

Site Characteristics and Issues Matrix

Site Name Packer Island

Terrestrial Biophysical Attributes		Extent and Condition			Level of Confidence	Potential for Significant Risk / Hazard and Impact of Development at this Site
Rainfall: 769 mm (Cape Leveque)		Extent Extent in the local area and regional context. Coastal area extent may be described as either alongshore and cross-shore length. Non-coastal extent could include; highly restricted to landform or habitat, locally common but regionally restricted, or widespread	Key Coastal and Ecological Processes Key coastal processes are defined by NCCOE (2004) and should be interpreted in the context of coastal landform description. Ecological processes relate to terrestrial ecology	Site Condition / Disturbance Factors Includes factors such as weed cover, apparent erosion (on ground or visible in aerial photography), excessive fire frequency	High: from site visit /survey, good map based knowledge, Medium: inferred from other good information sets, Low: limited information.	
Geological Province	Site Geology, Substrate Characteristics & Diversity	Extent in local area and region	Key Coastal / Ecological Processes	Site Condition / Disturbance Factors		Altered Drainage and Stormwater Management H: Site area or substrate restricts effective on site management of storm water, erosion, potential pollution issues M: Site size and / or substrate allows for some retention of stormwater L: Site size and substrate allows for retention and managed discharge of stormwater.
Canning Basin Sandplains	Pindan Red Earths	Widespread and dominant surface on the Dampier Peninsula	Limited coastal exposure on site.		High	M: Pindan allows some infiltration but careful erosion management is important
Coastal Deposits	Holocene coastal dunes	Prominent locally and one of the common coastal surface types in the region	Cyclonic winds, waves and storm surge. Extensive un-vegetated and vegetated dunes		High	H: Mobile dunes
	Tidal flat and mangrove swamp	Prominent locally and one of the common coastal surface types in the region	Cyclonic events and storm surge. Significant marine and terrestrial habitat significance		High	H Significant ecological community
	Supratidal mud flat	Significant local feature and common coastal surface in region	Cyclonic events and storm surge.		High	H: Significant ecological community
	<i>Bossut Formation</i> Calcareous and Quartzose Sandstone: Coastal	Localised to Packer Island and Chile Head and few other coastal locations in the region.	Karst solution and erosional feature. Barrier that provides sheltered conditions that support mangrove forests and creeks. Tombolo formed behind the barrier.		High	H: Packer Island is the best developed example of a restricted environment in the region.
Site Diversity/ Extent	Total Five substrate types- moderate diversity.	4 common, 1 localised occurrence. Hub site on regionally widespread surface but crosses restricted surface.				H: Diverse and sensitive coastal environments dominate the area around the hub site
Coastal Geomorphology, Geomorphological Processes & Landform Stability		Extent in local area and region	Key Coastal / Ecological Processes	Site Condition / Disturbance Factors	Level of Confidence	Potential for Coastal impacts from altered coastal wave / energy regime, or concentrated stormwater flows H: Low lying topography; Proximity to tidal creeks; Cheniers, Tombolos, narrow barrier dunes & associated extensive wetlands; Extensive mudflats; considerable longshore sand drift regime with significant potential for impact M: Moderately elevated topography (to 10 m); Sandy & silty beaches limited longshore sand movement; Moderate to wide barrier dunes and wetlands; Erodable or eroding cliff. L: Elevated topography (>10m); rocky coast and landward

					landform with little evidence of recent erosion; low longshore sediment drift
<p>Coastal Geomorphology, Geomorphological Processes & Landform Stability</p> <p>General Description</p>	<p>Extent in local area and region</p> <p>Shag Rocks, Packer Island and Chile Head apparently are emergent parts of a narrow, 0.5km wide rock outcrop, extending SW to NE across the site.</p> <p>Sheltered embayments with sandy beaches and dunes have formed landward of the submarine sections of the outcrop, and tidal creeks are located in the lee of headlands.</p> <p>The 20 metre depth contour is within 3 km of the ocean shore along Packer Island and is approximately parallel to the coast.</p>	<p>Key Coastal / Ecological Processes</p> <p>Along Packer Island and Chile Head the exposed coast is rocky, with the geology ranging from a weathered calcarenite to hard quartzite sandstone close to sea level. As throughout the Kimberley, the geological structure of the site provides the framework in which the coastal morphology has developed.</p> <p>Sandy beaches, tidal creeks, mangal and vegetated mudflats are exposed to sea level fluctuations, high water levels and seas associated with onshore winds, particularly those generated by tropical cyclones. Primary processes are of high importance on the open coast and within embayments. The processes include:</p> <ol style="list-style-type: none"> 1. Mean Sea Level changes 2. Ocean Currents 3. Ocean Temperature 4. Wind Climate 5. Wave Climate 6. Rainfall & Runoff 	<p>Site Condition / Disturbance Factors</p> <p>Secondary processes include the variables causing local disturbance and include:</p> <ol style="list-style-type: none"> 1. Local sea level 2. Local currents 3. Local winds 4. Groundwater 5. Coastal flooding 6. Sediment transport 7. Tidal creek hydraulics 8. Coastal water quality 9. Ecology of mangals and mudflats <p>Overtopping of Packer Island by storm surge and wave action during extreme weather events, possibly coincidentally with spring high tides.</p> <p>Reworking of sediments occurs within the Lombardine Point embayment, especially amongst the shallow sand flats, deeper waters of the embayment, its beaches and tidal creeks.</p> <p>Erosion of the Packer Island tombolo may be occurring in response to encroachment of tidal creeks from the SW and NE. Water surrounds the island during spring high tides.</p>	<p>Level of Confidence M to H: based on field survey in fine weather and interpretation of aerial photography</p>	<p>H: This is a complex location with high potential for coastal impacts arising from modification of the geological structure. Much of the location is low lying topography affected by or close to tidal creeks. The two tombolos of the location tied to fixed geological structures and major changes in the shoreline would result from their destabilisation. There are extensive wetlands and mangals as well as sand flats held in place by a rock bar; any modification of the bar by excavation for a channel or anchorage would have very significant potential for impact</p>
<p>Inshore features</p> <p>(a) Ebb-tide deltas</p>	<p>There are three ebb-tide deltas in this location: Chile Creek, two creeks commonly debouching onto the sand flats south of Lombardine Point and Gilbut Creek at the southern end of Packer Island.</p>	<p>Tropical cyclones, monsoonal activity, sea level fluctuations and storm surge</p>	<p>Chile Creek – tidal processes and sea level fluctuations, including storm surge, inundate mudflats.</p> <p>The complex Lombardine Point delta is subject to tidal processes and sea level fluctuations.</p> <p>Gilbut Creek drains a significant vine thicket. Groundwater processes as well as surface drainage interact with tidal and sea level fluctuations.</p> <p>The ebb-tide deltas play significant roles in the circulation of sediment between the upper tidal reaches of the creeks and the inshore waters. Offshore movement of sediment is anticipated during inter annual phases of sea level rise and/or extreme meteorological events.</p> <p>The projected future rise in sea level (CSIRO 2007) may cause salt water intrusion through Gilbut Creek.</p>		<p>H: Changes to the delta are subject to all coastal processes in the area</p>
<p>(b) Sandy beaches & sand flats</p>	<p>Embayments are located between Cape Borda and Packer</p>	<p>Tropical cyclones, monsoonal activity, sea level fluctuations and</p>	<p>Key processes include recirculation of sediments within the semi-</p>		<p>L: There is potential for long-term changes in the embayments as a result of projected rise in sea level but in the immediate future(10</p>

	Island; Packer island and Chile Head; and Chile Head and Thomas Bay) north of Chile Head).	storm surge	enclosed embayments by tidal currents, as well as wind driven water circulation and wave action during extreme meteorological events. Long-term (>decadal) changes in water depth over the offshore reefs and/or changes to the structure of the offshore would affect the shore.		to 20 years) this would appear to be limited given the effect of a macro-tidal range and intermittent storm surge events.
Rocky shores					
(a) Stable cliffs - sandstone (b) Stable cliffs - limestone	An extensive, approximately 18km long and 500m wide, limestone and sandstone barrier formation comprises Packer Island. Both the seaward and landward sides of the island are cliffed.	Tropical cyclones, monsoonal activity, sea level fluctuations and storm surge	Storm surge associated with fluctuations in sea level, and oceanographic changes associated with extreme meteorological conditions and wave run-up overwash the barrier at elevations less than 10 m. Recently formed surge overwash channels and fans are present on the northern and southern parts of Packer Island. A structurally controlled tidal channel abuts the rock platform on the inland side of the island. This may not affect the cliff or rock platform but would be associated with sediment movement on the sand flats.		H: In areas where the rocky barrier is overtopped by storm surge.
Rocky headlands					
Rocky headlands (c) Localised outcrops - platform	Packer Island and Chile Head – the rocky headland north of Packer Island has several erosion al benches which may be related to Pleistocene changes in sea level.	Tropical cyclones, monsoonal activity, sea level fluctuations and storm surge	Sea level fluctuations are likely to affect the stability of the tombolo and sand spits at the mouth of the tidal creeks, including Lombardine Creek and Chile Creek behind the barrier formations and stability of the coast between them. Packer Island & Chile Head are structures supporting formation of tombolos, control the location of Lombardine Creek and Chile Creek, influence the function of the local sediment cells and provide sheltered marine conditions supporting mangrove creeks and mudflats Tombolos (sand spit) have formed behind Packer Island and Chile Head to the North. At Packer Island the tombolo connects the island with the Pindan soils of the mainland proper. The sand flats behind the northern end of Packer Island are supported by a rock bar.		H: Tombolos are unstable coastal landforms potentially subject to sudden significant change through cyclonic forcing, or sea level fluctuation. There is a high volume of sediment circulating in the embayment between Packer Island and Chile Head, any facility constructed in this bay would suffer from significant sand infill and maintenance dredging. The projected rise in sea level would likely result in significant coastal landform movement.
Dunes & Beach Ridges Barrier dune ridge & vine thicket	Dominant landform on N and S facing coasts of Packer Island	Tropical cyclones and monsoonal activity	Washover and storm surge, extensive aeolian reworking of mobile sand		H: large mobile dunes, unstable with potential for significant movement of substantial volumes of sand and coastline.

(a) Mobile dunes	tombolo and adjacent bays		dunes during extreme onshore wind events.		
(b) Vegetated dunes	Present inland of mobile dunes	Groundwater recharge	Landward migration of the active dunes and potential salt water intrusion under projected rise in sea level.		M/H: Related to migration of active dunes
Cheniers					
(a) Lithified – perched beach	See Above (Rocky headlands)				
Mud Flats & Tidal Creeks					
(c) Tidal creek – vegetated tributaries	Two tidal creeks have formed on the landward of the Packer Island tombolo; Chile Creek and Gilbut Creek are also tidal creeks.	Tropical cyclones, monsoonal activity and storm surge	Cyclonic activity and storm surge, as well as sea level fluctuations affect the upper, tidal reaches of the tributaries. Creeks landward of Packer Island are interconnected on high tides and storm surge. Gilbut Creek has tributaries rising in the vine thicket. Flow from the creek has formed a small delta on the supratidal mud flats.		H: Tidal / Storm surge interconnection, fragile tombolo landform
Site Diversity Four coastal landform units on site.	Moderately Diverse – one relatively restricted occurrence regionally.				M
Diversity of Vegetation Communities - on site and regional context	Extent in local area and region	Key Coastal / Ecological Processes	Site Condition / Disturbance Factors	Level of Confidence	Potential for Significant Impacts from Site Clearing H: Conservation Significant communities, high physical / biological diversity, or restricted community/s. M: Moderate physical / biological diversity. L: Low diversity, communities widespread regionally
Coastal Vegetation Communities					
Foredune vegetation	Present, but dunes associated with the site are predominantly bare mobile sand				H
Supratidal Flats					
(a) Samphire (b) Saltwater couch (c) Bare surface-algal crust	Present	Nutrient cycling	Excellent limited localised disturbance from vehicle tracks	H	M
Mangrove –					
(a) closed forest,	Present and well developed	Important terrestrial and marine fauna habitat. Nursery and nutrient cycling.	Excellent		H: significant community ecologically important and restricted
Rocky coast community	Present-Packer Island				H regionally restricted environment
Wetland Vegetation Communities					
Wetland vegetation					
(a) Seasonal	Present, drainage area fringing supratidal flat east of hub site	Stands of <i>Melaleuca alsophila</i>			M
Stream Riparian vegetation					
(a) Seasonal Stream	Present – minor drainage line east of hub site	Drains to Supratidal flat and mangrove creek			M: Careful management of stormwater would be required
Upland Vegetation Communities					
(c) Upland on Pindan surfaces	Present and dominant on non-coastal lands on site				
High rainfall Pindan Open Eucalyptus dominated woodland / forest	Present dominant and characteristic of pindan soil surfaces	This vegetation is the high rainfall version of the widespread pindan vegetation/environment. It is not represented in any conservation reserves and is relatively	Generally very good, fire frequency the major disturbance factor, limited localised disturbance associated with vehicle tracks, no history of pastoral use.	H	M

		restricted in extent by the limited area of northern end of Dampier Peninsula			
Vine Thicket/Rainforest TEC in Dune Swale	Vine thicket TEC present minor adjacent the site.	Located in areas where drainage is impeded by coastal dunes and/or supplied with moisture stored in dunes.	Excellent condition, Disturbance factors fire, potential weed invasion	H	H: Very extensive significant rainforest patch south of the site, one of the largest and best developed on Dampier Peninsula
Site Diversity Diverse vegetation communities	Diverse – 8 vegetation communities present on or adjacent to the potential Hub site.			H	H
Threatened, Priority, Significant Flora (Population) (Species/status)	Extent in local area and region	Key Coastal / Ecological Processes	Site Condition / Disturbance Factors	Level of Confidence	Potential for Significant Impacts from Site Clearing H: Threatened species recorded, High quality/extensive suitable habitat for threatened species, high physical / biological diversity, or restricted community. M: Limited representation of restricted habitat type/s, or habitats suitable for priority/significant species, moderate physical / biological diversity. L: Low habitat diversity, Habitats widespread regionally, limited potential to support threatened/priority or other significant species.
DRF (Wildlife Conservation Act) / Endangered (EN)/Vulnerable (VU) EPBC Act Species/Habitat	None recorded			M	L
Priority flora	3 priority species- <i>Pterocaulon sp.</i> A Kimberley Flora (B.J. Carter 599) (P2), on coastal limestone, <i>Gomphrena pusilla</i> (P2) - recorded in the Dampier Peninsula (including islands) on limestone and coastal dunes, and <i>Glycine pindanica</i> (P1) occurs on Pindan soils.			M-H Dry season survey only	M
Other significant flora. (eg Unnamed species, Range end/outlying populations)	7 species are known, or likely to be, range extensions. 4 species have unusual forms and 1 of these may be of regional significance			M-H Dry season survey only	M
Habitat specialist restricted taxa, restricted habits	None recorded			M	L
Threatened, Priority, Significant Fauna Population or Habitat (Species / status)	Extent in local area and region	Key Coastal / Ecological Processes	Site Condition / Disturbance Factors	Level of Confidence	Potential for Significant Impacts from Site Clearing H: Threatened (Rare) species recorded, High quality/extensive suitable habitat for Threatened species, high physical / biological diversity, or restricted community. M: Limited representation of restricted habitat type/s, or habitats suitable for threatened/priority species, moderate physical / biological diversity. L: Low habitat diversity, Habitats widespread regionally, limited value as habitat for threatened/priority or other significant species.
Threatened (Rare) Wildlife Conservation Act / Endangered (EN), or Vulnerable (VU) EPBC Act Species / Habitat (ie Turtle nesting beach)	Records of <i>Erythrura gouldiae</i> (Gouldian Finch) EN near this location. The species is widely distributed but in savannah woodlands with suitable habitat, but populations are declining across its range.			M	M
Priority listed sp / habitat	<i>Burhinus grallarius</i> (Bush			H	M

	Stone-curlew) P4 – wide ranging species, <i>Ardeotis australis</i> (Australian Bustard) P4 - widely distributed in savannah woodlands with suitable habitat, <i>Mormopterus loriae</i> (Western Little Free-tailed Bat) P1 mangrove specialist coastal margins of Pilbara, SW Kimberley and Northern Territory, both <i>Lerista separanda</i> (burrowing skink) P2 and <i>Simoselaps minimus</i> (Dampierland Burrowing Snake) P2 - are associated with sandy substrates /leaf litter which is widely distributed on the Dampier Peninsula.				
Ramsar/JAMBA/CAMBA/ROKAMBA Migratory sp /	50 migratory bird species recorded	Provides significant seasonal habitat but small scale in region		H	L-M
Other significant fauna. (eg Unnamed species, Range end/outlying populations, species with declining range	<i>Diporiphora pindan</i> (Pindan dragon) – on low grassy woodlands semi arid acacia scrub on Pindan soils SW Kimberley and Great Sandy Desert, <i>Ctenotus colletti</i> (Collett's Ctenotus Skink) – semi arid acacia scrub on Pindan soils in SW Kimberley			H	L
Potential habitat for Short Range Endemic inc subterranean fauna	Extent in local area and region	Key Coastal / Ecological Processes	Site Condition / Disturbance Factors	Level of Confidence	Potential for Significant Impacts from Site Clearing H: Restricted habitat with high potential for short range endemic species, or restricted community/s or restricted environment with substrate characteristics (high porosity, connectivity and high humidity/moisture) favourable for subterranean fauna M: Moderately restricted habitat with some potential for short range endemic species, or environment with substrate characteristics (high porosity, connectivity and high humidity/moisture) potentially favourable for subterranean fauna. L: Common substrates and communities regionally widespread, without substrate characteristics normally favourable for subterranean fauna
Site environment likely to support restricted habit specialist fauna, SRE fauna Substrate/habitat potential suitability for subterranean fauna, (ie fractured rock, karst environment, springs etc)	Packer Island has a restricted calcareous sandstone geology with evidence of karst solution, has potential to support SRE and subterranean fauna. Vine thickets have potential to support SRE		Excellent condition	H	M-H restricted limestone and vine thicket environments that are recognised elsewhere in the Kimberley for supporting SRE.
Visual Landscape Significance	Visual landscape Significance Assessment			Level of Confidence	Potential significance of Landscape Impacts from development of the site
Landscape character of hub site and broader context	<i>Landscape Region:</i> The Kimberley <i>Character Type:</i> Dampier Tableland <i>Landscape context:</i> The Packer Island node is located within a broad-scale landscape with a landform of gently undulating sand plains with closely spaced linear dunes and dramatic coastal features. Vegetation			H	High <i>Suitability rating:</i> Low <i>Absorption Capability:</i> Low to Moderate

	<p>cover is open woodland with pindan thickets and hummock grass understorey common to the Dampier Peninsula. Numerous creeks dissect the peninsula and mangroves, bays, mud-flats, swamps and sandy beaches occur along the coastline. Grazing has occurred on pastoral leases with evident signs of pastoral/residential infrastructure – roads, fences, out-camps and yards. There are residential communities, localised evidence of mining and exploration and public recreation use in this sub-type.</p> <p>View character of this development node: The landscape is characterised by dramatic coastal dune ridge with rocky outcroppings and erosion/cliffs transitioning to a narrow rocky beach strand. Vegetation cover is sparse with grasses and low shrubs dominant on the island ridge. A zone of unusual and distinctive surface features (perhaps petrified mangal) is locally significant. The diversity of water-forms, mangrove, mud flats and low-lying adjacent savannah woodland east of the Island is exceptional.</p> <p>Absorption capability: Low to moderate, due to the diversity of visual landscape elements, height of coastal fore-dune (island) landform and complex patterns of land cover, the landscape could absorb low levels of industrial infrastructure, but would be overwhelmed by a project the size and scale of the proposed industrial hub.</p> <p>Landscape character significance rating: High coastal, moderate inland.</p> <p>Comments: Packer Island, adjacent wetlands, coastal dunes and part of the inland woodland are a landscape of unusual cultural significance and visual significance due to diversity of landform, vegetation and water features.</p>			<p>Analysis (+ positive and - negative):</p> <ul style="list-style-type: none"> - high level of visual landscape significance - proximity to marine tour boat routes - proximity to dispersed coastal campsites - established user patterns - low to moderate visual absorption capability - cultural landscape of significance
Degree of evident alteration or change from the 'naturally established' landscape character based on levels of 'naturalness'	<p>Degree of evident change from naturally established character: Low on the coast, moderate inland; tracks and outcamps are evidence of human activity as viewed from some observation positions, some roads are visible from the Island landform.</p> <p>Naturalness rating: High</p>	H		
Degree and sensitivity of views and seen areas from travel routes and use areas (duration, frequency, position in landscape, number of viewers, distance)	<p>Viewer positions: Relatively small number of very sensitive visitors on tour and cruise boats - often with a special focus on scenic assets and expert interpretation of bio-physical and landscape values and features. A residential outcamp is located within the development node. The Cape Leveque Road and Lombadina community are approximately 6-10km to the east and northeast respectively, views are currently filtered by woodland vegetation.</p> <p>Distance zone: Foreground, middleground and background</p> <p>Duration of view: Variable from marine positions but long duration views provided by some operators while in transit near the shoreline.</p> <p>Viewer position: Generally level, but can be below as one approaches the shoreline of the Island.</p> <p>Sensitivity Level: Level 1 from Lombadina, the highway and marine routes - seasonally variable.</p> <p>Implications: Development in this landscape would become visually dominant as viewed from a number of established marine and terrestrial view points and travel routes and alter a highly valued and significant landscape. Height of the island dune ridge would help reduce but not eliminate negative visual impacts resulting from development. Development would severely impact on the landscape of extraordinary significance due to its sense of remoteness, naturalness, ruggedness and natural diversity, most notably along the coastline. Development would be dominant as viewed by passing pleasure/tour craft, and would potentially be seen in the foreground from minor tracks servicing out-camps and small Aboriginal settlements.</p>	H		
Special features and focal points within view of the hub site	Packer Island, Shag Rocks and Lombardina Point, Chile Head, Cape Leveque, numerous creeks and inlets.	H		
Remote Area - Quarantine Risks / Hazards from Construction / Operation of development Introducing new species	Site Context	Site Condition and Disturbance Factors	Level of Confidence	Quarantine - Potential Hazard from Introduction of New Species H: Island, or remote mainland area currently largely free of introduced species and distant from most human vectors M: Site has few weeds and limited vehicle access. L: Site some development / existing vehicle access / weeds are common and a stock grazing history
Relative quarantine risk from developing/operating Hub at the location	Site is close to Lombardina but has limited track access	Site has weed problems	H	L:
Remote area – potential for future development of Land-based transport or Infrastructure links.			Level of Confidence	Potential for major impacts from off site transport / infrastructure links H: Remote mainland area currently distant from most human vectors M: Mainland area currently not serviced by main road access.

				L: Island with no potential for off site impacts. or mainland location close to major roads with existing vehicle access.
Degree of impact from potential future land-based transport or infrastructure links	Mainland area close to existing settlement (Lombardina) and established road access.		H	L:
Existing or proposed conservation reserve (inc marine) or Indigenous Protected Area			Level of Confidence	Conservation Reserve Status H: Existing reserve M: Recommended Reserve L: No reserve proposed
Existing / Proposed Conservation reserve	EPA/ CALM recommended Cape Borda Nature Reserve		H	M:
Existing / Proposed Marine Reserve	Wilson report recommended reservation of one of the V Shaped Bays on Dampier Peninsula Pender Bay or Beagle Bay.			M :
Existing / Proposed Indigenous Protected Area	No Indigenous reserve proposed.			L:

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