets Policy (Department of Sustainability, Environment, Water, Population and Communities, 2012); and
- Commonwealth Offsets Assessment Guide (DSEWPaC 2013).

4.3.3 Receiving Environment

4.3.3.1 Eighty Mile Beach Marine Park

The *Conservation and Land Management Act 1984* is relevant to the proposal as the cable corridor traverses the Eighty Mile Beach Marine Park (BMT 2018a). The Marine Park is central to the Northwest Marine Bioregion and covers an area of approximately 200,000 ha, extending for nearly 260 km from Mulla Mulla Downs Creek in the south to Cape Missiessy in the north (BMT 2018a). The Marine Park extends seaward from the high water mark to the limit of State Waters (and includes the waters, the airspace above those waters, the seabed below those waters, and the subsoil to a depth of 200 m below the seabed).

The Marine Park was gazetted as a Class A Marine Park in January 2013 and is jointly managed by the DBCA, Traditional Owners and other stakeholders, through the establishment of joint management agreements with the Karajarri, Nyangumarta and Ngarla people who have native title determinations for the lands and waters (to low astronomical tide; LAT) in and adjacent to Eighty Mile Beach. All intertidal areas within the Marine Park, and the adjacent Mandora Salt Marsh ~40 km inland, are listed under the Ramsar Convention as recognised feeding grounds for migratory shorebirds and waders (Department of Parks and Wildlife 2014).

Offshore Commonwealth waters are generally clear, but the nearshore State Waters within the scope of the current proposal are turbid due to high energy macro-tidal flows (as well as episodic river run-off in the region, particularly during cyclone events) (BMT 2018a). The low relief and a macro-tidal regime result in an almost continuous 220 km beach supporting a large tidal mudflat area of approximately 60,000 ha (Department of Parks and Wildlife 2014). The intertidal zone benthic habitats are characterised by silty/clay organic marine sediments (within the 20 m isobath). The upper intertidal areas are coarser grained, changing to an approximately 100 m wide white sandy beach fringed by low sand dunes to the east (Hale and Butcher 2009). The intertidal mudflats are on average 2.6 km wide but at the lowest spring tides can be up to 4 km wide, and tend to be more extensive in the north (Department of Parks and Wildlife 2014).

4.3.3.2 Benthic Communities and Habitat

BMT (2018b) mapped the benthic communities and habitat (BCH) of the cable corridor portion of the development envelope (Appendix 2). The cable corridor is situated approximately 18 km northeast of Eighty Mile Beach Caravan Park (Figure 2.5), and the survey area was approximately 2 km wide and 6 km from the lowest astronomical tide (LAT), with the intertidal area extending to the high water mark. The survey area was limited to the LAT and did not include the intertidal area (BMT 2018b).

Side scan sonar (SSS) and towed video transects were completed along the cable corridor between 12 and 16 October 2017. The survey was completed during a neap tide cycle and wind was predominately from the west during the survey (BMT 2018b). These weather conditions typically would have resulted in very good conditions for limited turbidity in the water column, but even with limited tidal range and favourable weather conditions, the naturally high turbidity in the majority of the survey area limited the underwater visibility to <1 m (BMT 2018b).

Prior to commencing SSS operations, a reconnaissance was conducted along the centre-line of the survey area to confirm average seabed depths and identify any possible SSS obstructions. Following SSS data acquisition, the SSS data were assessed in the field to identify targets for the video tow operations. A geophysicist, with particular experience in shallow water benthic habitat recognition using SSS, screened the data to determine areas of interest which may represent benthic habitat (BMT 2018b) (Appendix 2).

Areas of interest captured from the high-resolution SSS images were designated as potential targets for ground-truthing using underwater video footage. A total of 18 towed video transects were completed between 15 and 16 October 2017 and subsequently reviewed by an experienced marine scientist to identify BCH. The processed SSS data were used in combination with the video data and high-resolution field SSS images to map benthic habitats over the survey area. Both the individual lines and full mosaic images were visually assessed at a scale of approximately 1:1000, and the images were enhanced to highlight relevant benthic features and improve separation of potential habitats (BMT 2018b). Overlapping lines captured at different angles were assessed individually to make sure no features were missed.

Due to the high levels of turbidity, not all towed video footage could be used to identify benthic habitats. However, it was apparent from the different levels of turbidity that very high levels of energy (bedload/suspension) were evident in sections of the survey area.

Reconnaissance of the bathymetry of the area showed a homogenous shallow gradient along the cable corridor. Starting from the central point on the northern limit of the development envelope boundary and working directly south, the gradient ranged from approximately a 1 m rise over the first 2.5 km; steepening slightly to 1 m per 1 km to the southern boundary (BMT 2018b).

Overall, the area was a homogenous sand flat with no significant topographic features (BMT 2018b). The SSS data supported this, as although areas of interest were identified, these were very small in scale and likely sediment density related (e.g. sand versus sand/silt) for the most part (e.g. Plate 4.1). Some areas of interest were identified as coral rubble that had likely been transported inshore from unidentified coral areas in deeper water outside of the development envelope (BMT 2018b).

The towed video footage ground-truthing supported this information, identifying a mostly featureless flat sandy seabed (Plate 4.2 to Plate 4.4). In the deeper water, the video footage had better visibility and revealed some filter feeders (<1%) and some bioturbation within the sand flats (Plate 4.2). Turbidity increased greatly with shallowing water and the bioturbation and presence of filter feeders quickly diminished as the areas become higher energy with greater sediment bedloads (Plate 4.3). In the central and southern portions of the cable corridor turbidity was high due to high levels of re-suspension of bedload materials which appeared to limit bioturbation and excluded filter feeders or other habitats (Plate 4.4) (Appendix 2).

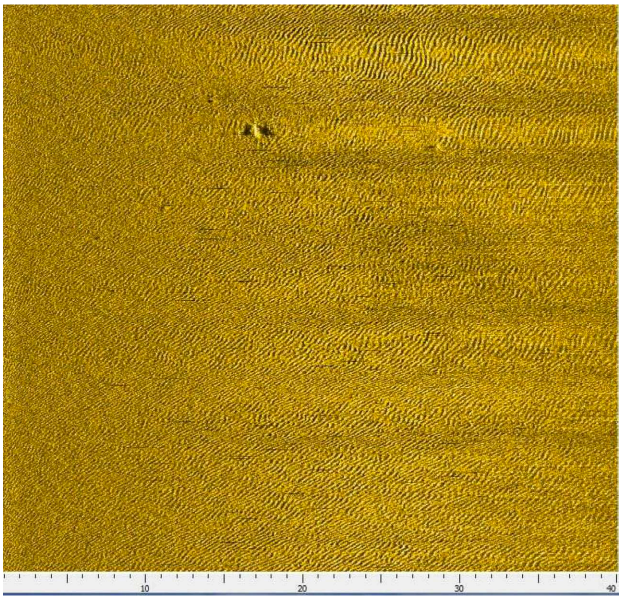

Plate 4.1: SSS image showing sand ripples with small boulder (<2 m diameter) (BMT 2018b).

Plate 4.2: Towed video of sand-dominated, moderate energy, bioturbated habitat (BMT 2018b).

Plate 4.3: Towed video of sand-dominated, high energy, lightly bioturbated habitat (BMT 2018b).

Plate 4.4: Towed video of sand-dominated, high energy habitat (BMT 2018b).

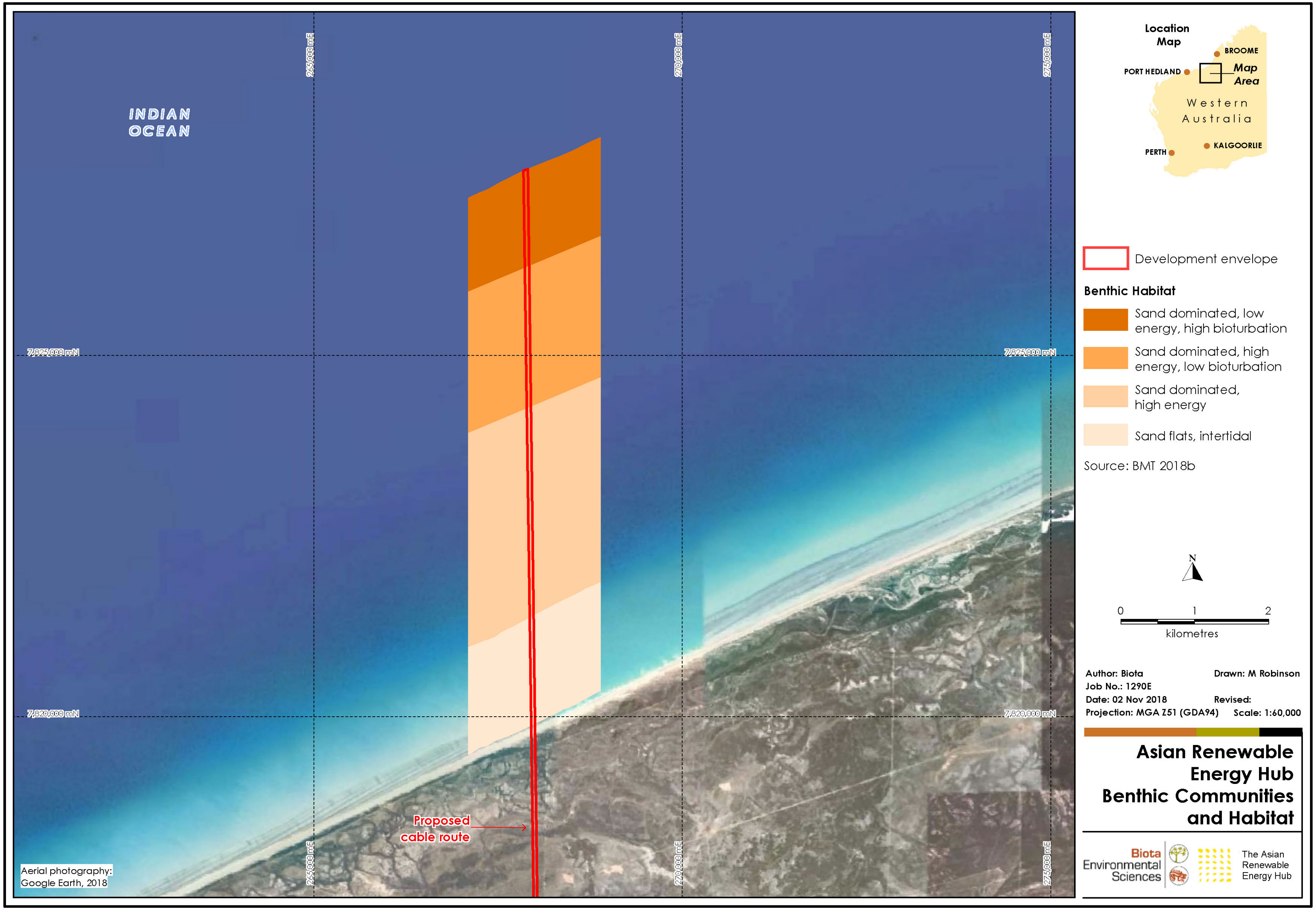

Figure 4.1: Benthic habitats of the cable corridor portion of the development envelope in the context of wider habitat mapping, which equates to a provisional local assessment unit (BMT 2018b).

No significant BCH was found during the survey (BMT 2018b) (Appendix 2). The seabed habitat that was present was sand-dominated and moderate to high energy with significant turbidity throughout the cable corridor portion of the development envelope. As the seabed within the development envelope was identified as being entirely sand-dominated, the area was divided up into four different sand-dominated habitat units by BMT (2018b). From lowest to highest in the tidal range, these were:

- sand-dominated, moderate energy, bioturbated;
- sand-dominated, high energy, lightly bioturbated;
- sand-dominated, high energy; and
- sand flats, intertidal (Figure 4.1).

4.3.4 Potential Impacts

The proposal will result in impacts on the seabed within State Waters during cable installation, maintenance and decommissioning, which are generally assumed to be similar during these phases (Gill 2005). These potential impacts of relevance to the Benthic Communities and Habitats factor may occur as a result of:

- direct disturbance to the seabed during cable lay or pull-up;
- increased water column turbidity during cable lay or pull-up;
- release of sediment contaminants;
- hydrocarbon spills and waste generation from vessels; and
- introduced marine species from vessel biofouling or ballast water; and
- the effect of any of the above impacts on the BCH values of the Eighty Mile Beach Marine Park (BMT 2018a).

As sediment contaminants, hydrocarbons and introduced marine pests are of broader relevance to the marine environment, they are addressed as potential impacts under the Marine Environmental Quality factor (Section 4.4.4), with the potential impact of the direct disturbance to the sea bed and relative turbidity in the water column considered in this section. The extent to which all of the above potential impacts could affect the values for which the Eighty Mile Beach Marine Park was vested is addressed in Section 4.5.6.5, including marine fauna and marine environmental quality.

The installation and decommissioning of each cable from the beach to the edge of State Waters will take a period of a few weeks and direct disturbance impacts are therefore highly transitory. Maintenance activities that require disturbance of the seabed are unlikely to occur every year. However, in the unlikely scenario of the cable requiring repair work, such activities would also be completed in a matter of weeks.

During the operational phase of the proposal, the potential impacts relevant to the Benthic Communities and Habitats factor arising from the operating HVDC cables may involve:

- chlorine formation during monopole operation; and
- sediment contamination related to cable deterioration (BMT 2018a).

Again, these potential impact mechanisms during the operational phase are more directly linked to the Marine Environmental Quality factor and are considered in Section 4.4.4.

4.3.5 Assessment of Impacts

Given the highly mobile nature of the marine sediments and the strong currents in the area (Section 4.3.3), establishment of macroalgae, seagrass or coral communities is unlikely (BMT 2018a). Direct disturbance of sediments during cable installation, decommissioning or maintenance may potentially lead to an increase in local water column turbidity and sediment deposition, arising from suspended and re-suspended sediments being transported by prevailing water movements (Meissner et al. 2006, OSPAR Commission 2009).

The prevailing high energy tidal regime of the region causes naturally turbid coastal waters and precludes the growth of benthic primary producers, meaning there are no significant BCH present within the development envelope (Section 4.3.3). Additional turbidity and sediment deposition caused by cable trenching, ploughing or jetting is expected to be localised, temporary and not significant to ecological processes (Meissner et al. 2006).

Trenching, ploughing or jetting activities to install the four cables may result in the temporary disturbance of an area of bioturbated sediments (<1% bioturbated) equivalent to approximately 15.3 ha within the development envelope (Figure 4.1). This small scale and localised disturbance of bioturbated sediments is not considered to be ecologically significant (BMT 2018a).

EPA (2016f) guidance on the assessment of potential BCH impacts recommends the use of a local assessment unit of approximately 50 km^2 (5,000 ha) to assess potential impacts on benthic habitat at an appropriate scale. Direct temporary loss of 15.3 ha of bioturbated bare sand within a nominal 5,000 ha local assessment unit (LAU) equates to a potential loss of 0.3% of habitat. The extent of benthic habitats mapped by BMT (2018a) provides an even more precautionary scale of consideration for the potential impact of the cable installation, whereby that 1,380.6 ha mapped extent can be adopted as an LAU (Figure 4.1). Even this very localised context, the direct temporary loss of 15.5 ha only represents 1.1% of the local sand-dominated habitat. Noting further that the disturbance will be temporary only, and sediments will likely be rapidly reinstated due to the high energy environment, the impact is not significant (BMT 2018a).

Trenching, ploughing or jetting activities will also cause reworking and settling out of sediments along the cable route, which may cause temporary, localised changes in particle size distribution (e.g. an increase in the silt and clay fractions) and carbon content (e.g. a lower proportion of organic carbon than natural sediments, which contain microphytobenthos and detritus) (BMT 2018a). Changing the physical and chemical properties of sediment may impact the abundance of macroinvertebrates (Hale and Butcher 2009). However, since the HVDC cables will be completely buried, any temporary and localised changes in particle size distribution and carbon content are not anticipated to permanently impact the sediment quality of the marine environment, particularly given the influence of tidal flows (BMT 2018a).

The direct temporary loss of 15.3 ha of bioturbated bare sand within the broader context of the 200,000 ha Marine Park represents a very localised and short-term disturbance to <0.01% of the Marine Park by area (Figure 4.2). The potential impact on any unique attributes or any of the ecological characters for which the Eighty Mile Beach Marine Park was established (Hale and Butcher 2009, Department of Parks and Wildlife 2014) is negligible (Appendix 3; Section 4.5.6.5).

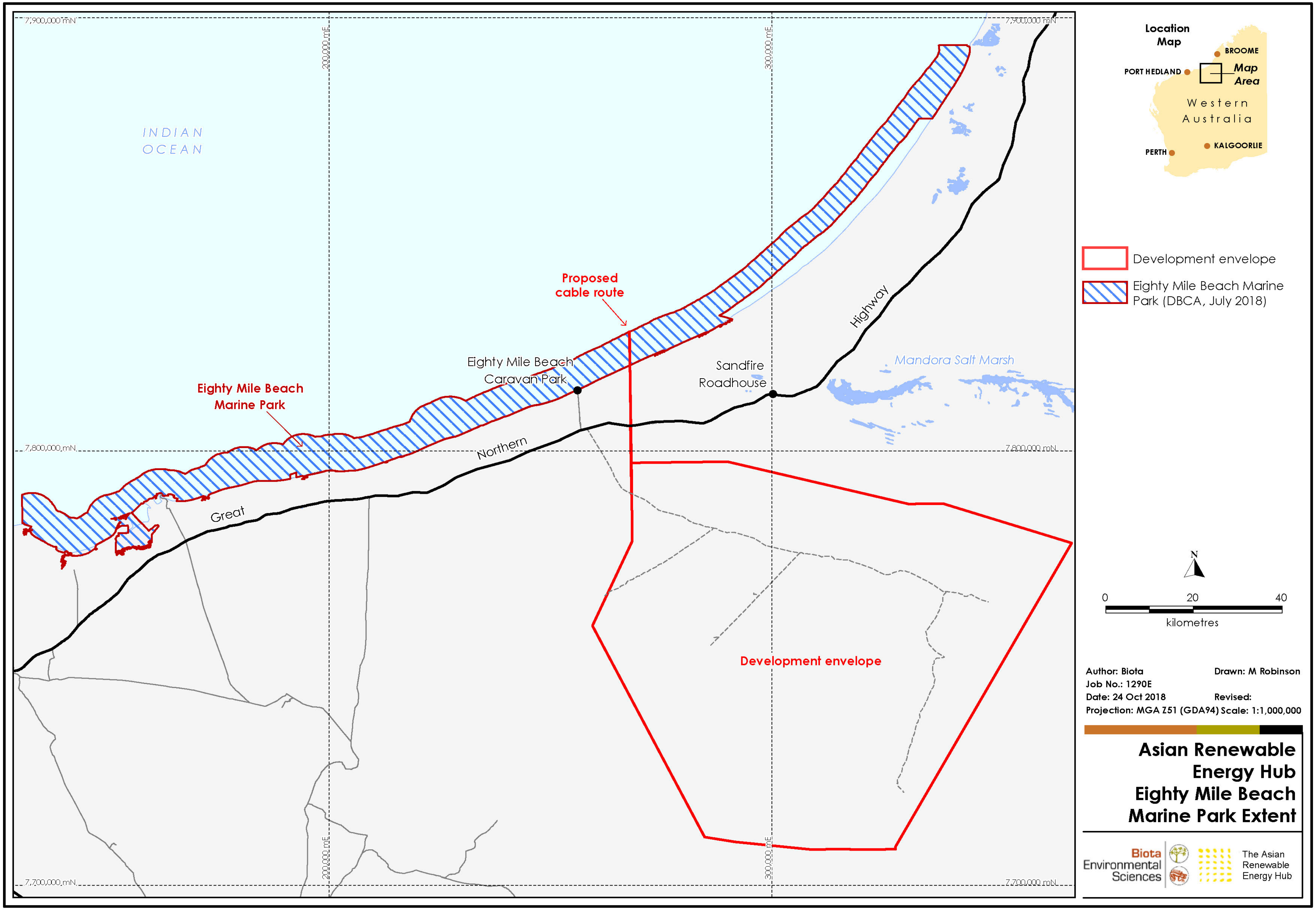

Figure 4.2: Cable corridor portion of the development envelope in context with the Eighty Mile Beach Marine Park.

4.3.6 Mitigation

Mitigation measures that will be implemented to minimise impacts on BCH have followed the Western Australian mitigation hierarchy (Avoid, Minimise, Rehabilitate, Offset (Government of Western Australia 2011)). The mitigation of potential impacts on BCH from the cable installation has followed avoidance and minimisation, as a function of:

- the initial cable route selection process undertaken by the proponent, which has resulted in a short crossing of the Eighty Mile Beach Marine Park while minimising potential impacts on other values for which the Park was established (Section 2.3.4.5), and at a location where there are no BCH of significance; and
- the installation method of the cable means that it will be buried to a depth of 5-10 m below the sea bed (Section 2.6.11.3) and there will therefore be no ongoing operational impacts on benthic habitats.

While the predicted residual impacts on BCH are not significant, the proponent will still implement standard management measures for the installation, maintenance and decommissioning of the cable, with the preparation and implementation of a Construction Environmental Management Plan (CEMP) (Appendix 1), which will include the following measures relevant to reducing impacts on BCH:

1. procedures to ensure that cable installation only occurs within the surveyed corridor and that the finished cable is buried to the specified depth below the sea bed; and
2. navigational aids on the installation vessel to track cable lay operations.

4.3.7 Predicted Outcome

EPA sets out eight criteria that may be considered where relevant to determining the significance of predicted impacts. Those that are relevant to BCH, and a summary assessment of the key findings from the preceding sections, comprise:

a. *values, sensitivity and quality of the environment which is likely to be impacted* – no significant BCH present;
b. *extent (intensity, duration, magnitude and geographic footprint) of the likely impacts* – very localised and short-term disturbance that will affect an insignificant proportion of BCH in the LAU and surrounding Marine Park;
c. *consequence of the likely impacts (or change)* – negligible impact on BCH values;
d. *resilience of the environment to cope with the impacts or change* – impacts are set in a highly dynamic offshore environment and are minor in this context;
e. *cumulative impact with other existing or reasonably foreseeable activities, developments and land uses* – no significant existing impacts or relevant land uses, meaning that cumulative impacts can effectively be discounted;
f. *connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment* – unlikely to have any influence on broader ecological processes or values as disturbance is localised and temporary;
g. *level of confidence in the prediction of impacts and the success of proposed mitigation* – very high, being based on surveys and well-demonstrated management measures; and
h. *public interest about the likely effect of the proposal or scheme, if implemented, on the environment and public information that informs the EPA's assessment* – there may be some public interest, given the location within the Marine Park, but submissions on the initial referral were few and none specifically mentioned BCH.

Given the above, the residual impacts of the proposal on BCH are not significant. Additional management will be implemented to further minimise the minor impacts that remain, such that the EPA's objective for the Benthic Communities and Habitats factor can be met.

4.4 Marine Environmental Quality

4.4.1 EPA Objective

The EPA objective for the Marine Environmental Quality factor is to maintain the quality of water, sediment and biota so that environmental values are protected.

4.4.2 Policy and Guidance

The following guidance and policy documents are relevant to the Marine Environmental Quality factor:

EPA Policy and Guidance

- Instructions on how to prepare an Environmental Review Document (EPA 2017);
- Statement of Environmental Principles, Factors and Objectives (EPA 2015);
- Environmental Factor Guideline: Marine Environmental Quality (EPA 2016h); and
- Technical Guidance - Protecting the Quality of Western Australia's Marine Environment (EPA 2016g).

Other Policy and Guidance

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000);
- Eighty Mile Beach Marine Park Management Plan 80 2014 – 2024 (Department of Parks and Wildlife 2014); and
- Aquatic Biosecurity Policy 19 January 2017 (Department of Fisheries 2017).

4.4.3 Receiving Environment

The cable corridor portion of the development envelope passes through the Eighty Mile Beach Marine Park (Section 4.3.3.1). The Leeuwin Current and Indonesian Throughflow drive warm, low salinity ocean currents south into the region of the Marine Park (Condie et al. 2006). The wave climate in the region is influenced by the effects of tide and seasonal winds acting on a predominantly westerly swell regime that ranges from 0.5 to 1.3 m (Hesp and Curry 1984). The nearshore State Waters marine environment is very turbid due to high energy macro-tidal flows, as well as episodic river run-off in the region, particularly during cyclone events (Condie et al. 2006). Sea temperatures in the region range from 24 to 32°C throughout the year (BMT 2018a).

Given the lack of historical industrial activities in both the marine receiving environment and adjoining land-side areas, water quality in the cable corridor portion of the development envelope is likely to be high and consistent with normal conditions in nearshore areas in the region (BMT 2018a). Baseline data on key parameters will be collected as part of the project CEMP ahead of the commencement of works to confirm this and provide a baseline against which to measure the effects, if any, of the cable burial (see Sections 4.4.4 and 4.4.6; and Appendix 1).

4.4.4 Potential Impacts

The proposal will result in potential impacts on the marine environment within State Waters during cable installation, maintenance, operation and decommissioning.

These potential impacts of relevance to the Marine Environmental Quality factor may occur as a result of:

- release of sediment contaminants;
- hydrocarbon spills and waste generation from vessels; and
- introduced marine species from vessel biofouling or ballast water (BMT 2018a).

During the operational phase of the proposal, the potential impacts relevant to the Marine Environmental Quality factor arising from the operating HVDC cables themselves may involve:

- chlorine formation during monopole operation; and
- sediment contamination related to cable deterioration (BMT 2018a).

The extent to which any of the above potential impacts could affect the values for which the Eighty Mile Beach Marine Park was vested is addressed in Section 4.5.6.5, which also addresses BCH and marine fauna values.

4.4.5 Assessment of Impacts

4.4.5.1 Release of Stored Sediment Contaminants

The risk of contamination from seabed disturbance arises from the potential release and mobilisation of contaminated sediments into the water column during cable burial, maintenance work, and eventual decommissioning and removal of the cables (Meissner et al. 2006). A risk of such contamination of the water column is only anticipated for localities that have historically been used for human activity in the vicinity of coastal infrastructure and urban or industrial catchments (Meissner et al. 2006).

The risk of contamination arising from seabed disturbance during cable installation, decommissioning or maintenance works for the current proposal is considered negligible, given the cable corridor traverses the coast through a State Marine Park bordered on the landside by low density pastoral leases, with limited public access points, and no history of urban or industrial development (BMT 2018a) (Appendix 3).

4.4.5.2 Hydrocarbon Spills and Waste Generation

Various hydrocarbons will be used during the cable commissioning, decommissioning and any maintenance repair works, including fuel, oil and lubricants. There is therefore a risk that hydrocarbon spills will negatively impact on marine environmental quality. Rubbish and hazardous waste may also be generated, which can pollute the environment if not contained and removed from site, though this can be readily mitigated by standard environmental management measures (Section 4.4.5.2).

4.4.5.3 Introduced Marine Species

Commissioning, decommissioning and maintenance works may result in the introduction of non-indigenous marine species to the area (introduced marine species (IMS)). IMS can have significant impacts on marine ecosystems and marine industries, but only a small fraction of IMS are able to thrive and successfully colonise new habitats (Mack et al. 2000). IMS have the potential to displace native species, change community structure and food webs, and alter ecosystem processes such as nutrient cycling and sedimentation or damage marine industries through diminishing fisheries, fouling ships' hulls and clogging intake pipes (Molnar et al. 2008). The primary means by which IMS may be introduced is via biofouling (the attachment of organisms) to vessel hulls and/or ballast water (water that a vessel takes on board to provide stability) (BMT 2018a).

Both cable installation and maintenance vessels have the potential to introduce marine species via biofouling or ballast water exchange. Cable ships are equipped with a variety of devices to locate, raise, lay or bury cables. Cables in water depths of less than 2,000 m, which accounts for the cable route for the proposal, are routinely buried via a cable plough or water jetting (Kinloch et al. 2003). These factors, in addition to the vessels large size and extensive seawater plumbing systems, including bow and stern thrusters, mean that cable vessels may entrain marine pests when remotely deploying cables or through biofouling (Kinloch et al. 2003). The cable ships' equipment and previous use are factors that will influence their potential to carry introduced marine species (BMT 2018a).

In Australia, around 250 introduced marine pests have been identified, of which over 75% are believed to have been introduced through biofouling rather than in ballast water (Bax et al. 2003). Indeed, biofouling may pose a higher potential risk of introducing marine species in most settings (BMT 2018a). Mitigation measures will be employed for both biofouling and ballast water to minimise the risk of IMS associated with the proposal (Section 4.4.6.3).

4.4.5.4 Chlorine Formation During Monopole Operation

In a monopole transmission system using a ground return, the entire reverse electrical current flows to the ground via electrodes; whereas in a bipolar transmission system, the reverse current flows via cable (closed circuit) and no electrodes are used (Schmidt et al. 1996). In monopole operation, hydrogen (at the cathode) and chlorine (at the anode) are produced in the surrounding seawater by electrolysis. Chlorine gas generated will react almost exclusively with water to produce hypochlorous acid (BMT 2018a).

As only the cathode will be located within the development envelope within State Waters, no potentially harmful chemical products will be produced (Baslev 2014). Anodes will not be located within the Eighty Mile Beach Marine Park waters and the potential impact of hypochlorous acid on marine flora and fauna, and marine water quality, has therefore not been investigated as part of this ERD.

4.4.5.5 Sediment Contamination from Cable Deterioration

There is a potential risk of contamination from subsea cables during the operational phase of the project, which may arise from cable deterioration and the release of contaminants from the cable itself due to cable damage or degradation. Contamination through cable damage or deterioration has the potential to expose marine organisms to toxic substances (Meissner et al. 2006). However, as the HVDC cables will be buried to a depth of 5-10 m below the seabed (Section 2.6.11.3), cable weathering due to wave action or currents will be negligible (BMT 2018a) (Appendix 3).

4.4.6 Mitigation

As the risks of contamination arising from sediment disturbance during installation and chlorine formation are negligible, no additional mitigation is required for these potential impact mechanisms.

Mitigation measures for the remaining three potential impact mechanisms on marine environmental quality have followed the Western Australian mitigation hierarchy (Avoid, Minimise, Rehabilitate, Offset (Government of Western Australia 2011)), and are detailed in Sections 4.4.6.1 to 4.4.6.3 below.

4.4.6.1 Hydrocarbon Spills and Waste Generation

Hydrocarbon use and waste will be managed via appropriate housekeeping and spill prevention processes during commissioning, maintenance and decommissioning work. These well-demonstrated and industry standard protocols will be detailed and contractually required in the project CEMP.

4.4.6.2 Contamination Related to Cable Deterioration

The primary control reducing risk of deterioration of the HDVC cable and the release of contaminants into the marine environment is the construction measure of the burial of the cable 5-10 below the seabed. The low risk of cable deterioration will be further managed through the implementation of a maintenance schedule as part of the CEMP.

4.4.6.3 Introduced Marine Species

The proponent will verify each vessel's operational history, fouling control and ballast water details are accurate and reliable before contracting vessels. This process will involve completing the DPIRD risk assessment (including liaison with DPIRD; see https://vesselcheck.fish.wa.gov.au/) once the proposed cable lay or maintenance vessels have been identified.

All work vessels (from intrastate, interstate and international waters) will comply with the current Department of Fisheries Aquatic Biosecurity Policy (Department of Fisheries 2017) and vessel management procedures in line with Australian Government tmarine pest management guidelines (Department of Agriculture and Water Resources 2009), with the following information to be provided to the relevant government authorities:

- Evidence that sediment and ballast water has been, or will be, managed to prevent IMS entering and moving within WA. Alternatively, a maintained ballast water management plan and record book should be provided on request;
- Vessel's log entries showing operational history since last antifouling coating application or IMS inspection, or a maintained biofouling management plan and record book;
- The most recent in-water cleaning or dry dock/slip report and IMS inspection report;
- Evidence of either an active marine growth prevention system or a suitable manual treatment regime for internal seawater pipe-works;
- The most recent antifouling coating application certificate or original receipts or invoices stating the coating type, volume purchased, vessel name (if possible) and date of application; and
- Type of vessel (see Appendix 3).

4.4.7 Predicted Outcome

The risk of significant impacts to marine environmental quality from the release of contaminants from sediments and chlorine generation are negligible. The remaining three potential impacts:

- hydrocarbon spills and waste generation from vessels;
- contamination related to cable deterioration; and
- introduced marine species,

will all be managed through well-established and understood mitigation measures as part of the CEMP, such that the residual risk of any significant impacts is low.

Given the above, the EPA’s objective for the Marine Environmental Quality factor can be met.

4.5 Marine Fauna

4.5.1 EPA Objective

The EPA objective for the Marine Fauna factor is to protect marine fauna so that biological diversity and ecological integrity are maintained.

4.5.2 Policy and Guidance

The following guidance and policy documents are relevant to the Marine Fauna factor:

EPA Policy and Guidance

- Instructions on how to prepare an Environmental Review Document (EPA 2017);
- Statement of Environmental Principles, Factors and Objectives (EPA 2015); and
- Environmental Factor Guideline: Marine Fauna (EPA 2016i).

Other Policy and Guidance

- A Directory of Important Wetlands in Australia (Department of the Environment 2000);
- Eighty Mile Beach Marine Park Management Plan 80 2014 – 2024 (Department of Parks and Wildlife 2014);
- Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012);
- Aquatic Biosecurity Policy 19 January 2017 (Department of Fisheries 2017);
- Relevant Commonwealth recovery plans, conservation advice and/or threat abatement plans;
- WA Environmental Offsets Policy (Government of Western Australia 2011);
- WA Environmental Offsets Guidelines (Government of Western Australia 2014); and
- EPBC Act Environmental Offsets Policy (Department of Sustainability, Environment, Water, Population and Communities 2012).

4.5.3 Receiving Environment

The marine waters adjacent to the development envelope support a variety of fauna, several of which are significant and protected under the EPBC Act. A search of the online EPBC Act Protected Matters Search Tool completed by BMT (2018a) identified 26 listed threatened species and 61 listed migratory species that may occur in the development envelope locality. Additional marine fauna species identified as possibly occurring within the development envelope locality included pipefishes (19 species), seahorses (four species) and sea snakes (16 species) (BMT 2018a) (Appendix 3).

Excluding migratory shorebirds, which are addressed separately in Sections 4.7.3 and 7.2.3, the listed marine fauna species of potential relevance to the proposal include:

- 11 marine mammal species (Table 4.2 and Section 4.5.3.1);
- six marine reptiles (five turtle and one sea snake species) (Table 4.2 and Section 4.5.3.2); and
- eight species of elasmobranch fish (four sawfish, two shark and two manta ray species) (Table 4.2 and Section 4.5.3.3) (BMT 2018a) (Appendix 3).

There are no, or in some cases limited, data for these species specific to the development envelope itself, and many are not even confirmed as occurring within Eighty

Mile Beach Marine Park (Sections 4.5.3.1 to 4.5.3.3) (BMT 2018a). Most of the species are also migratory (Table 4.2) and would only be present periodically if they do occur.

Table 4.2 provides an overview of each of the potentially present listed marine fauna species, summarising their typical habitat, distribution and ecological functions (e.g. breeding migration, feeding, nesting etc.). Reviews of the literature and site-specific consideration of the habitats present within the development envelope has allowed the list to be refined to a subset of those species considered to have a moderate or high likelihood of occurrence within the nearshore habitats of the development envelope (as detailed in Sections 4.5.3.1 to 4.5.3.3). Therefore, the impact assessment and relative mitigation measures detailed in Section 4.5.5 and 4.5.6 focuses on the turtle, cetacean and sawfish species most likely to be present within the development area (Table 4.2).

4.5.3.1 Marine Mammals

The marine mammals that may occur in the development envelope include dugongs, whales and dolphins. Current knowledge of the distribution, migratory habits and local importance of the Eighty Mile Beach Marine Park for whales and dolphins is limited (BMT 2018a). Humpback and blue whales are known to move through the region during their annual migration, north from April to August for calving in tropical waters, and south from August to October for feeding, but are most often seen in deeper offshore waters rather than the shallow and intertidal waters intersected by the cable corridor portion of the development (BMT 2018a). Similarly, migrating killer whales and Bryde's whales are most commonly seen along the continental slope and shelf areas (IFAW 2011). Due to the area's shallow water depth (<10 m) and large tidal range, it is unlikely that the Eighty Mile Beach Marine Park comprises significant habitat for these larger marine mammal species (Department of Parks and Wildlife 2014), and nor, by inference, does the development envelope (Table 4.2).

The Indo-Pacific humpback dolphin, dottlenose dolphin and Australian snubfin Dolphin have a preference for nearshore waters and are known to congregate in Roebuck Bay for breeding, feeding and/or calving (IFAW 2011, Brown et al. 2014), though there is no record of specific association with the Eighty Mile Beach Marine Park. Risso's Dolphin is pelagic (IFAW 2011), and unlikely to occur in nearshore shallow waters of the development envelope (BMT 2018a). The common bottlenose dolphin occurs in both offshore and nearshore populations and can be associated with other dolphins and marine mammals (IFAW 2011).

Information on dugong in the Kimberley region is limited and the Western Australian Marine Science Institute (WAMSI) is currently completing a program that will integrate indigenous knowledge, aerial surveys and tagging to develop a baseline dugong management plan for the region (BMT 2018a). Dugong commonly aggregate in protected shallow bays and mangrove channels, primarily feeding on seagrass (Bennelongia et al. 2009, Department of Parks and Wildlife 2014), and are regularly sighted in relatively large aggregations in the shallow embayments at the southern end of Eighty Mile Beach Marine Park (Department of Parks and Wildlife 2014).

Concern has been raised in the past regarding declining dugong populations regionally, partially attributed to the indigenous use of the dugong (Chalmers and Woods 1987), though this practice is infrequent in the Marine Park (Department of Parks and Wildlife 2014). While dugong utilise other parts of the Marine Park, the complete lack of seagrass in the cable corridor portion of the development envelope (Section 4.3.3.2) indicates that it does not comprise significant habitat for dugong (Table 4.2).

Table 4.2: Listed marine fauna of potential relevance to the proposal (listed from most likely to occur in the development envelope to least within each faunal group; species of moderate or high likelihood to occur highlighted in grey).

	Conservation Status					
Species	**State**	**EPBC Act**	**Habitat**	**Period of Habitat Use** [1]	**Assessment** [2]	**Likelihood**
Marine Mammals						
Spotted bottlenose dolphin (*Tursiops aduncus*)	-	Cetacean; Migratory	No specific association with habitats present within the development envelope	-	Likely that the species moves through the development envelope on occasion.	Moderate
Common dolphin (*Delphinus delphis*)	-	Cetacean	No specific association with habitats present within the development envelope	-	Likely that the species moves through the development envelope on occasion.	Moderate
Indian Ocean bottlenose dolphin (*Tursiops aduncus*)	-	Cetacean	No specific association with habitats present within the development envelope	-	Likely that the species moves through the development envelope on occasion.	Moderate
Bottlenose dolphin (*Tursiops truncatus*)	-	Cetacean	No specific association with habitats present within the development envelope	-	Likely that the species moves through the development envelope on occasion.	Moderate
Indo-Pacific humpback dolphin (*Sousa chinensis*)	-	Cetacean; Migratory	No specific association with habitats present within the development envelope	-	Likely that the species moves through the development envelope on occasion.	Moderate
Blue whale (*Balaenoptera musculus*)	Schedule 2	Endangered; Cetacean; Migratory	Deeper offshore waters during migration for both whale species	July–September (migration)	Shallow water (<10 m) and strong tidal current mean that the species is more likely to occur further offshore than the development envelope	Low
Humpback whale (*Megaptera novaeangliae*)	Schedule 6	Vulnerable; Cetacean; Migratory	Deeper offshore waters during migration for both whale species	July–September (migration)	Shallow water (<10 m) and strong tidal current mean that the species is more likely to occur further offshore than the development envelope	Low
Dugong (*Dugong dugon*)	Schedule 7	Marine; Migratory	Shallow bays and channels, primarily feeding on seagrass	-	No foraging habitat within the development envelope	Low
Bryde's whale (*Balaenoptera edeni*)	-	Cetacean; Migratory	Continental slope and shelf areas during migration	-	Shallow water (<10 m) and strong tidal current mean that species would occur further offshore than the development envelope	Very low
Killer whale (*Orcinus orca*)	-	Cetacean; Migratory	Continental slope and shelf areas during migration	-	Shallow water (<10 m) and strong tidal current mean that species would occur further offshore than the development envelope	Very low
Risso's dolphin (*Grampus griseus*)	-	Cetacean	Pelagic	-	Shallow water (<10 m) and strong tidal current mean that species would occur further offshore than the development envelope	Very Low

Species	Conservation Status		Habitat	Period of Habitat Use [1]	Assessment [2]	Likelihood
	State	EPBC Act				
Marine Reptiles						
Flatback turtle (*Natator depressus*)	Schedule 3	Vulnerable; Marine; Migratory	Nest on low energy beaches bound by broad shallow intertidal zone with soft sediments	November–December (nesting) and January–March (hatching)	Eighty Mile beach is a known rookery for flatback turtles, and a body hole from nesting activity recorded within the development envelope	Occurs
Loggerhead turtle (*Caretta caretta*)	Schedule 2	Endangered; Marine; Migratory	Waters of coral and rocky reefs, seagrass beds and muddy bays	-	Possible that any of these three turtle species move through the development envelope on occasion, but no breeding records for any three species from Eighty Mile Beach	Low
Green turtle (*Chelonia mydas*)	Schedule 3	Vulnerable; Marine; Migratory				
Hawksbill turtle (*Eretmochelys imbricata*)	Schedule 3	Vulnerable; Marine; Migratory				
Leatherback turtle (*Dermochelys coriacea*)	Schedule 3	Endangered; Marine; Migratory	Pelagic feeder	-	Occurs offshore and no breeding records from Eighty Mile Beach	Very low
Short-nosed sea snake (*Aipysurus apraefrontalis*)	Schedule 1	Critically Endangered; Marine	Prefers reef flats or shallow waters along the outer reef edge in water ≤10 m deep	-	There is no reef habitat within the development envelope.	Very low
Elasmobranch Fish						
Green sawfish (*Pristis zijsron*)	Schedule 3	Vulnerable; Migratory	Inhabit coastal estuaries, river mouths, embayments and along sandy and muddy beaches	January–May (pupping) Throughout the year (foraging and refuge)	Likely to be present within the development envelope (Department of the Environment and Energy 2015)	High
Dwarf sawfish (*Pristis clavata*)	Priority 1	Vulnerable; Migratory	Inhabit shallow (≤3 m) coastal waters and occur further offshore	January–May (pupping) Throughout the year (foraging and refuge)	Likely to be present within the development envelope (Department of the Environment and Energy 2015)	High
Largetooth sawfish (*Pristis pristis*)	Priority 3	Vulnerable; Migratory	Juveniles occur in inshore and estuarine waters, adults occur further offshore	-	River systems important for juvenile fish are not present near the development envelope but adults may pass through the area (Department of the Environment and Energy 2015)	Moderate
Narrow sawfish (*Anoxypristis cuspidata*)	-	Migratory	Juveniles occur in inshore and estuarine waters, adults occur further offshore	-	It is likely that these species move through the area but do not have specific association with the habitats of the development envelope	Moderate

Species	Conservation Status		Habitat	Period of Habitat Use [1]	Assessment [2]	Likelihood
	State	EPBC Act				
Whale shark (*Rhincodon typus*)	Schedule 6	Vulnerable; Migratory	Ningaloo reef is the main known aggregation of this species in Australia. Often observed offshore but can come close to shore on occasion	-	Unlikely that this species will access the shallower waters of the development envelope	Low
White shark (*Carcharodon carcharias*)	Schedule 3	Vulnerable; Migratory	Range from inshore around rocky reefs, and shallow coastal bays to outer continental shelf and slopes	-	The development envelope and Eighty Mile Beach is not within the mapped distribution of the species (DSEWPaC 2013)	Very Low
Reef manta ray (*Mobula alfredi*)	-	Migratory	Generally associated with reef structures	-	There is no reef habitat within the development envelope	Very low
Giant manta ray (*Mobula birostris*)	-	Migratory	Generally oceanic but occasionally observed in sandy bottom or seagrass meadow areas	-	The species have no significant habitat association within the development envelope	Very low

1. Period of habitat use as referenced in text, – indicates there are no available data related to the species’ distribution or habitat association with Roebuck Bay or species occurs in the area but Roebuck Bay is not considered significant habitat for that species.

4.5.3.2 Marine Reptiles

Five species of turtles are known to occur in the Marine Park (BMT 2018a). Four of these species may breed or forage in the locality, but Eighty Mile Beach Marine Park is not considered a significant habitat for them (BMT 2018a) (Appendix 3).

The remaining turtle species, the flatback turtle, is endemic to northern Australian waters and the Marine Park is an important rookery for the species (Department of Conservation and Land Management 2009, DSEWPaC 2012), with peak nesting activity occurring between late-November and early December.

Unlike other turtle species, flatback turtles spend the majority of their lives in shallow water (<20 m), migrating long distances between feeding and breeding (Hale and Butcher 2009). The species occurs along the entire northwest coast, and Figure 4.3 shows mapping of local and regional occurrences.

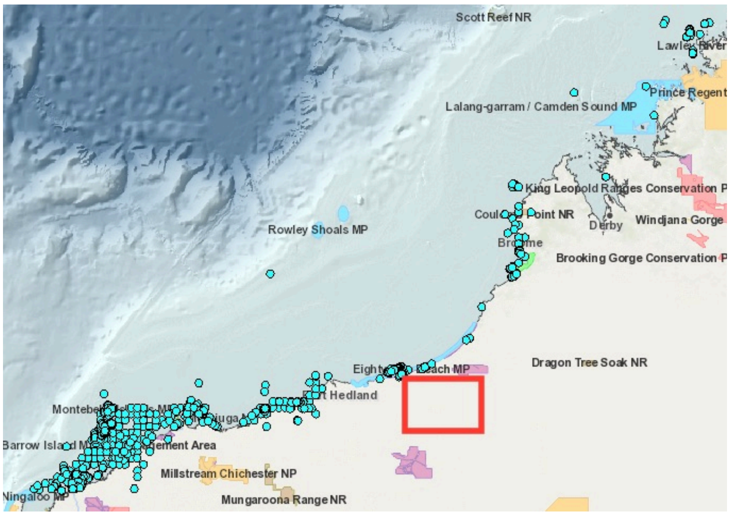

Figure 4.3: Wider distribution of flatback turtle in the region (blue circles) relative to the approximate location of the development envelope (red square) (source: NatureMap 2019).

The short-nosed sea snake (*Aipysurus apraefrontalis*) has a distribution that includes the locality of the development envelope, but it occurs primarily on reef flats or in shallow waters of the outer reef edges to depths of 10 m (DEWHA 2010a). As there is no reef habitat within the development envelope, the species would be unlikely to occur (Table 4.2).

4.5.3.3 Elasmobranch Fish

Four of the elasmobranch fish with habitat or breeding known to occur in the area are sawfish (BMT 2018a). The Eighty Mile Beach Marine Park is known to support green and dwarf sawfish breeding and represents suitable habitat for largetooth and narrow sawfish (DSEWPaC 2012, Department of Parks and Wildlife 2014). Sawfish tracking surveys by Stevens et al. (2008) indicated that sawfish prefer very shallow water over mudflats and sandbanks, often resting during slack tide when water movement is low. Net and gillnet fishing were identified as the main threat for both the freshwater and green sawfish, as the saw can become entangled in nets, and was banned in 2013[2].

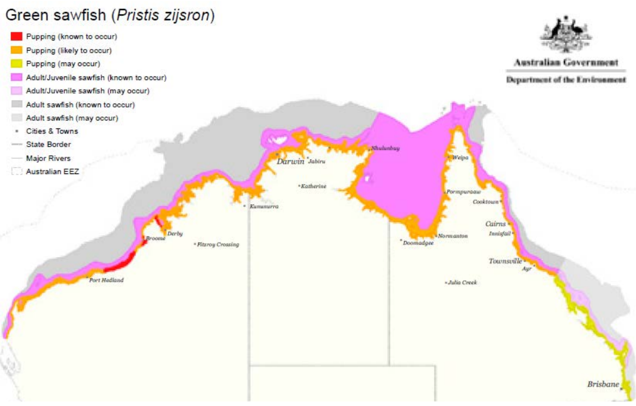

Figure 4.4: Australian distribution of green sawfish.

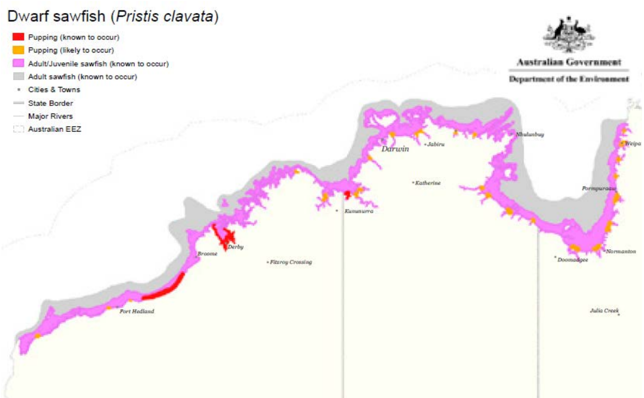

Figure 4.5: Australian distribution of dwarf sawfish.

[2] http://www.abc.net.au/local/stories/2013/11/05/3884584.htm

There are a number of sharks and rays that inhabit the nearshore waters of the Marine Park, including: whaler shark, pigeye shark, nervous shark, graceful shark, black-tip shark, spinner shark, hardnose shark, lemon shark, hammerhead sharks, stingrays and shovelnose rays (Department of Parks and Wildlife 2014). Commercial longline fishing was banned in 2005 to protect breeding stocks of sharks that use the shallow nearshore waters as a nursery (Department of Parks and Wildlife 2014). The listed white shark and whale shark would, however, be unlikely to occur within the development envelope (see (Table 4.2).

Manta rays range from Geraldton and through the Kimberley. They are commonly sighted along coastlines where regular upwelling occurs, around shallow reefs and in sandy bottom areas, and may occur within the Marine Park (BMT 2018a), but have a very low likelihood of occurrence within the development envelope (Table 4.2).

4.5.4 Potential Impacts

The proposal may result in potential impacts on marine fauna within State Waters during cable installation, maintenance, operation and decommissioning. Potential impacts may also arise during the construction phase of the project as a result of vessel movement during international shipping to deliver the turbine components that are manufactured overseas. Potential impacts on migratory shorebirds are addressed separately in Sections 4.7.4 and 7.3.3.

These potential impacts of relevance to the Marine Fauna factor may occur during the construction phase of the project as a result of:

- introduced marine species from vessel biofouling or ballast water;
- hydrocarbon spills and waste generation from cable installation and maintenance vessels;
- disturbance from vessel movements (collisions/noise), both in relation to international shipping for the project and cable installation vessels;
- direct disturbance of beach nesting areas for marine turtles; and
- behavior modification from artificial lighting on vessels (BMT 2018a) (Appendix 3).

The potential impacts of introduced marine species and hydrocarbon spills have been addressed earlier under the Marine Environmental Quality factor (Sections 4.4.5.2 and 4.4.5.3, respectively). Marine fauna disturbance from vessel movements and artificial lighting are addressed in Section 4.5.5 below.

During the operational phase of the proposal, the potential impacts relevant to the Marine Fauna factor arising from the operating HVDC cables themselves may involve:

- electromagnetic field (EMF) generation during cable operation; and
- heat dissipation during cable operation (BMT 2018a).

The extent to which all of the above potential impacts could affect the values for which the Eighty Mile Beach Marine Park was vested is addressed in Section 4.5.6.5, where marine fauna considerations above are consolidated with potential impacts on BCH and marine environmental quality values.

4.5.5 Assessment of Impacts

4.5.5.1 Marine Fauna Disturbance from Vessels

The marine fauna species that may potentially interact with the proposal are detailed in Section 4.5.3. Marine fauna may potentially be impacted by collisions with vessels, or entanglement with equipment and anchor lines during installation, decommissioning and any maintenance works. The potential impact could result in injury or fatality to individual animals but the loss of individual animals would not significantly impact regional populations (BMT 2018a) (Appendix 3).

All international shipping to deliver turbine components for the project from overseas will be via existing commercial ports on the Pilbara coast, with the most likely destinations being Port Hedland and Dampier. Components will then be trucked from the port to the development envelope (see Section 2.6.12.3). No international freight vessel movements will occur within the Eighty Mile Beach Marine Park as part of the proposal. As Port Hedland and Dampier are existing commercial ports with numerous daily heavy shipping movements, including through international shipping lanes further offshore, the delivery of components for the project will represent an incremental increase on existing vessel movements only, with no risk of new impacts on marine fauna in the Eighty Mile Beach Marine Park as a result of the proposal.

In comparison to activities such as seismic surveys, military activities and pile driving works, maximum sound pressure levels related to the installation and decommissioning of power cables are considered moderate to low (BMT 2018a). There are no clear indications that underwater noise impacts related to the installation, decommissioning and maintenance repair works of subsea cables pose a high risk of harming marine fauna (OSPAR Commission 2009). The risk of adverse impacts from noise are particularly low given significant marine fauna likely to occur within the area (i.e. turtles, cetaceans and sawfish) will have time to respond to the noise and the capability to avoid the local area (BMT 2018a) (Appendix 3).

Cable lay and trenching vessels move very slowly and those species or individuals that are naturally inquisitive and attracted to moving vessels (e.g. dolphins) will have time to leave the area in the event of a disturbance response. Trenching through the intertidal area of the cable corridor has potential to impact sawfish pupping activities but this will be mitigated by scheduling works outside of this season (Section 4.5.6.1).

In summary, cable installation, maintenance and decommissioning will be a small-scale, temporary disturbance relative to the range of the marine fauna that may potentially occur, and is unlikely to significantly affect regional populations. There will be no risk of marine fauna entanglement or entrainment with the cables once they are operational, as they will be buried 5-10 m below the seabed.

4.5.5.2 Direct Disturbance of Beach Nesting Areas

Eighty Mile Beach is a known nesting area for flatback turtle (Section 4.5.3.2) and a body hole nest site was located within the development envelope during the terrestrial fauna survey (Biota 2018a).

Trenching through the beach section of the cable corridor therefore has the potential to impact on nest success for the species. This can be readily mitigated however, by scheduling works to avoid the breeding season for the species (see Section 4.5.6.1).

4.5.5.3 Artificial Lighting

If artificial lighting is used during cable installation, decommissioning or maintenance works, it has the potential to disrupt the behaviour of light sensitive marine fauna (Peters and Verhoeven 1994, Biota 2008, EPA 2010). Since commissioning, decommissioning and any maintenance works will be temporary and localised in nature, marine fauna behavioural modification due to artificial lighting is not expected to be a significant environmental impact during cable works (Appendix 3).

4.5.5.4 Electromagnetic Field Generation During Cable Operation

EMFs consist of both magnetic and electric fields that many marine species can detect (BOEMRE 2011). Magnetic or electric senses have been recorded for a wide range of marine taxa including marine mammals, sea turtles, many groups of fishes (including elasmobranches) and groups of invertebrates (BOEMRE 2011) (BMT 2018a).

Functions supported by an electro or magnetic sense may include the detection of prey, predators, or conspecifics to assist with feeding, navigation, predator avoidance, and social or reproductive behaviours. These functions are at risk of interference if sensory capabilities overlap with cable EMF levels detectable by the organism (BMT 2018a) (Appendix 3).

Factors influencing the environmental impact of EMFs include:

- type of cable used and transmission system (monopolar or bipolar);
- depth of cable burial;
- distance between cables in bipolar configuration;
- strength of current passed through the cable;
- marine biota present along the cable route and their sensitivity to EMF (either magnetosensitivity or electrosensitivity); and
- ability of marine biota to avoid the EMF (BMT 2018a).

In general, HVDC cables produce stronger EMF than HVAC cables (OSPAR Commission 2009). In the case of monopolar HVDC systems, with a single power cable and return current via the ground, there can be a resultant direct electric field of 20 mV/cm, which is above the sensory detection thresholds for elasmobranchs (sharks and rays), and which may result in behavioural changes within a few metres of the cable; either repelling or attracting elasmobranchs (BOEMRE 2011, Sutton et al. 2016) (BMT 2018a).

In contrast, bipolar HVDC transmission systems should have no direct electric current path in seawater; rather a magnetic field will be produced, which induce a smaller electric field than the monopolar HVAC configuration (BOEMRE 2011). As the strength of both magnetic and electric fields rapidly declines as a function of distance from the cable, exposure of marine species to EMF can be eliminated by cable shielding and burial to adequate depths (OSPAR Commission 2009) (see Section 4.5.6).

The proponent will ensure that cable burial depth and shielding specifications are such that EMF will be negligible at the level of the seabed prior to cable installation, which will be verified once cable/s are operational (see Section 4.5.6.3). This will follow the mitigation hierarchy to eliminate the impact and means that further consideration of exposure and tolerance levels of various marine species is then not required.

4.5.5.5 Heat Dissipation During Cable Operation

Theoretical calculations of the heat dissipation of operational buried subsea power cables are consistent in their predictions of temperature rise of the surrounding environment (OSPAR Commission 2009). In addition to the direct effects on marine biota, heat dissipation leading to a temperature rise in the sediment may also alter the physico-chemical conditions and potentially increase bacterial activity (Meissner et al. 2006) (BMT 2018a).

Heat generation was considered a potential impact during the monopole HVDC Basslink subsea cable operation in Bass Strait, Australia (OSPAR Commission 2009). The external surface temperature of the subsea cable was calculated to reach 30–35ºC, and the seabed surface temperature directly overlying the cables was predicted to rise by a few degrees Celsius at a burial depth of 1.2 m (OSPAR Commission 2009).

However, given the tropical seawater temperatures in the region of the current proposal naturally range from warm to hot conditions of 23–32°C, heat dissipation in the small footprint affected by the proposal is unlikely to have any negative impacts, particularly with the cable burial that will be implemented for the project (BMT 2018a) (see Section 4.5.6).

4.5.5.6 Cumulative Impacts

EPA (2018c) requires the cumulative impact of the proposal on marine fauna to be considered in context with other existing or reasonably foreseeable activities and developments when considering the significance of impacts.

The marine component of the proposal is set in a nearshore location within a vested Marine Park, and there are therefore no notable existing impacts on the marine fauna of the immediate locality. There have been historical regional impacts on sawfish as a result of bycatch and fishing (commercial, recreation and cultural), which culminated in these practices being completely banned in 2013 as part of the multispecies recovery plan for sawfish and river sharks (Department of the Environment and Energy 2015). As this review has identified that all potential impact mechanisms will result in either no impact, or minor potential impact that can be readily mitigated or eliminated, there would be no significant impact to add to any context of historical impacts. There are therefore no significant cumulative impacts on marine fauna to be considered for the assessment.

4.5.5.7 Recovery Plans and Threat Abatement Plans

Of the marine fauna known from the development envelope (Section 4.5.3; Table 4.2), only two have recovery plans or threat abatement plans in place; the flatback turtle and the sawfish. These are not species-specific plans, but rather address recovery and threatening processes for all marine turtle, sawfish and river shark species.

The relevant threat abatement plans address fox predation (turtles only) and marine debris, which are effectively embodied in the recovery plan actions for marine turtles and sawfish (Department of the Environment and Energy 2015, 2017). Table 4.3 and Table 4.4 below summarises the key recovery plan actions and demonstrates that the proposal, taking due account of the predicted impacts and mitigation measures detailed in the preceding sections, is not inconsistent with them.

Table 4.3: Consistency of the proposal with marine turtle recovery plan actions.

Recovery Plan Actions	Proposal Consistency
A1 Maintain and improve efficacy of legal and management protection	Not inconsistent (No effect on legal protection)
A2 Adaptively manage turtle stocks to reduce risk and build resilience to climate change and variability	Not inconsistent (No bearing on management of turtle stocks)
A3 Reduce the impacts from marine debris	Not inconsistent (All potential marine waste will be managed during a short-term construction period)
A4 Minimise chemical and terrestrial discharge	Not inconsistent (All potential marine waste will be managed during a short-term construction period)
A5 Address international take within and outside Australia's jurisdiction	Not inconsistent (No relevance to the proposal)
A6 Reduce impacts from terrestrial predation	Not inconsistent (No risk that the proposal will increase terrestrial predation)
A7 Reduce international and domestic fisheries bycatch	Not inconsistent (No relevance to the proposal)
A8 Minimise light pollution	Not inconsistent (All potential light impacts be managed during a short-term construction period)
A9 Address the impacts of coastal development/infrastructure and dredging and trawling	Not inconsistent (No coastal infrastructure, dredging or trawling; cable to be installed outside nesting period)
A10 Maintain and improve sustainable Indigenous management of marine turtles	Not inconsistent (No relevance to the proposal)

There are 10 actions identified in the sawfish and river shark recovery plan but only the four components of Action 5, which addresses the recovery plan objective of *"…to reduce and, where possible, eliminate adverse impacts of habitat degradation and modification on sawfish and river shark species")* (Department of the Environment and Energy 2015), are relevant to assessing the consistency of this proposal with the recovery plan (Table 4.4).

Table 4.4: Consistency of the proposal with sawfish recovery plan actions.

Recovery Plan Actions	Proposal Consistency
5a. Ensure all future developments will not significantly impact upon sawfish and river shark habitats critical to the survival of the species or impede upon the migration of individual sawfish or river sharks.	Not inconsistent (No BCH of significance and only temporary disturbance to <0.01% of sand and mudflat within Marine Park; cable specifications to ensure modelled EMF is negligible prior to installation)
5b. Determine the effect of river and estuarine barriers on the movements of sawfish and river sharks and undertake an audit of barriers to establish whether removal or modification is feasible to allow for the riverine migration of sawfish and river sharks.	Not inconsistent (No river or estuarine barriers associated with the proposal)
5c. Identify risks to important sawfish and river shark habitat and measures needed to reduce those risks.	Not inconsistent (No BCH of significance and only temporary disturbance to <0.01% of sand and mudflat within Marine Park; cable specifications to ensure modelled EMF is negligible prior to installation)
5d. Implement measures to reduce adverse impacts of habitat degradation and/or modification.	Not inconsistent (No BCH of significance and only temporary disturbance to <0.01% of sand and mudflat within Marine Park)

4.5.6 Mitigation

Mitigation measures for the potential impacts of the proposal on marine fauna relating to hydrocarbon spills and introduced marine species are detailed in Sections 4.4.6.1 and 4.4.6.3, respectively. Mitigation measures for the remaining four potential impact mechanisms on marine fauna have followed the Western Australian mitigation hierarchy (Avoid, Minimise, Rehabilitate, Offset (Government of Western Australia 2011)), as detailed in Sections 4.5.6.1 to 4.5.6.4 below, and will be incorporated into the CEMP (Appendix 1).

4.5.6.1 Marine Fauna Disturbance from Vessels and Cable Trenching

Flatback turtles and sawfish are amongst the marine fauna most at risk from the cable works component of the proposal, given their use of shallow and intertidal environments of Eighty Mile Beach for foraging and nesting/pupping (Section 4.5.3.2). The mitigation hierarchy will be observed in respect of this, with all cable works scheduled to avoid peak turtle nesting and hatchling emergence periods and sawfish pupping periods. The CEMP will specify that installation, maintenance and decommissioning of cables will only occur during the period April to July (Appendix 1).

The overall risk of marine fauna disturbance from cable laying vessels is low (Section 4.5.5.1), but marine fauna observation and avoidance management measures will still be implemented as part of the CEMP to ensure vessel strikes or entanglement of marine fauna are avoided.

4.5.6.2 Artificial Lighting

The primary mitigation of behavioural impacts will be through avoidance, both by staging cable works to avoid peak turtle nesting and hatchling emergence periods (Section 4.4.6.1), the marine fauna at most risk of exposure to this impact, and by managing cable works such that they are preferentially conducted during daylight hours.

In the event that work is required after sunset, the potential impact of artificial lighting can be mitigated through the implementation of appropriate management systems to ensure there is no unnecessary external lighting and that light spill is minimised. These measures will be specified in the project CEMP (Appendix 3).

4.5.6.3 Electromagnetic Field Generation During Cable Operation

The principal mitigation for potential impact of EMF on marine fauna follows the mitigation hierarchy, with avoidance through burial of the cable to a depth of 5-10 m below the seabed.

In addition, the proponent will define cable specifications and ensure that modelled EMF is negligible prior to installation, to further mitigate potential EMF impacts on marine fauna. The CEMP for the project will include post-installation verification of the effectiveness of these mitigation measures on EMF generation at and above the seabed level. More detail on the HDVC cable specification in nearshore waters is provided in Appendix 4. That sets out the multiple layers of screening, insulation, metallic and polyethylene sheaths, galvanized steel and bitumen that are layered consecutively around the conductor core to provide protection, insulation and shielding (see Appendix 4). Considering this, and that the cable will be buried 5-10 m below the seabed, the predictions are that EMF at the surface of the seabed will be negligible. Given this effective mitigation, no further evaluation of species potential sensitivity to EMF is necessary in this review.

4.5.6.4 Heat Dissipation During Cable Operation

The principal mitigation for potential impact of heat generation on marine fauna also follows the mitigation hierarchy, with avoidance through burial of the cable to a depth of 5-10 m below the seabed. Post-installation verification to confirm no elevated temperatures beyond the already warm natural water conditions at and above the seabed level will again be part of the CEMP (Appendix 3).

4.5.6.5 Impacts on the Values of the Eighty Mile Beach Marine Park

The then Department of Parks and Wildlife identified a series of cultural and ecological values for which Eighty Mile Beach Marine Park is managed (Department of Parks and Wildlife 2014). In assessing the potential impacts of the proposal on these values, this review has followed the approach of BMT (2018a) in aligning the preliminary key environmental factors with the equivalent Marine Park cultural and ecological values (Appendix 3).

Table 4.5 sets out this framework, summarising the values and the assessment of potential impacts of the proposal. The summary review of impacts, which relates the Marine Park values to the earlier assessments detailed in Sections 4.3 to 4.5, shows that there will be either no significant impact or no impact at all on the Marine Park values (Table 4.5).

Table 4.5: Preliminary key environmental factors for the assessment and equivalent management values for the Eighty Mile Beach Marine Park (BMT 2018a).

Factor	Equivalent Marine Park Cultural and Ecological Values	Assessment	ERD Reference
Benthic Communities and Habitat	Intertidal sand and mudflat communities	• No BCH of significance and only temporary disturbance to <0.01% of sand and mudflat habitat within Marine Park ⇒ No significant impact on value	Section 4.3.5
	Subtidal filter-feeding communities	• None present • No impact on value	Section 4.3.3.2
	Macroalgal and seagrass communities	• None present ⇒ No impact on value	Section 4.3.3.2
	Coral reef communities	• None present ⇒ No impact on value	Section 4.3.3.2
	Mangrove communities and saltmarshes	• None present ⇒ No impact on value	Section 4.3.3.2
Marine Environmental Quality	Water and sediment quality	• Negligible risk of contamination arising from seabed disturbance • No Chlorine formation • Mitigation measures to address hydrocarbon spills, cable deterioration and introduced marine species ⇒ No significant impact on value	Section 4.4.5 Section 4.4.6
Marine Fauna	Waterbirds, including migratory species	• Mitigation measures to eliminate direct impacts during main migration season • Inland components of the proposal unlikely to significantly impact migratory birds ⇒ No impact on value	Section 4.7.4 Section 7.3.3
	Marine turtles and marine mammals	• Mitigation measures to address vessel collision and cable entanglement risks • Mitigation measures to eliminate direct and indirect impacts on turtle breeding ⇒ No significant impact on value	Section 4.5.5.1 Section 4.5.5.2 Section 4.5.6.2
	Invertebrates	• Exposure to EMF reduced to negligible levels through cable shielding and burial ⇒ No impact on value	Section 4.5.5.4
	Scalefish, sharks and rays	• Mitigation measures to eliminate direct and indirect impacts on sawfish pupping • Exposure to EMF reduced to negligible levels through cable shielding and burial ⇒ No impact on value	Section 4.5.5.1 Section 4.5.5.4

Note that four other Marine Park values, namely Aboriginal culture and heritage, European heritage, Remote seascapes and Nature-based tourism (Department of Parks and Wildlife 2014), relate to the Social Surroundings factor and are therefore addressed in Section 4.8.6.

4.5.7 Predicted Outcome

With the implementation of the mitigation hierarchy in respect of direct disturbance to marine turtles, and EMF and heat dissipation from the cable through avoidance of these potential impacts by burying the cable, the residual risk of these mechanisms presenting any significant impacts to marine fauna is low.

The remaining two potential impacts:

- marine fauna disturbance from vessels during cable works; and
- behavioural modifications in marine fauna due to artificial lighting during cable works,

are also at low risk of significant impact on marine fauna, but will still be managed through well-established and understood mitigation measures as part of the CEMP, such that the residual risk of any significant impacts is again low.

EPA (2018c) sets out eight criteria that may be considered where relevant to determining the significances of predicted impacts.

Those that are relevant to marine fauna, and a summary assessment of the key findings from the preceding sections, comprise:

a. *values, sensitivity and quality of the environment which is likely to be impacted* – potential foraging areas for marine turtles and nesting on beach habitats; foraging habitat for migratory shorebirds when present in Australia; possible habitat for other marine species of conservation significance;
b. *extent (intensity, duration, magnitude and geographic footprint) of the likely impacts* – very localised and short-term disturbance that will be timed to avoid critical breeding and foraging periods for marine turtles and migratory shorebirds respectively, and will only affect an insignificant proportion of habitat in the surrounding Marine Park;
c. *consequence of the likely impacts (or change)* – negligible impact on marine fauna values and local and regional population scales;
d. *resilience of the environment to cope with the impacts or change* – impacts are set in a highly dynamic offshore environment and potentially have only very localized and short-term effects on marine species which mostly have very large areas of occupancy at population level;
e. *cumulative impact with other existing or reasonably foreseeable activities, developments and land uses* – no significant existing impacts or relevant land uses, meaning that cumulative impacts can effectively be discounted;
f. *connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment* – unlikely to have any influence on broader ecological processes or values;
g. *level of confidence in the prediction of impacts and the success of proposed mitigation* – very high, being based on reliable existing data on marine fauna and well-demonstrated management measures; and
h. *public interest about the likely effect of the proposal or scheme, if implemented, on the environment and public information that informs the EPA's assessment* – may be some public interest, given location within the Marine Park, but submissions on the initial referral were few and none specifically mentioned marine fauna.

Given the above, the EPA's objective for the Marine Fauna factor can be met.