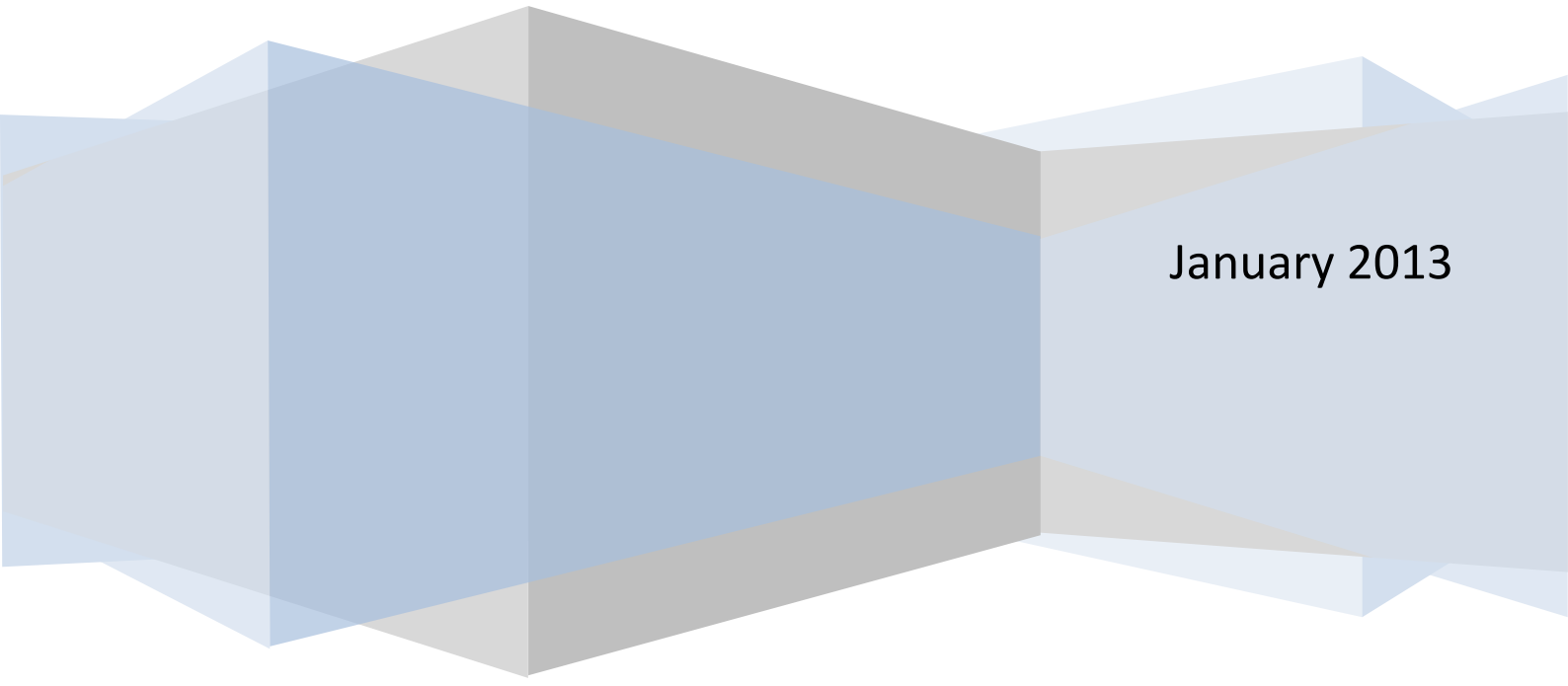
LeProvost Environmental Pty Ltd

PRELIMINARY BPPH LOSS ASSESSMENT

BARGE LOADING FACILITY near WEST MOORE ISLAND

for

Forge Resources Pty Ltd



January 2013

FORGE RESOURCES BALLA BALLA PROJECT

Preliminary Benthic Primary Producer Habitat Loss Assessment

Table of Contents

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1.0 Introduction

1.1 Purpose of this document

The purpose of this document is to present a preliminary Benthic Primary Producer Habitat (BPPH) Loss Assessment in accordance with guidance provided in the WA Environmental Protection Authority's (EPA) Environmental Assessment Guideline No3 (EAG 3) for a proposed barge loading export facility to be constructed on the Pilbara coast near Whim Creek in north Western Australia (Figure 1).

In EAG 3 the EPA has provided a framework to impart clarity and consistency to the environmental impact of proposals that have potential to result in irreversible loss of, or serious damage to, benthic primary producer habitats in Western Australia's marine environment. The framework is underpinned by a set of overarching environmental protection principles. In summary, the EPA expects all proponents of proposals for which loss of and/or serious damage to benthic primary producer habitat is a relevant factor to demonstrate application of the impact avoidance and minimisation principles as well as how best practice has been incorporated into project formulation and management before any quantitative appraisal of cumulative residual losses are made.

1.2 Structure of report

This document presents background on the project characteristics and provides a summary description of the environmental characteristics of the project area. The document also describes the scope of works undertaken to date to produce the BPPH mapping that is currently available. To demonstrate the application of impact minimisation principles by the Proponent, the document presents a summary description of the range of alternative locations considered before the preferred export solution was selected. A preliminary BPPH Loss assessment is then undertaken to show that the proposed losses are within applicable EPA loss guidelines. The document concludes with identification of further BPPH related studies proposed to be undertaken during 2013. Plates and figures are presented at the back of the report.

1.3 Scope of Works

The scope of works undertaken by the author (Ian LeProvost) for this report includes;

- Interpretation of available bathymetric and topographic charts
- Interpretation of high quality aerial photographs supplied by Atlas Iron
- An aerial inspection by helicopter of the coast between Sherlock River mouth and Cape Thouin during both high and low spring tides on 4th June 2012.
- A helicopter inspection of causeway alignment options on 12th Nov 2012.
- A two-day on ground and diving inspection of key sites and habitats in the vicinity of jetty options undertaken from West Moore Island Lodge during Nov 12-14, 2013. (Refer Figure 6)
- Consultations with DEC Karratha officers in June 2012 and Nov 2012
- Consultation with current managers of West Moore Island Lodge (Fred and "Action" Jackson, and Dillan) (1-2 years occupancy of island).

- Consultation with Dave Jackson manager of Norwest Pearls who set up and ran the pearl lease associated with West Moore Island for five years and has dived throughout the lease area in the channel.
- Consultation with Rick McGregor (Point Samson Charters) who has fished and worked the coast between Cape Lambert and Port Hedland most of his adult life (35+years).
- Review of applicable guidance documents (CALM 1994, EPA 2001, DoE 2006, EPA 2009)

1.4 Acknowledgements

The BPPH mapping was undertaken by the author using the high quality aerial photographs (Figure 2) provided by Landgate as the base. All diagrams and habitat maps presented in the report have been produced by CAD Resources who also calculated the habitat areas within the Loss Assessment Unit and beneath the footprint of the preferred causeway/jetty alignment using GIS Arcview software.

Mintrex engineers have lead the design for the barge loading facility infrastructure.

Blair Cuthbertson and Dan Hayes - Caretaker and surveyor of the Forge camp at Balla Balla assisted with field inspections.

Thanks also to Rick McGregor, Dave Jackson, Fred and "Action" Jackson, and DEC staff in Karratha for provision of valuable local knowledge.

1.5 Description of Proposal

Forge Resources (Forge) owns the Balla Balla magnetite deposit near Whim Creek and has environmental approval to develop the mine. This approval was obtained by a previous owner when the associated ore export solution was to slurry the ore via pipeline to Port Hedland, dewater the ore and ship it out of Port Hedland harbour. The project was subsequently bought by Atlas Iron to gain ownership of the project's access to Port Hedland harbour for the shipment of iron ore from other mines. Atlas then sold the mine to Forge, minus the port access. Hence Forge have a need to find a new export solution for the ore at Balla Balla because Port Hedland harbour is at full capacity and not able to cater for any further ore exports, and the recently approved new port at Anketell Point in the Pilbara is still many years away from realisation.

The preferred solution is to ship 6 MTPA of ore concentrate from a simple trestle jetty style barge loading facility out to ocean going export vessels moored at various locations offshore depending on depth requirement. The facilities required include a (Figure 3):

- ~7 km long slurry pipeline from the mine to a dewatering pond and stockyard located on the mainland at the base of the conveyor
- ~10 km long rock causeway across tidal flats to a trestle jetty
- ~2.6 km long trestle jetty terminating in a 100m long barge loading wharf situated in 10m depth of water at low tide, plus a series of navigation aids to mark the sailing channel
- ~12.5 km long continuous conveyor system to transport the crushed damp ore concentrate from the stockpiles direct to the barge. The conveyor will be enclosed to minimise potential for dust loss and have dust suppression water sprays installed at transfer stations if these are needed. The jetty will have containment slabs and sumps to recover any spilled material
- large self-propelled and self-unloading barge with a capacity of up to 15,000 dwt and a loaded draft of up to 8.5m. Loading cycle between trips from the jetty is estimated to be between 10-16 hrs depending on wind and tide conditions. Only one barge is proposed, plus a support vessel

Note that:

- No dredging is proposed.
- No waste water discharges are proposed.
- No refuelling of barges is proposed at the BLF. All refuelling will be undertaken at Port Hedland or Dampier

Infrastructure works are being designed to enable completion of construction during the 8 month winter dry season. This will probably require two piling spreads, one operating from a barge and starting at the wharf, the other operating from land out toward the wharf. Jetty piles will be ~ 10 m apart.

The rock causeway will be constructed by progressively dumping waste rock from the mine along the alignment until the base of the jetty is reached. The walls of the causeway will be armoured to protect against damage from cyclone induced storm surge. A small laydown area for jetty construction will be constructed near the base of the jetty. The floor level of the causeway will be about 7.5m wide to support the conveyor and a light vehicle access road alongside. Passing and turn around points will be installed at regular intervals along the causeway. Culverts will be installed where required to maintain tidal flow in drainage lines and small creeks. It is anticipated that the final width of the causeway disturbance footprint will be 30 -35 m.

2. 0 Summary Description of Environment

2.1 Geomorphology

The preferred location for the proposed barge loading facility is in the western part of the larger Forestier Bay, on the coast near Whim Creek, approximately 50 km due east of Point Samson on the Pilbara Coast between Roebourne and Port Hedland (Figure 4).

The project area is a large shallow and protected intertidal embayment located to the west of Depuch Island (refer Figure 5). The Sherlock River discharges into the western side of the bay via the Padthureena Creek. The embayment is protected from ocean swell and storm waves by islands of the Forestier Group, namely Depuch island (a large ironstone formation), West Moore and East Moore islands, and an unnamed island (at low tide) to the west of West Moore island (Sherlock Island?). These latter islands are limestone barrier islands with a sand veneer. A 1km wide intertidal limestone platform extends seaward of the limestone islands and forms an almost continuous barrier to wave energy entering the bay. A relatively deep channel occurs to the west of West Moore Island through which tidal waters flow and ebb on a semi diurnal basis. Tidal range is approximately 6m.

2.2 Habitat types and distribution

The **principal ecosystem types** within the embayment are mainly bare sandy to muddy intertidal flats but in places supporting a mangrove and samphire based ecosystem. The principal habitats which occur within the embayment in descending order of tidal reach are (Figure 6):

A red sandy **supratidal floodplain** supporting grasses characterises the mainland on which the mine is located. Most of this habitat is grazing land within the Sherlock pastoral lease. During cyclone induced rainfall, much of this habitat floods for a short period of time and all creeks flow into the embayment

Rock islands occur near the seaward margin of the project area. The largest of these is Depuch Island which is a very large ironstone outcrop. Its intertidal rocky shores are encrusted with oysters and barnacles. Two smaller granite outcrops occur on the tidal flats in the vicinity of the proposed causeway/jetty alignment (Figure 3). Both of these outcrops are registered aboriginal heritage sites, presumably for the large piles of shell middens which occur on and adjacent the rocks. (Plates 1 and 2)

Sand cheniers also occur occasionally within the embayment usually on the edge of the mangrove fringe. They are storm deposits of sand in the shape of a large ribbon dune. The jetty base will be located on this habitat (Plates 3 and 4).

Vegetated **Sand dune** habitat is abundant on the offshore islands which protect the bay. The dune forms a beach in the intertidal zone. Turtle tracks have been recorded on the seaward side of the large sand dune to the southwest of West Moore Island.

Upper tidal salt encrusted flats fringe the mainland. These flats also support an extensive covering of **algal mat** in areas that are wet more frequently by spring tides (Plates 5 and 6).

Samphire flats supporting salt tolerant low shrubs in varying density and size comprise the largest habitat type in area within the project locality. These shrubs are more dense and larger closer to mean sea level and smaller and scattered in higher parts of the flats). These flats also support a dense population of burrowing fiddler crabs (*Uca sp*.) which heavily bioturbate the flats at low tide. (Plate 3)

Mangroves tend to fringe mean sea level along all creek and embayment foreshore. In most places this fringe is relatively narrow (100-300m) and generally consists of large old trees on the seaward fringe, with smaller trees and different species occurring higher up the flat towards the samphires. Three species (*Avicennia, Rhizophora and Ceriops)* have been identified to date, but others are likely to occur. Raptors such as Brahminy kites and Ospreys are common in this habitat. (Plates 3, 4, 5, 7)

Lower intertidal flats are comprised of bare sandy mud and support a burrowing infauna of worms and molluscs (particularly cockles (*Anadara* sp)). These flats support large flocks of migratory waterbirds at low tide and shoals of fish at high tide.

Sand shoals and spits occur mainly near the mouth of the embayment and appear barren except at higher tides when they provide roosting areas for large flocks of seabirds of various species (eg., terns, pelicans).

Large intertidal limestone platforms protect the embayment. These platforms are the base on which the sand dune "islands' sit. The platforms support primarily red and brown algae communities with small sponges and scattered encrusting corals in shallow pools. Reef oysters and mud oysters are plentiful as are reef herons and oyster catchers. (Plates 8-10)

The seafloor of **shallow subtidal waters** near the edges of the channel is comprised of hard **limestone pavement** and variously supports green and brown algae, sponges and scattered corals. No dense true coral reefs occur, but there are one or two locations where accumulations of encrusting corals (favids, turbinaria sp) occur over a flat pavement habitat in shallow subtidal protected waters in the channel to the west of West Moore Island and seaward of the tidal platform (Plates 11 and 12). No dense seagrass beds have been recorded, although Dave Jackson has reported the occurrence of sparse thin seagrasses growing on flats near the mouth of Ball Balla Creek.

The seafloor of **deep subtidal waters** within the channel between the two islands is primarily a **sand-gravel veneered limestone pavement** which supports a garden habitat of filter feeders (sponges and sea whips, fans

etc) (Plate 13). Most of the channel area was incorporated within an aquaculture lease granted in 2005 (figure 5) and supported pearl grow out lines and infrastructure. The pearling operation has since been abandoned.

Further offshore seaward of the tidal limestone platform the seafloor is comprised mainly of barren **flat hard packed sand** (Plate 14). According to Rick McGregor, much of the seafloor in this area was heavily trawled during the 80 and 90's but is no longer trawled today.). Closer inshore the subtidal pavement is colonised by dense green algae (Plate 15) and possible supports seagrass.

2.3 Human use of region

The earliest human use is Aboriginal and there are a number of heritage sites within the vicinity of the project. One in particular located to the south of the laydown area at the landward end of the jetty is a collection of very large shell middens comprised of cockles (*Anadara sp*.) (Plate 16). Depuch Island also has strong Aboriginal heritage significance and petroglyphs (rock carvings of turtles and fish) can be found in the vicinity of water holes and springs on the east coast of the island.

Depuch Island also has European heritage significance. It is known to have been inspected by the French expedition in "Le Geographe" commanded by Baudin in 1801 and is believed to have been named after a mineralogist on board. There is a small cairn and European graffiti to mark the place where crewmen from HM Sloop "Beagle" came ashore in 1840 to replenish water supplies (Sledge 1978). Balla Balla harbour was established in 19th century for export of copper ore from Whim creek. The harbour operated as a barge loading area for transport to ships anchored out in deep water off the eastern coast of Depuch island. The WA Museum shipwrecks database records that there are some 9 wrecks within the harbour area.

The anchorage is a designated port administered by the WA Dept of Transport. The port boundary is shown on Figure 5. The port is no longer used commercially, but the boat ramp at Balla Balla creek is used by recreational fishers, particularly grey nomads who camp in the vicinity over winter months (Plate 17). West Moore Island Lodge provides accommodation for mangrove and reef fishing adventures (Plate 18). However consultation with the owner indicates that the Lodge may be closing down in 2013. The lodge was originally built by Norwest pearls to support a pearling venture which was abandoned after approximately 7 years because it was deemed to be commercially non-viable.

3.0 BPPH Loss Assessment

3.1 EPA Guidance

There are three key EPA policy documents relevant to the assessment of impacts on the marine environment in Western Australia which are applicable to the Project area. These are:

1. Guidance Statement for the Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline; EPA Guidance Statement No. 1 (EPA 2001);

2. Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment; EPA Environmental Assessment Guideline No. 3 (EPA 2009); and

3. Pilbara Coastal water Quality Consultation Outcomes: Environmental values and Environmental Quality Objectives (DoE 2006).

Guidance statement No: 1 (GS1) specifically addresses the protection of tropical arid zone mangroves, habitats and dependent habitats along the Pilbara coastline. *The designation of mangrove areas for*

representation and conservation in the Pilbara Region are based on a number of criteria that address significance. The significance may be international, national, or regional. Accordingly the significance of mangroves is dependent on:

• the extent or rarity of the habitat;

• the internal diversity of the habitat;

• the ecological significance of a given stand; and

• the nationally to internationally significant features of a given site.

Semeniuk (1997) determined these significant areas on the basis of coastal type, habitat, species diversity and plant form. "Regionally significant" mangroves are considered to be of very high conservation value. The remaining mangroves along this part of the Pilbara coast, although not "regionally significant", are also regarded as important and considered to be of high conservation value (EPA 2001).

When the two mangrove categories are considered in relation to areas along the Pilbara coast that are already identified as where intensive industrial developments and associated port areas and related developments are likely to occur, they give rise to four types of management areas for which guidelines have been prepared. The four types of management areas are:

Guideline 1 Regionally significant mangroves - Outside designated industrial areas and associated port areas.

Guideline 2 Other mangrove areas - Outside designated industrial areas and associated port areas.

Guideline 3 Regionally significant mangroves - Inside designated industrial areas and associated port areas.

Guideline 4 Other mangrove areas - Inside designated industrial areas and associated port areas.

Reference to Table 1 and Figure 7 of GS1 indicates that the project area is not considered to contain "regionally significant mangroves", but does contain important and high conservation value mangroves that occur outside a designated industrial area. As such the mangroves within the Project area fall under the category Guideline 2 which identifies the EPA's expectations that (EPA 2001):

"Proposals will be subject to a presumption against finding the proposal environmentally acceptable unless the proponent can demonstrate that there are no unacceptable impacts, based on the following performance objectives:

• demonstrate a significant understanding in relation to the scale and nature of potential environmental impacts on the mangrove systems;

• evaluate how the mangrove system (the mangroves, habitats, dependent habitats, ecological function and ecological processes which sustain the mangrove habitats) would be affected by the proposed development and the environmental significance of any such impacts, including cumulative impacts; and

• demonstrate that the proposed development adopts good engineering design and 'best practice' processes for minimising potential environmental impacts and maintains the ecological function and overall biological value and environmental quality of the area".

Environmental Assessment Guideline No. 3 (EAG 3) sets out a framework for the assessment of proposals that may impact on Benthic Primary Producer Habitats (BPPH). The Guidance considers that benthic primary producers are "…seabed communities within which algae (e.g. macroalgae, turf and benthic microalgae), seagrass, mangroves, corals or mixtures of these groups are prominent components."(EPA 2009).

EAG3 identifies a hierarchy of general principles of assessment in relation to the protection of BPPH (EPA 2009). The three principles require initial evaluation prior to carrying out the impact assessment through the risk-based framework set out in the Guideline:

• Principle 1: Demonstrate consideration of options to avoid damage/loss of BPPH;

• Principle 2: Design to minimise loss of BPPH and justify unavoidable loss of BPPH; and

• Principle 3: Best practicable design/construction/management to minimise BPPH loss.

EAG3 requires a staged approach to assessing any potential impacts on BPPH ecosystem integrity. The first, and perhaps most significant, step is the definition of a "Local Assessment Unit" (LAU) for the purposes of applying the Guideline. EAG3 suggests the identification of an area of marine habitat in the order of 50 km2 in size for BPPH LAUs (EPA 2009), but larger or smaller LAU's will be considered if well justified. The LAU also needs to have an ecosystem protection Category assigned to it (ranging from A-F), based on defined criteria related to perceived conservation values (EPA 2009). Once these parameters are defined, the potential impacts of the project can be put into a context of percentage cumulative loss of BPPH within the LAU, and evaluated against threshold criteria. These thresholds differ for different Categories, with a significant increase in EPA assessment expectations once crossed.

The ecosystem protection categories are presented below:

Table 1: Cumulative loss guidelines for benthic primary producer habitat within defined local assessment units for six categories of marine ecosystem protection that will be applied only after proponents can demonstrate to the EPA that all practicable options to avoid/minimise damage/loss of BPPH have been considered.

Category	Description	Cumulative loss guideline*
A	Extremely special areas	0%
B	High protection areas other than above	1%
C	Other designated areas	2%
D	Non-designated area	5%
E	Development areas	10%
F	Areas where cumulative loss guidelines have been significantly exceeded	No net damage/loss

** Defined as a percentage of the original area of BPPH within a defined local assessment unit*

Reference to the guidance criteria for each of the above categories indicates that the category most likely to apply to the Forge Project is Category B High Protection Areas = 1% cumulative loss guideline. The criteria applicable to Category B: High Protection Areas are (EPA 2009):

"(a) Area of Application

• *Marine Park zones other than those in Category A;*

• Some zones within Marine Management Areas as detailed in their Management Plans (i.e. some special conservation zones);

• Waters of the Rottnest Island Reserve other than those specified in Category A

• Areas recommended for inclusion in WA's marine reserve system (i.e. 'Wilson' report areas, CALM 1994);

• Guideline 2 areas as defined in EPA Guidance Statement No.1; and

• Other areas identified through the literature, by statutory processes or by the EPA as having a high conservation or ecological significance or otherwise being special.

Only the last two criteria listed above apply. The project area does not occur within a Marine Park or Marine Management Area, and has not been recommended for inclusion in WA's marine reserve system (CALM 1994), although this was largely owing to the fact that little data were available on which to base selection of a representative site for the coast between Cape Lambert and Cape Thouin. The Working Group recommended that a survey be undertaken of the intertidal and nearshore marine habitats between Cape Lambert and Cape Thouin so that one or more parts of that coast may be selected for reservation to represent coastal type III and protect its associated marine flora and fauna.

Since release of the Working Groups report, the EPA GS1 has effectively reserved a number of areas along this stretch of coast by declaring them Guideline 1 Regionally Significant Areas. Reference to Figure 6 and 7 in GS1 shows that two such areas occur either side of the Project area. These are "location 17 –Sherlock Bay" which occur to the west; and "location 18 - Ronsard Island to Cape Cossigny area" which occurs to the east of Depuch island. Hence the conservation values of this stretch of coast can be considered to be protected within the GS1 "de-facto reserves".

Recent consultations with DEC officers in Karratha (McDonald pers. com.) and in Perth confirm that the coastal area in the vicinity of the project still has not been surveyed and that there are no current plans for reservation of any area along this stretch of coast.

However one of the criteria which applies is the fact that mangroves of the project area fall within the Guideline 2 area as defined in EPA GS1. The other criterion which applies is the fact that the Forestier Bay region has been identified as an area requiring "maximum" level of protection in the EPA's **Pilbara Coastal Water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives** (DoE 2006). This report presents the findings of a planned and targeted public consultation process to obtain comment on environmental values, environmental quality objectives and how they should be applied geographically within the State marine waters from Exmouth Gulf to Cape Keraudren. This region has long been recognised for its very high marine biodiversity and conservation values, its extensive mineral resources, and as a focus of rapidly increasing development pressures.

"The overall response from the public consultation was one of strong support for the permanent protection of environmental values associated with the ocean and with people's social and spiritual life. The North West communities consulted want an end to avoidable pollution sources, wastes, contamination and discharges despoiling or compromising their own closely-held environmental values (Vital Options Consulting, 2005).

A majority of respondents (77%) were unwilling to accept waste inputs anywhere that would make water quality unsuitable for social uses such as fishing and swimming. Community and stakeholder responses indicated strong support and recognition for the value of ecosystem health and the Environmental Quality Objective for maintenance of ecosystem integrity. This Environmental Quality Objective is spatially defined by allocating one of four different levels of ecological protection (Maximum, High, Moderate or Low) to each

location throughout the ecosystem. The community recognised the need to assign different levels of ecological protection so as to facilitate the management of conservation values and multiple human uses, while protecting ecosystem integrity overall. The community indicated that it wants to see the highest achievable levels of ecological protection applied and realized throughout the region. There was clear support for the adoption of the High Level of Ecological Protection goal as the minimum default setting across most of the region." (DoE 2006).

Map 2: Cape Lambert to Port Hedland (Figure 7) shows that the coastal waters in the Forge Resources project area have been designated a "maximum" level of Protection. The report indicates that multiple respondents marked this as an area that they wanted protected to the highest level. In effect this means that the waters are considered pristine and that no contaminant input will be tolerated, and that there should be no detectable change in condition of biological indicators other than from natural variation. Figure 6 also shows the boundary of the GS1 Guideline 1 location 18 – Ronsard-Cape Cossigny mangrove ecosystem.

The EPA guidance in EAG3 which applies to Category B level of Protection is as follows (EPA 2009)

• *No development should take place that would adversely affect the ecological integrity of these areas.*

• *Minor damage/loss of benthic primary producer habitat may be acceptable where proponents can demonstrate that there are no feasible alternatives to avoid damage/loss and/or where proposals are consistent with relevant management plans (e.g. an approved management plan for a marine reserve) or a use of the local assessment unit that is consistent with a State Government decision. (Cumulative Loss Guideline = 1% loss of BPPH)*

• *The EPA expects a substantial justification for the proposal supported by technically defensible information demonstrating understanding of the ecological role and value of the benthic primary producer habitat in the local context. Using this understanding, the proponent would be expected to describe and evaluate the significance of potential impacts on ecological integrity.*

• *The acceptability of any damage/loss will be a judgement of the EPA."*

3.2 Site selection and alternatives considered

As indicated previously the EPA expects proponents to demonstrate application of the impact avoidance and minimisation principles prior to undertaking a quantitative assessment of BPPH loss/damage. The key principles are repeated below.

• *Principle 1: Demonstrate consideration of options to avoid damage/loss of BPPH, by providing the rationale for selection of the preferred site;*

• *Principle 2: Design to minimise loss of BPPH and justify unavoidable loss of BPPH; and*

• *Principle 3: Best practicable design/construction/management to minimise BPPH loss.*

This section describes the site selection and design process to demonstrate that a range of options have been considered in an effort to minimise both BPPH and terrestrial habitat loss. The search for a site for a barge loading facility began in mid 2011 when Forge engaged Marine Logistics Australia (MLA) to investigate and recommend potentially economically viable export solutions for their Balla Balla mine near Whim Creek. MLA reported in January 2012 (MLA 2012) and indicated that the most economically viable solution was to construct a small barge loading facility in the vicinity of the West Moore Island – Depuch Island region at a site where dredging was not required. The only location believed to meet the no dredging requirement at the time was the seaward side of the un-named low-tide island which is located immediately to the south west of West Moore Island (Option 1 in figure 6). Initial investigations then focused on finding an acceptable route across

the Sherlock River delta to the island and undertaking detailed bathymetric surveys in the vicinity of jetty options 1A and 1B (figure 6). The environmental constraints on this route were substantial. Not only did it sit in the middle of an active river delta, but at high spring tide it was completely flooded by seawater (Plate 19). The best practice construction approach required a substantial amount of trestle bridges and culverts to minimise impedance of both tidal flows and flood runoff during cyclones. The expense of such structures rendered this route marginally viable.

Consultation regarding option 1 with the Department of Transport, Ports and Harbours Division indicated that the Department would prefer that the BLF was constructed inside the existing Balla Balla port boundary which terminated east of option 1B (refer figure 5). Subsequent consultations with the owner of the West Moore Island Fishing Lodge confirmed that the pearling lease (figure 5) was no longer operational and that the Lodge was likely to close down in 2013 because it was commercially non-viable. Bathymetric surveys confirmed that depth in the channel area was adequate for the barge loading operation and as a result options 2 and 3 (figure 6) were developed as being the most direct routes to the nearest navigable water. Option 3 was subsequently selected as the preferred alignment after a field survey conducted in November 2012 by LeProvost Environmental and a Forge surveyor reported that option 3 was less cramped for space and "drier" than option 2 which was considered very swampy and muddy and close to mangrove creeks. Option 3 supports more algal mat habitat indicating that it is flooded less frequently than is option 2.

The preferred alignment (figure 3) has been designed by Mintrex to minimise disturbance of mangrove habitat and minimise curvature of the conveyor. The main constraint in the current design is that it has been aligned to avoid encroaching on the 250m buffer around the registered Aboriginal heritage site located to the south of the laydown area (figure 3). As a result it does currently encroach on mangrove habitat located to the immediate south of the laydown area. However it is intended to undertake aboriginal heritage surveys of the site later in 2013 which hopefully will clarify the exact location and significance of the site and enable re-alignment of that section of causeway out of the mangroves. Bridges or culverts are incorporated into the design where small creeks or obvious drainage lines occur to minimise impedance of tidal flows. At this location and orientation, the option 3 causeway will not impede flood runoff from the mainland or Sherwood River. It also results in less loss of mangrove and samphire habitat than option 2.

3.3 Loss Assessment Unit.

The first step in the BPPH Loss Evaluation scheme presented in EAG3 is to *"define an appropriate boundary for the Loss Assessment Unit (LAU), taking into account key physical and biological ecosystem attributes such as bathymetry and position of offshore reefs/islands, water circulation patterns, habitat/substrate types and energy/material flows. A local assessment unit is generally geomorphologically determined and the area will be of the order of 50 km2 defined considering local biophysical and geomorphic features for example."*

Figure 8 presents an aerial photograph of the larger Forestier Bay to place the project into a regional ecological and geomorphological perspective. The larger bay is predominantly a shallow intertidal embayment protected from offshore wave energy by a series of nearshore barrier limestone ridges upon which sand dune islands have developed (eg Ronsard, West Moore Island). Depuch Island is an anomalous ironstone outcrop located inside the bay. Large active deltas occur at both ends of the bay; the Sherlock River delta to the west, and the Yule River delta to the east, whilst a number of smaller creeks discharge into the bay (eg., Balla Balla Creek).

The principal ecosystems in the larger bay are the intertidal flats which support mangroves and samphires; and the limestone platforms which support macroalgae and a wide range of marine invertebrates in pools at low tide.

There are three distinct mangrove ecosystems inside the larger bay. One is the large system identified in GS1 as Regionally Significant Mangrove location 18 – Ronsard to Cape Cossigny and shown on Figure 7. The second is centred on Balla Balla Creek, and the third is the large system located to the southwest of Depuch island which is situated on the eastern side of the Sherlock River Delta. This latter system is the one in which the Proposed Project is located. As indicated in Section 2.0, this region is a relatively pristine area which has been little disturbed. The only known disturbance has occurred as a result of the establishment of a pearling lease on the seafloor of the channel southwest of West Moore Island in the vicinity of the proposed barge loading wharf. A very small area of mangrove and samphire habitat has been removed in the vicinity of Balla Balla harbour by the construction of boat ramps, historical barge loading wharfs and the causeway to the harbour (Plate 17).

Figure 9 presents the preliminary BPPH map with two LAU boundaries superimposed. The outer boundary (ignoring the middle vertical boundary) represents an ecosystem based boundary for the LAU which encompasses all of the mangrove ecosystem and associated tidal flats which occur west of Depuch island and are influenced by flood runoff from the Sherlock River delta and associated creeks, and by tidal flows through the channel in which the wharf is situated. It does not include subtidal waters because these areas have not been surveyed to accurately determine habitat boundaries as yet, and it is clear that a trestle jetty and wharf will remove a very small area of seafloor habitat whilst also providing additional hard surfaces for colonisation by marine invertebrates and fish. Furthermore the habitat beneath the wharf is known to support predominantly sponge and seafan garden habitat which are filter feeders rather than benthic primary producers. (NB: It is proposed to clarify the extent of this filter feeder habitat by underwater survey later in 2013).

The larger ecosystem based LAU is some 140km^2 in area. The middle vertical boundary separates this LAU into two equal sized portions of 70km^2 in area. This has been done to create an LAU which is closer in area to the 50km^2 preferred by the EPA. The areas of each individual habitat within both the larger LAU and the easternmost small LAU have been calculated by CAD Resources using Arcview GIS software. The area of each individual habitat type beneath the causeway footprint has also been calculated using GIS software and assuming that a 50m wide causeway will need to be constructed. This is a worst case estimate and is likely to be reduced to about 30-35 m once storm surge studies have been completed and the height of the causeway above sea level has been confirmed.

Table 2 presents these areas for selected BPPH and the percentage habitat loss from both the larger ecosystem based LAU and the smaller procedure based LAU. It shows that the percentage benthic primary producer habitat losses for the smaller LAU are close to the cumulative loss guideline for Category B of 1%.

Table 2: BPPH areas in hectares in the large ecosystem LAU and in the small LAU and beneath the causeway footprint, plus percentage losses of each habitat for both the large and small LAU's.

BPPH type	Area in large LAU	Area in small eastern LAU	Area beneath causeway	% loss in large LAU	% loss in small LAU
Mangroves	2102	1004	8.63	0.41	0.86
Samphires	3593	1560	19.24	0.53	1.23
Algal mat	2109	1904	19.72	0.93	1.03

Given that:

1. this is a worst case loss estimate and is likely to be reduced once engineering design studies and aboriginal heritage studies are completed,

2. the EPA advises in EAG 3 that the cumulative loss guidelines are not to be applied as rigid limits, and

3. the percentage loss within the larger ecosystem is generally much less than 1%,…

it is considered that the proposed project can be designed and constructed to meet the EPA's objectives regarding protection of benthic primary producer habitat in Western Australia.

4.0 Further studies

In recognition of the high conservation values of the Project area, and the guidance provided by the EPA in the range of documents cited above, Forge propose to undertake detailed surveys of both the intertidal habitats and subtidal habitats of the bay during the winter of 2013. The objective of these surveys will be to:

- characterise the flora and fauna component of each of the habitats identified to date
- confirm the reliability of the intertidal BPPH map and produce a subtidal BPPH map
- place the ecosystem into a regional perspective by comparison to other mangrove systems studied along this coast to date;
- demonstrate a significant understanding in relation to the scale and nature of potential environmental impacts on the mangrove systems, and
- demonstrate an understanding of the ecological role and value of the benthic primary producer habitat in the local context to enable evaluation of the significance of potential impacts on ecological integrity of the system.

Aboriginal heritage surveys will also be undertaken during the winter of 2013 with the hope that these will result in clarification of the location and significance of the heritage sites and allow realignment of the causeway out of the mangrove habitat which occurs to the south of the laydown area.

5.0 References

CALM (1994) A Representative Marine Reserve System for Western Australia; Report of the Marine Parks and Reserves Working group, July 1994.

DoE (2006) Pilbara Coastal water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives, Department of Environment, WA, Marine Series Report No. 1.

EPA (2001) Guidance Statement for the Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline; EPA Guidance Statement No. 1

EPA (2009) Protection of Benthic Primary Producer Habitats in Western Australia's Marine Environment, EPA Environmental Assessment Guideline No. 3.

MLA (2012) Initial Feasibility Study of Options for Export of ore from the Balla balla region. Confidential unpublished report to Forge Resources, January 2012

Semeniuk, V (1997) Selection of Mangrove Stands in the Pilbara Region of Western Australia – A discussion (unpublished).

Sledge S (1978) Wreck Inspection North Coast 1978. Report No 11, Department of Maritime Archeology, WA Museum.

Vital Options Consulting (2005). "Having a say. Community Input and Opinion Received on the Proposed Pilbara Coastal Water Quality Plan". A report on the Department of Environment Public Consultation Process 28 September-26 November 2004. March 2005.

PLATES and FIGURES follow

Plate 1: Depuch Island from granite outcrop near jetty base of Option 2 (fig 5)

Plate 2: Granite outcrops near base of jetty option 3 (fig 5) with upper tidal salt flats with algal mats in foreground

Plate 3: Sand chenier base for option 3 jetty showing mangroves and samphire flats in right and left foreground respectively

Plate 4: Close up of sand chenier near base for option 3 jetty. Note that the mangrove fringe is thin, discontinuous and comprised of relatively small trees.

Plate 5: Looking north along alignment of Option 3 causeway showing algal mat habitat in foreground and two granite rock outcrops shown in plate 2 in far background horizon

Plate 6: Looking south along alignment of Option 3 causeway taken from top of eastern granite outcrop shown in Plate 2. The tidal flats adjacent this alignment are relatively barren and dry compared to those of the other alignments investigated.

Plate 7: Looking northeast from the top of the eastern granite outcrop along causeway alignment 3. A large shell midden is shown in the foreground with a star picket believed to mark the location of the registered heritage site.

Plate 8: Looking east from West Moore Island toward northern end of Depuch Island showing large expanse of limestone platform exposed at low tide.

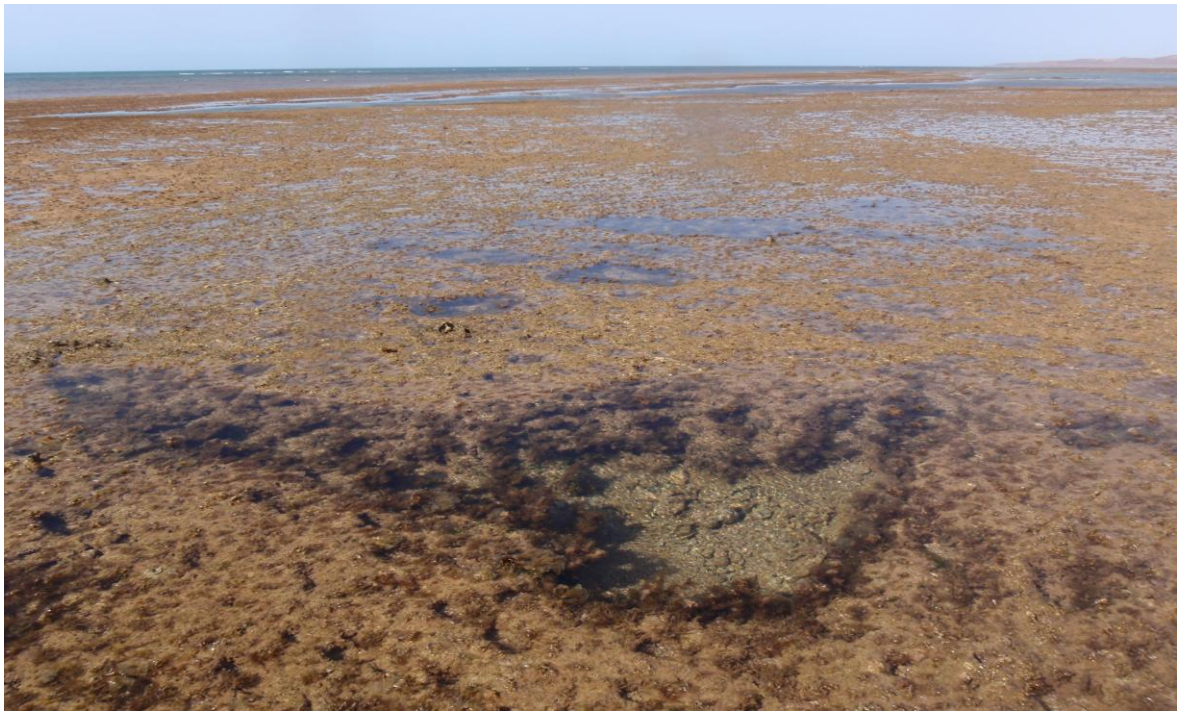

Plate 9: Close up of tidal limestone platform exposed at low tide with pools shown in background

Plate 10: Small fish and algae within tidal pools in limestone platform

Plate 11: Encrusting corals on shallow subtidal pavement near eastern edge of channel close to West Moore Island

Plate 12: Algae and scattered corals and sponges in shallow subtidal waters on western side of channel

Plate 13: sponges on gravel veneered pavement seafloor in deep (~10m) subtidal waters at jetty Option 2 location

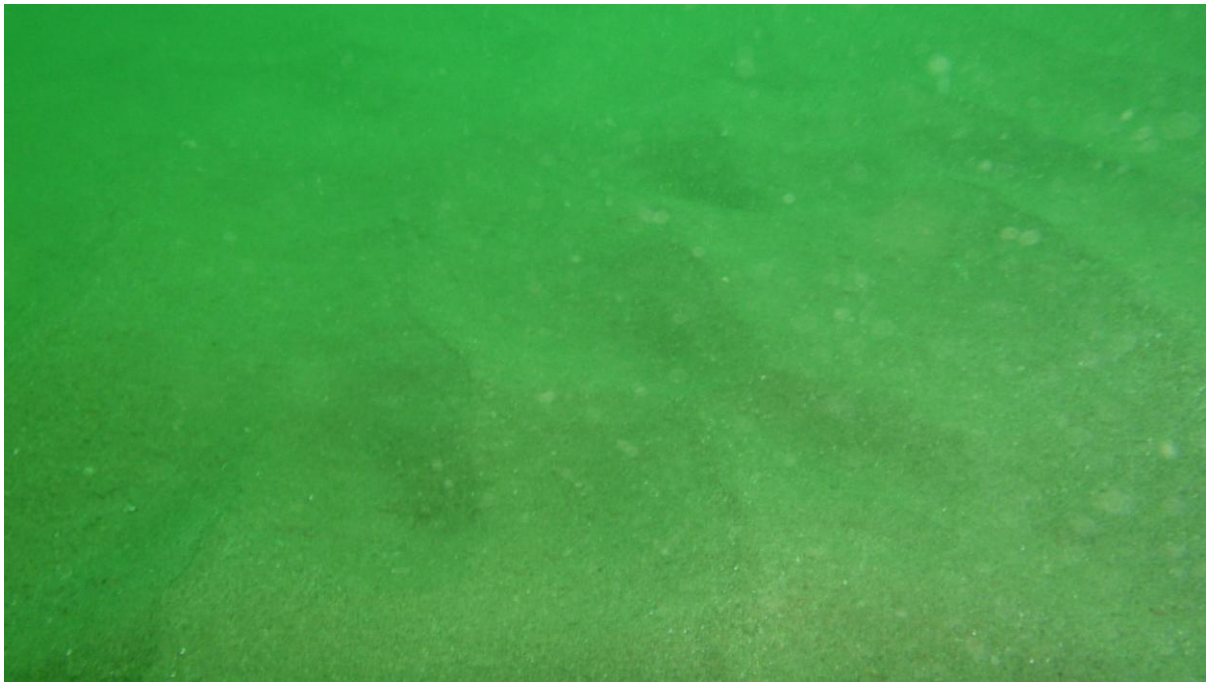

Plate 14: hard packed barren sand on seafloor at jetty option 1A

Plate 15: Green algae on subtidal pavement inshore of jetty option 1B

Plate 16: Looking west from top of eastern rock outcrop shown in Plate 2 showing large shell middens

Plate 17: Grey nomad caravans parked in vicinity of Balla Balla harbour boat ramp (June 2012).

Plate 18: West Moore Island Fishing Lodge

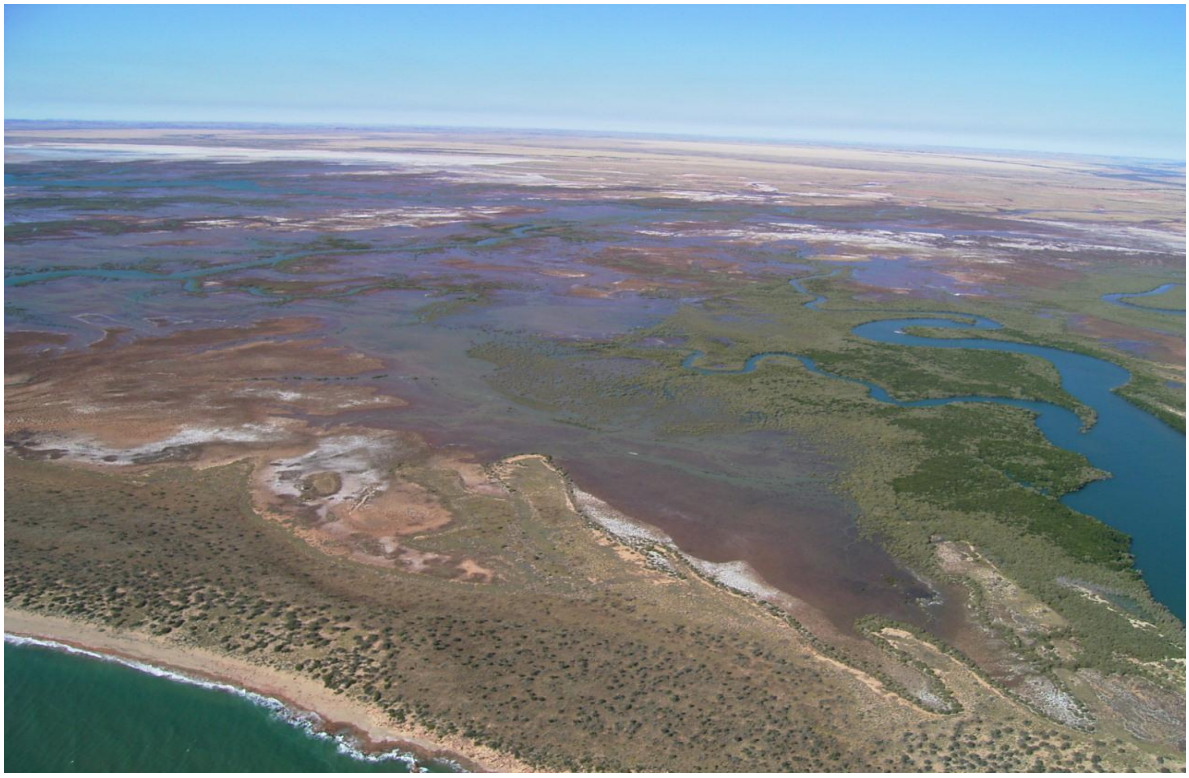

Plate 19: Looking south from the Sherlock(?) Island toward mainland along alignment of Option 1 causeway at high spring tide

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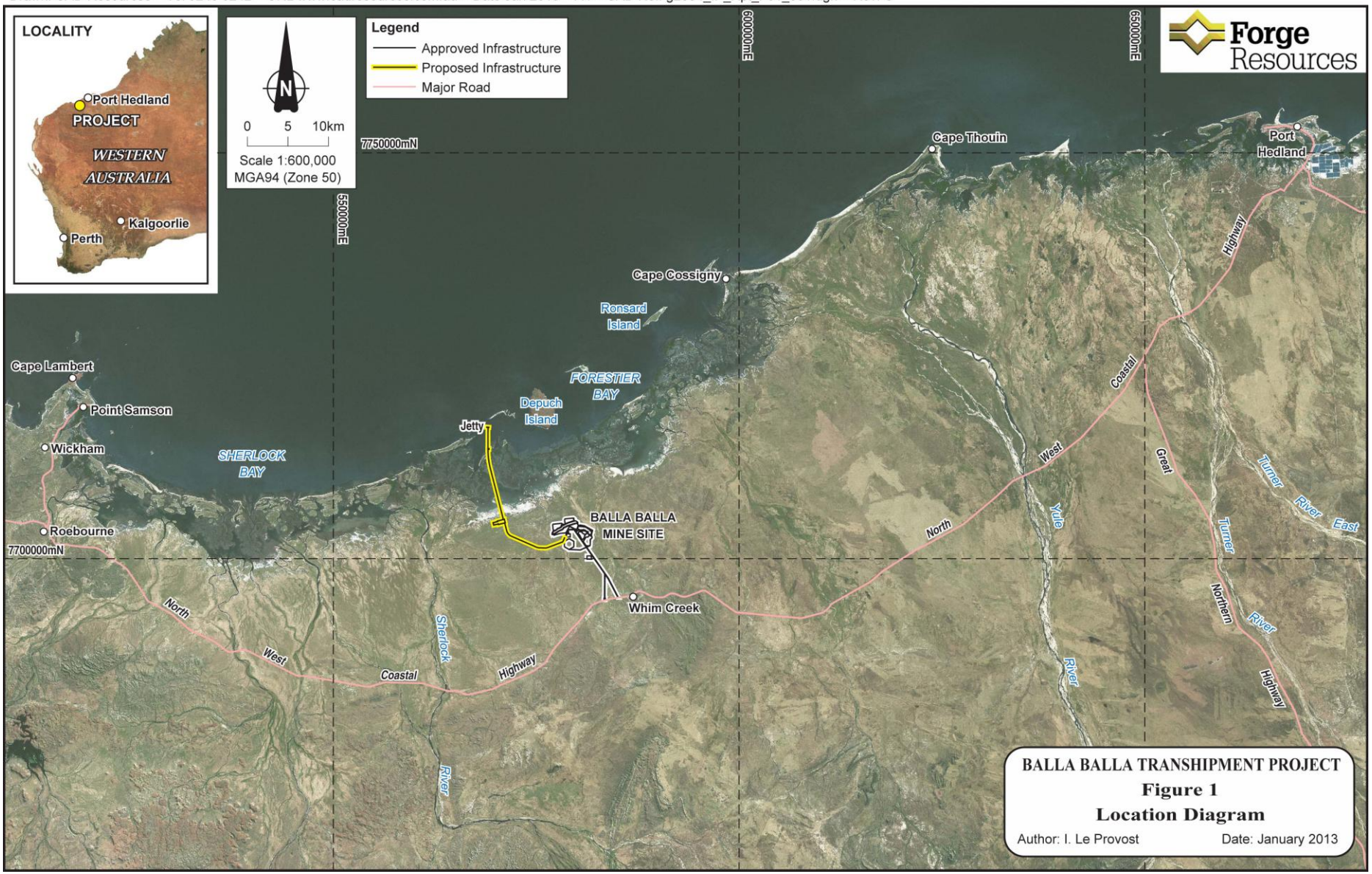

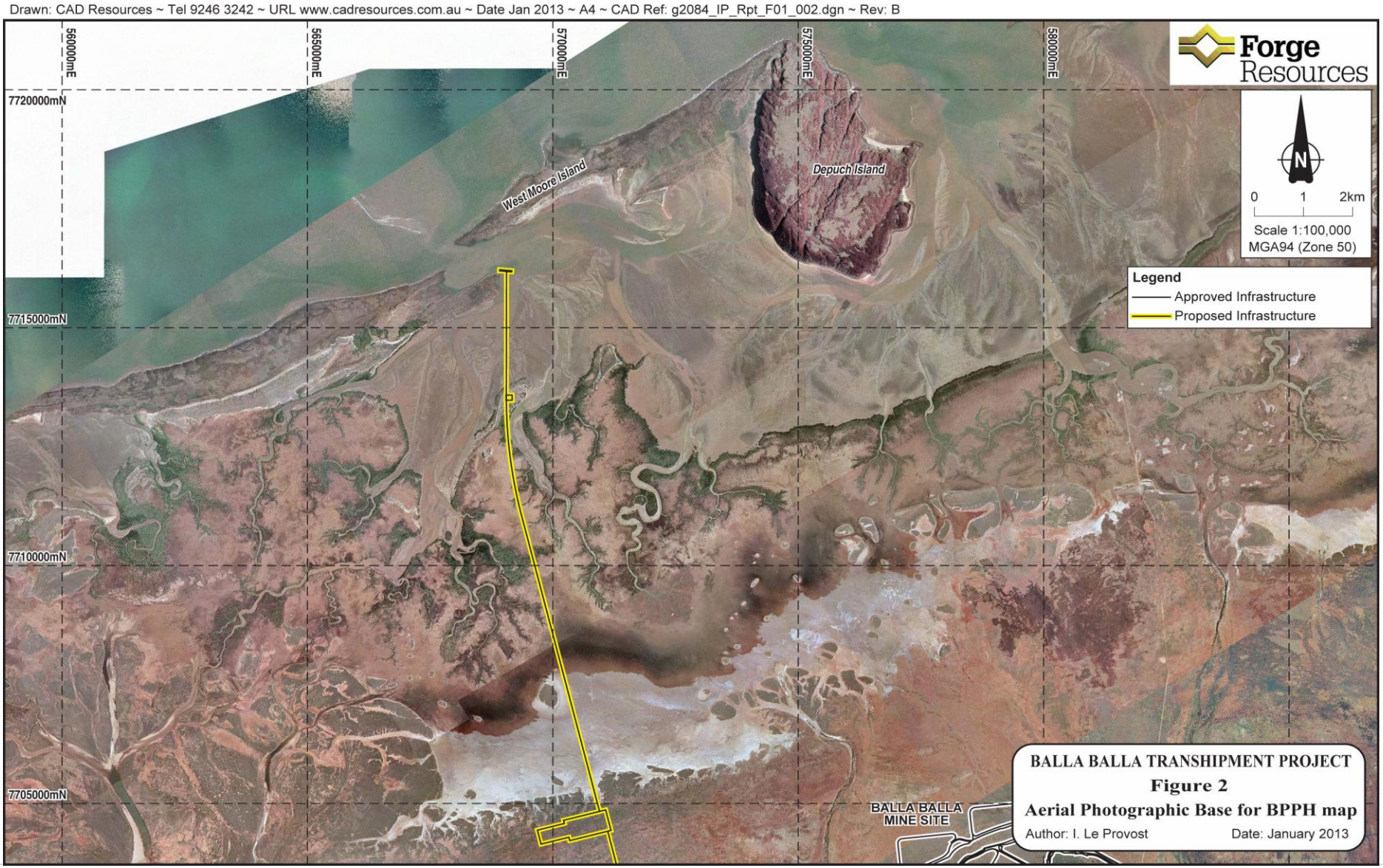
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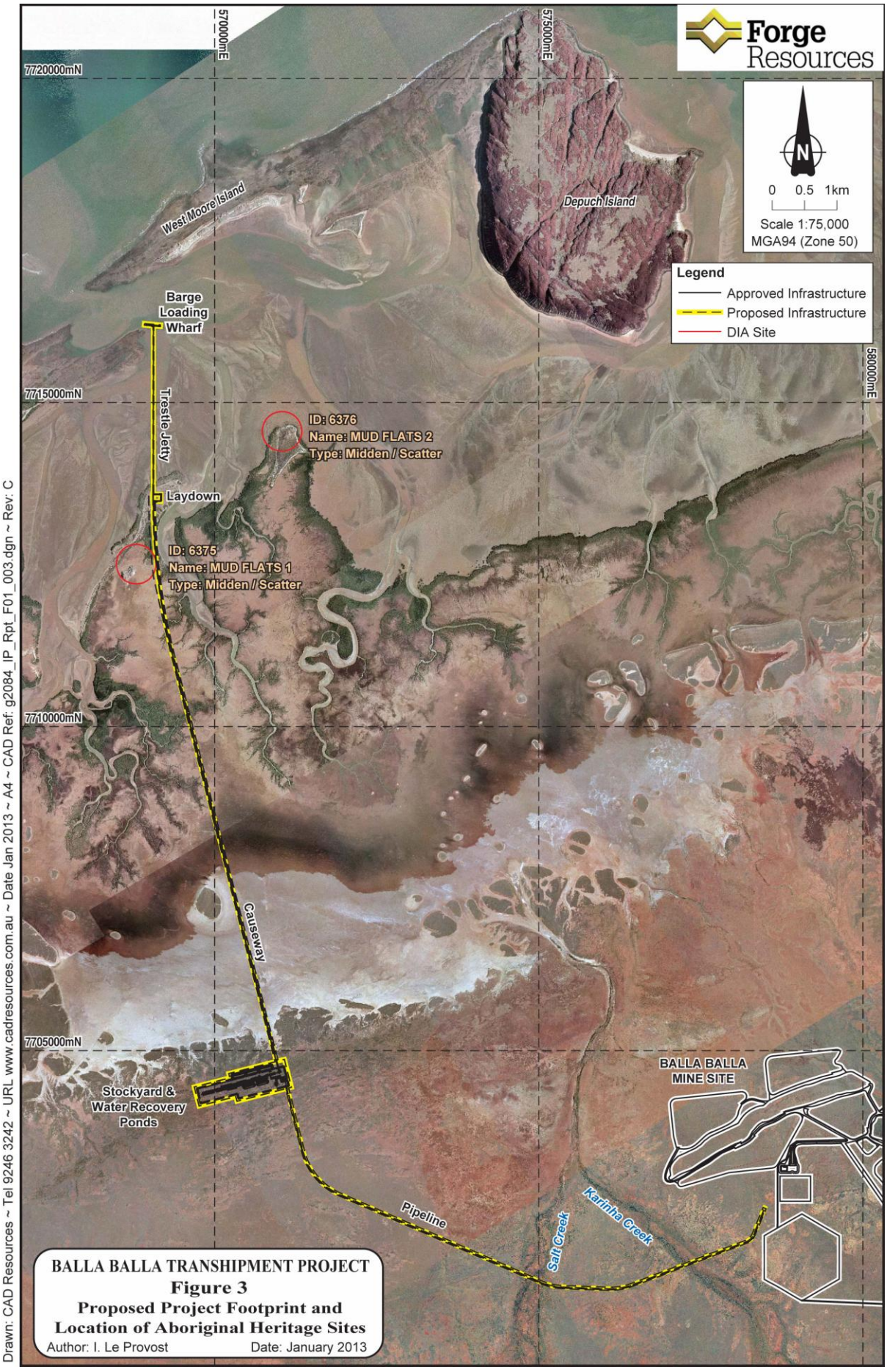
565000mE
570000mE
575000mE
580000mE
7720000mN
7715000mN
7710000mN
7705000mN
West Moore Island
Depuch Island
BALLA BALLA MINE SITE
Forge Resources
N
0 1 2km
Scale 1:100,000
MGA94 (Zone 50)
Legend
Approved Infrastructure
Proposed Infrastructure
BALLA BALLA TRANSHIPMENT PROJECT
Figure 2
Aerial Photographic Base for BPPH map
Author: I. Le Provost
Date: January 2013



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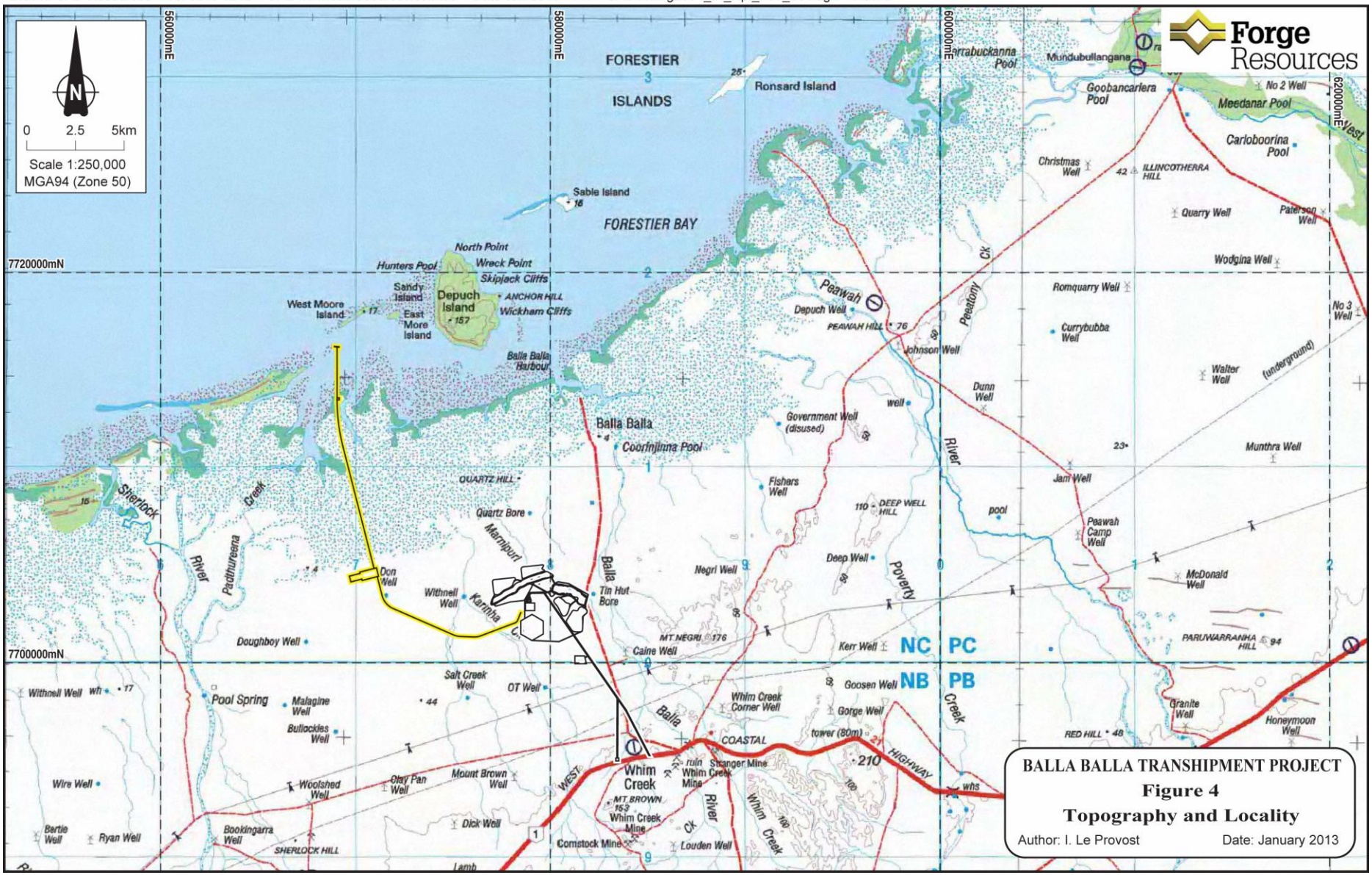

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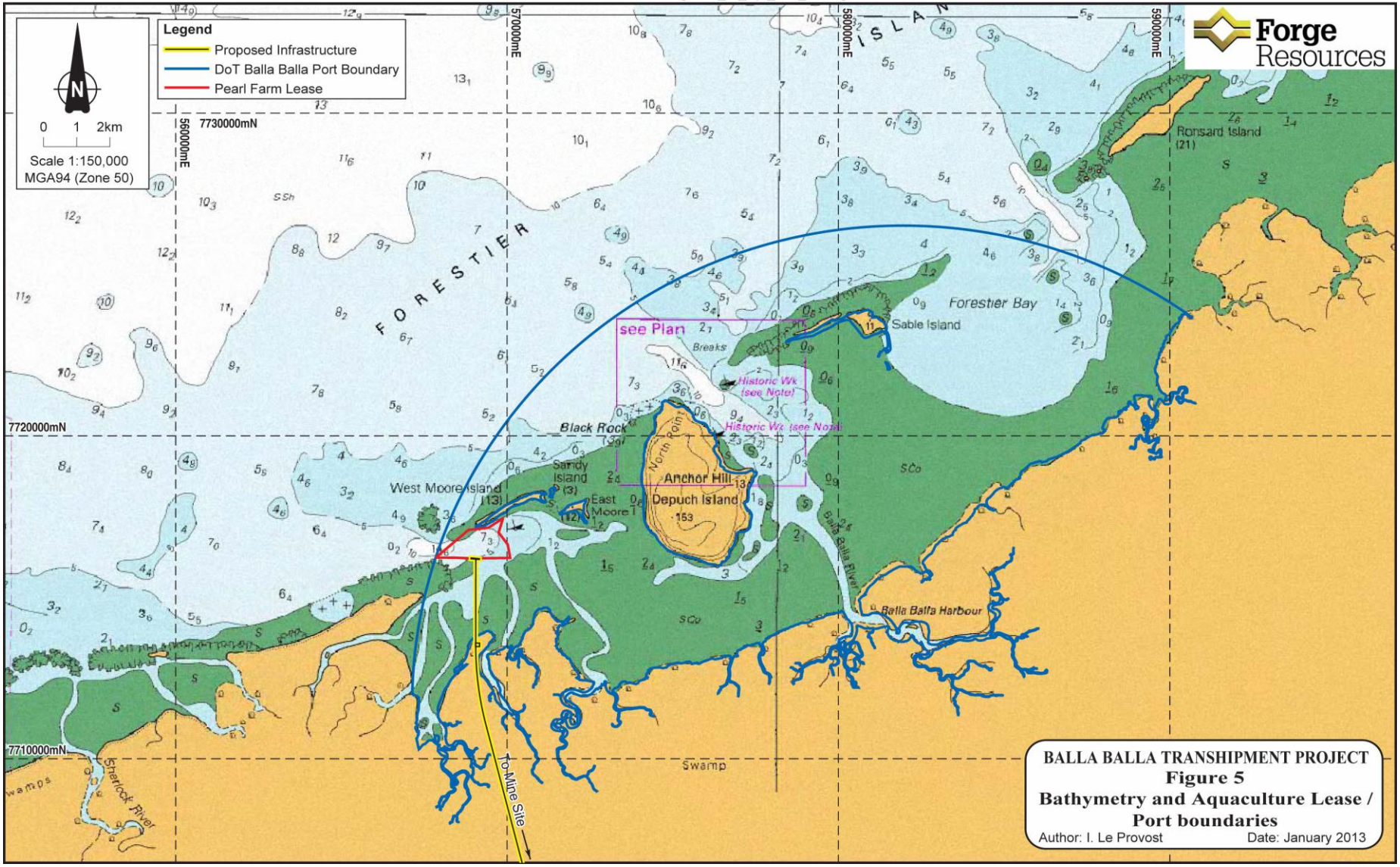

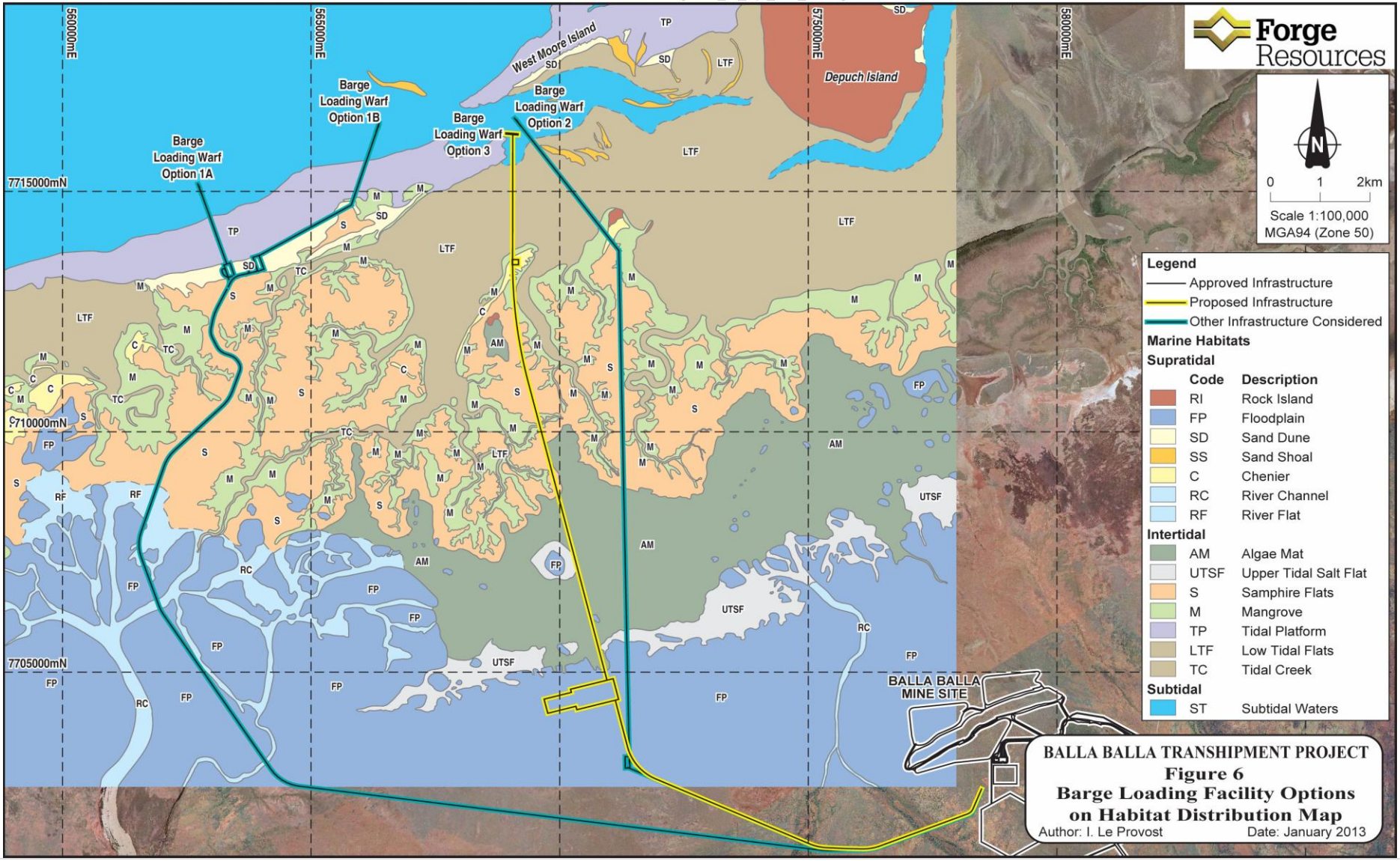
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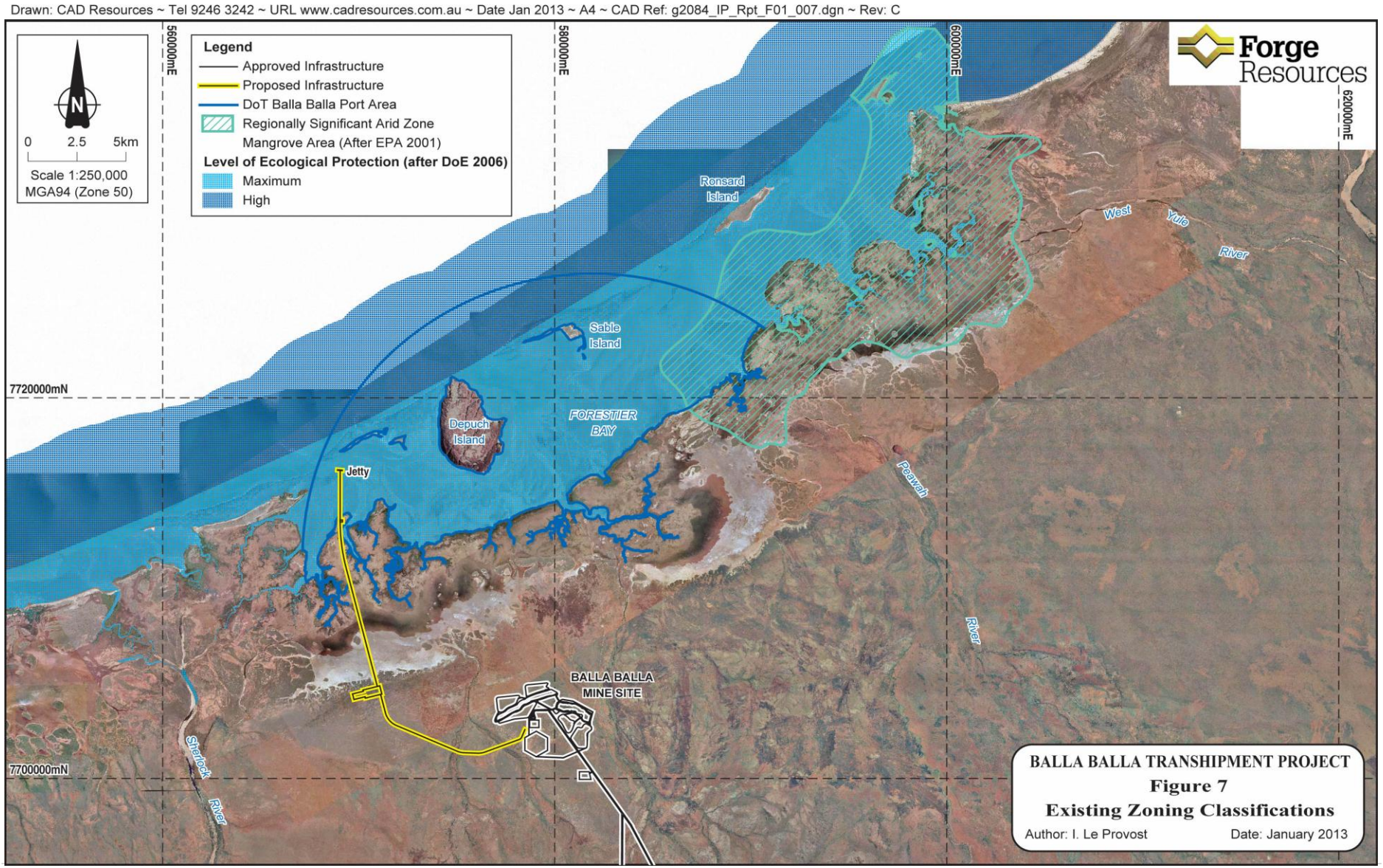
565000mE
570000mE
575000mE
580000mE
7715000mN
7710000mN
7705000mN
West Moore Island
Depuch Island
Barge Loading Warf Option 1A
Barge Loading Warf Option 1B
Barge Loading Warf Option 2
Barge Loading Warf Option 3
BALLA BALLA MINE SITE
Forge Resources
N
0 1 2km
Scale 1:100,000
MGA94 (Zone 50)
Legend
Approved Infrastructure
Proposed Infrastructure
Other Infrastructure Considered
Marine Habitats
Supratidal
Code Description
RI Rock Island
FP Floodplain
SD Sand Dune
SS Sand Shoal
C Chenier
RC River Channel
RF River Flat
Intertidal
AM Algae Mat
UTSF Upper Tidal Salt Flat
S Samphire Flats
M Mangrove
TP Tidal Platform
LTF Low Tidal Flats
TC Tidal Creek
Subtidal
ST Subtidal Waters
BALLA BALLA TRANSHIPMENT PROJECT
Figure 6
Barge Loading Facility Options on Habitat Distribution Map
Author: I. Le Provost
Date: January 2013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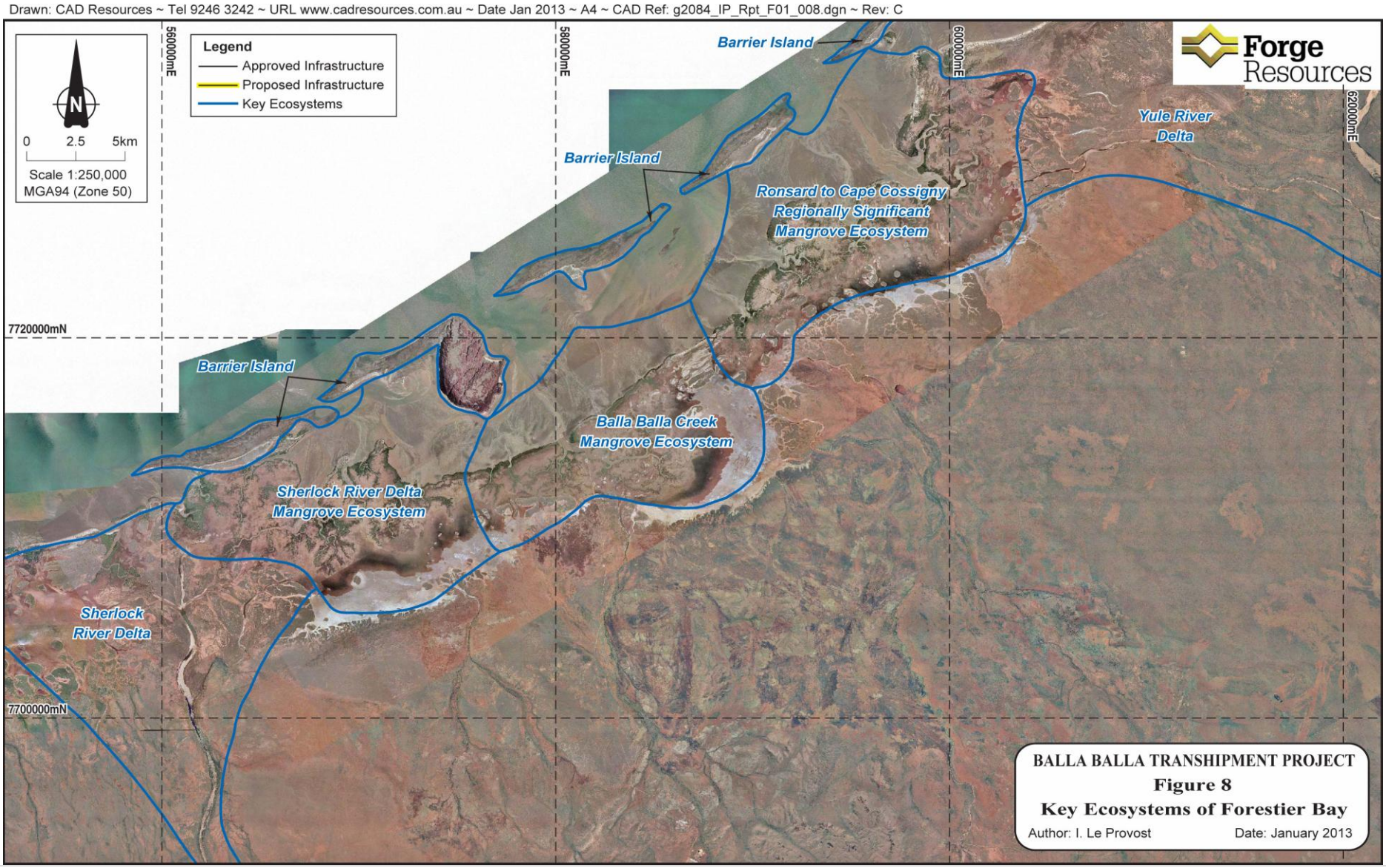
Scale 1:250,000
MGA94 (Zone 50)
Legend
Approved Infrastructure
Proposed Infrastructure
DoT Balla Balla Port Area
Regionally Significant Arid Zone
Mangrove Area (After EPA 2001)
Level of Ecological Protection (after DoE 2006)
Maximum
High
560000mE
580000mE
600000mE
620000mE
7720000mN
7700000mN
Forge Resources
Ronsard Island
West Yule River
Sable Island
Depuch Island
FORESTIER BAY
Jetty
Peawah River
BALLA BALLA MINE SITE
Sherlock River
BALLA BALLA TRANSHIPMENT PROJECT
Figure 7
Existing Zoning Classifications
Author: I. Le Provost
Date: January 2013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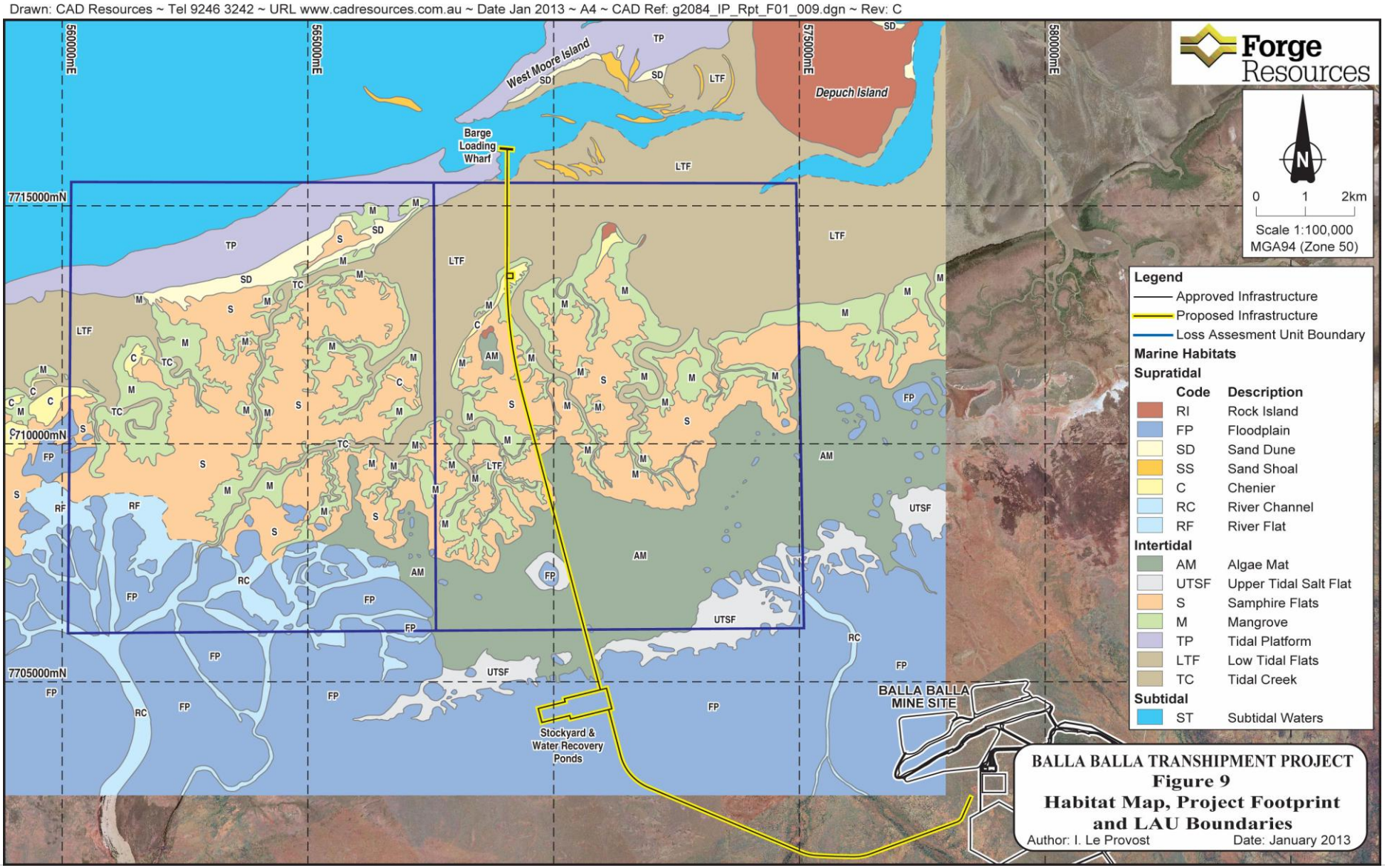
Scale 1:250,000
MGA94 (Zone 50)
Legend
Approved Infrastructure
Proposed Infrastructure
Key Ecosystems
560000mE
580000mE
600000mE
620000mE
7720000mN
7700000mN
Barrier Island
Barrier Island
Barrier Island
Yule River Delta
Ronsard to Cape Cossigny Regionally Significant Mangrove Ecosystem
Balla Balla Creek Mangrove Ecosystem
Sherlock River Delta Mangrove Ecosystem
Sherlock River Delta
Forge Resources
BALLA BALLA TRANSHIPMENT PROJECT
Figure 8
Key Ecosystems of Forestier Bay
Author: I. Le Provost
Date: January 2013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560000mE
565000mE
575000mE
580000mE
7715000mN
7710000mN
7705000mN
West Moore Island
Depuch Island
Barge Loading Wharf
Stockyard & Water Recovery Ponds
BALLA BALLA MINE SITE
Forge Resources
N
0 1 2km
Scale 1:100,000
MGA94 (Zone 50)
Legend
Approved Infrastructure
Proposed Infrastructure
Loss Assesment Unit Boundary
Marine Habitats
Supratidal
Code Description
RI Rock Island
FP Floodplain
SD Sand Dune
SS Sand Shoal
C Chenier
RC River Channel
RF River Flat
Intertidal
AM Algae Mat
UTSF Upper Tidal Salt Flat
S Samphire Flats
M Mangrove
TP Tidal Platform
LTF Low Tidal Flats
TC Tidal Creek
Subtidal
ST Subtidal Waters
BALLA BALLA TRANSHIPMENT PROJECT
Figure 9
Habitat Map, Project Footprint and LAU Boundaries
Author: I. Le Provost
Date: January 2013