## A4

**VOLUME A:** BACKGROUND AND NEED

# Project Description: Runway Layout

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## Part 1 – Permanent Works

The following table provides a summary of the permanent works associated with the New Parallel Runway (NPR) project and identifies those aspects of the project that are relevant to the assessment of the Master Development Plan (MDP) under section 91 (1) of the *Airports Act*.

| Design Element | Details | Further Information on Impact Assessment/ Mitigation | Relevant to the MDP Yes/No |
|---|---|---|---|
| Clearing of approximately 361 ha of vegetation. | Vegetation including plantation casuarina and mangroves will be removed for the NPR project. | Volume B: Airport and Surrounds (Refer Chapter B5 of Draft EIS/MDP) | Yes |
| Reclaiming 15 Mm$^3$ of sand from Middle Banks in Moreton Bay for site surcharging and filling. | Sand, proposed to be sourced from Middle Banks in Moreton Bay, will be used to surcharge and fill the NPR site. | Volume C: Middle Banks, Moreton Bay | Yes – relevant to consideration of section 91(1) (h) |
| Reconstructing the existing seawall along the Moreton Bay/ Airport boundary. | A seawall will replace an existing poorly constructed seawall on the foreshore of Moreton Bay. The seawall will provide protection to the NPR from storm tide events. | Volume B: Airport and Surrounds | Yes |
| Constructing the NPR and associated taxiways. | The runway will facilitate the arrival and departure of aircraft. Taxiways will be used to enable aircraft to manoeuvre between the runway and terminal facilities. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |
| Widening and strengthening of the 14/32 runway pavement, and enhancements to the existing runway system. | The existing 14/32 runway will be converted into a taxiway that links the northern end of the NPR system to the northern end of the existing major runway. Ahead of the opening of the NPR, the upgraded 14/32 will be used as a runway. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |
| Constructing a new dual parallel taxiway (adjacent to the NPR). | The full-length dual parallel taxiway system has been designed to service the expected Airport demand. Construction of this taxiway system will be staged as the full system is not required in the short to medium term. Its future construction will be dependent upon Airport demand and future developments within the airfield. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |
| Constructing a link taxiway from the NPR to the main existing runway. | A link taxiway will provide an efficient connection between the NPR and existing runway. It will be a dual link taxiway to allow for future connections into an expanded domestic terminal apron. Construction of the parallel link taxiway system will be staged as the full system is not required in the short to medium term. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |

| Design Element | Details | Further Information on Impact Assessment/ Mitigation | Relevant to the MDP Yes/No |
|---|---|---|---|
| Establishing new airfield lighting including approach lighting. | Approach lighting is provided at each end of the runway centreline to enable use during periods of low visibility. Because the NPR is close to the Moreton Bay boundary, approach lighting for planes landing over Moreton Bay is proposed to extend approximately 660 m from the Moreton Bay shoreline. It will be supported by piles. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |
| Constructing a new fire station. | A fire station within three minutes response time of the NPR is required under CASA regulations. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |
| Constructing a road tunnel along Dryandra Road under the link taxiway. | The construction of the NPR involves the construction of a major link taxiway between the existing runway and the new runway. As an area of the NPR site is allocated for future aviation facilities including the General Aviation Terminal and Royal Flying Doctor Service, there is a need to provide a vehicular link via a tunnel under the link taxiway. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |
| Constructing new perimeter roads around the airfield. | To enable regular maintenance of the airfield, security inspections and response to emergencies. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |
| Constructing new permanent drainage channels. | The Kedron Book Drain and Serpentine Inlet Drain are major tidal channels that will be constructed to provide flood immunity and to maintain existing flood immunity to existing infrastructure. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |
| Constructing new airfield drainage. | Substantial drainage infrastructure will be constructed to provide flooding immunity to new and existing infrastructure. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |
| Installing new security fencing. | To maintain safe, reliable Airport operations and defining a boundary between 'airside' and publicly accessible 'landside' areas. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |
| Relocating power and utility services. | Relocation and installation of water, electrical and telecommunication services will be required for the NPR. | Volume A: Background and Need (Refer Chapter A5 of Draft EIS/MDP) | Yes |
| Rehabilitating the site including the use of mangroves at selected locations along drainage channels. | The Kedron Brook Drain and Serpentine Inlet Drain include 10 m wide benches suitable for the establishment of mangrove communities. The mangrove benches assist in stabilisation of the tidal channels and enhance environmental amenity. | Volume B: Airport and Surrounds (Refer Chapter B5 of Draft EIS/MDP) | Yes |

## 4.1 Existing Development

### 4.1.1 Existing Infrastructure on Airport

The existing development on the Airport site includes both aviation related development and commercial development which benefits from close proximity to Airport operations.

The existing aviation-related development at Brisbane Airport is shown on **Figure 4.1.** The significant infrastructure includes:

- 01/19 runway (main runway);
- 14/32 runway (cross runway);
- International Terminal building and apron;
- Domestic Terminal building and apron;
- General Aviation area and apron;
- Control tower and related facilities;
- Catering facilities;
- Cargo handling facilities;
- Aircraft maintenance facilities;
- Services and utilities
- Car parking facilities;
- Local road network; and
- Airtrain link (Rail link from the Airport to the Queensland Rail network).

The NPR is part of Brisbane Airport Corporation's (BAC) $1.5B investment in infrastructure that includes additional roads, aprons and terminal expansions. These projects will interact with the runway project either through design or construction. Chapter A1 described the other significant projects that are occurring at Brisbane Airport.

## 4.2 Description of the New Parallel Runway

The proposed NPR consists of the following major elements:

- Dredging 15 million cubic metres (Mm$^3$) of sand from Middle Banks in Moreton Bay;
- Surcharging the NPR site with the dredged sand;
- Reconstructing the existing seawall along the Moreton Bay/Airport boundary;
- Constructing the NPR and associated taxiways;
- Widening and strengthening of the 14/32 runway pavement for its conversion to a taxiway for Code F aircraft (large wide-body);
- Constructing a new dual parallel taxiway (adjacent to the NPR);
- Constructing a link taxiway from the NPR to the main existing runway;
- Constructing rapid exit taxiways from the NPR to the parallel taxiway;
- Establishing new airfield lighting including approach lighting;
- Constructing a new fire station;
- Constructing a road tunnel along Dryandra Road under the link taxiway;
- Constructing new perimeter roads around the airfield;
- Constructing new permanent drainage channel upstream of the runway;
- Augmenting the existing permanent drainage channel at Serpentine Inlet with an additional drain;
- Constructing new airfield drainage;
- Installing new security fencing;
- Clearing and filling for the Future Aviation Facilities Area (FAFA); and
- Relocating power and utility services.

The construction methodology for each of these elements is further described in Chapter A5 Runway Construction.

## 4.3 Site Planning

### 4.3.1 Introduction

The location of the NPR is shown in the Brisbane Airport Master Plan (2003) and the current proposed location is consistent with the Master Plan (2003) in that it will be offset 2,000 m to the west and staggered 1,350 m to the north from the existing

***Figure 4.1:*** *Existing Airport Development.*

**Figure 4.3:** *Proposed New Parallel Runway Infrastructure.*

01/19 runway (refer **Figure 4.3**). The proposed configuration of the rapid exit taxiways was rationalised during the design process in recognition of the anticipated operating modes.

### 4.3.2 New Parallel Runway Design Standards

The International Standards and recommended practices are formalised in Annex 14 of the Convention on International Civil Aviation, adopted by the International Civil Aviation Organisation (ICAO). The national standards and advisory publications are administered in Australia by the Civil Aviation Safety Authority (CASA) under the *Civil Aviation Act 1988*, the Civil Aviation Regulation 1988 (CAR 1988) and the Civil Aviation Safety Regulations 1998 (CASR 1998).

The CASR 1998 is divided into a number of sections. This is known as the Manual of Standards (MOS) and specifies the requirements for safe air navigation. The key sections of the MOS are:

- MOS Part 139 – The requirements for aerodromes used in air transport operations are prescribed in the CASA policy manual;
- MOS Part 172 – The requirements and standards for compliance by an air traffic service (ATS) provider, including the facilities and equipment required; and
- Advisory Circulars (ACs) - intended to provide recommendations and guidance to illustrate a means of complying with the Regulations.

The planning and design considerations for the geometry of the new runway are predominantly the requirements and recommendations of ICAO and Part 139 CASA MOS.

## 4.4 Preliminary Design Process

The preliminary design of the runway was undertaken (initially pre-EIS/MDP works) to provide the basis for assessment of impacts in the Draft EIS/MDP and to establish the estimated cost for project construction.

The design was undertaken in four distinct phases:

- Scoping;
- Investigations and modelling;
- Option assessment; and
- Preliminary design.

The scoping phase focused on reviewing all relevant documentation regarding Airport infrastructure and environmental characteristics of the Airport site. This information was held by BAC at the time of preliminary design (before detailed ecological and other environmental studies were undertaken for the Draft EIS/MDP phase of work). The preliminary design built on existing work carried out in support of the BAC Master Plan (2003) and project definition phase.

The field investigations included commissioning geotechnical, acid sulfate soil and field survey investigations to support the development of the design. Flood modelling of Kedron Brook and the existing drainage on Airport was performed, and analysis of the geotechnical field data was undertaken.

Design options were investigated to understand and where possible, quantify the impacts of some design elements on the environment, Airport security, aviation operations and constructability. Existing information on the environmental condition of the Airport site was fundamental in informing the preliminary design of the NPR. A number of design iterations were assessed to understand the relative impact of some key components of the preliminary design and develop a preferred design to optimise whole-of-project outcomes, balancing aviation operations, constructability, security and environmental performance.

Preliminary design and documentation of the project along with preparation of a construction cost estimate followed the adoption of preferred design options.

The works for the Draft EIS/MDP commission commenced during the development of the preliminary design, allowing information from the Draft EIS/MDP investigations to be used to inform and improve the preliminary design of the project.

## 4.5 Existing Airport Conditions

### 4.5.1 Site History

Construction of the runway and domestic terminal, in its current location, commenced in May 1980 and was completed in March 1988. A program of dredging and reclamation was undertaken as part of the initial construction works to provide a foundation upon which the new Airport could be constructed. Approximately 16 $Mm^3$ of sand was dredged from Middle Banks, in Moreton Bay to complete the project. In 1990, a second dredging and reclamation project of approximately 4 $Mm^3$ of sand, again from Middle Banks, was undertaken for construction of the International Terminal building and apron.

Both of these projects required significant modification to the natural environment including tidal creek diversions, mangrove clearing and broad filling of the generally low lying site. As described in Chapter B5 Terrestrial and Marine Ecology, large numbers of casuarina were planted to stabilise the cleared surfaces and discourage colonisation by birds and other fauna. While most vegetation introduced onto the site are native species, some exotic species were used for landscaping purposes.

### 4.5.2 Environmental Condition

The site of the NPR is characterised by topography with little surface relief and generally low ground elevation. There are a number of remnant creeks and constructed earth channels on the site that are tidally influenced. Constructed tidal channels on the site maintain connectivity of remnant tidal channels and provide local drainage connections for existing Airport infrastructure.

Much of the NPR site maintains existing vegetation. Existing vegetation communities located within the NPR site include:

- Casuarina plantation;
- Freshwater wetland and sedge;
- Open grasslands;
- Mangroves;
- Salt marsh/mudflats; and
- Amenity landscaping.

Casuarina plantation is the dominant vegetation community located within the NPR site, and the plantation has low conservation value. The open grassland and associated freshwater wetland and sedge communities located adjacent Kedron Brook Floodway provide habitat for the Lewin’s Rail, listed ‘rare’ under the Nature Conservation (Wildlife) Regulation 1994.

The Airport Environment Strategy (2004) identifies three remnant mangrove areas that are environmentally significant, located at:

- The mouth and banks of Jacksons Creek;
- The mouth of old Serpentine Creek Inlet; and
- The abutment with the Pinkenba residential community.

The existing environmental condition of the NPR site was fundamental in informing the design of the runway and associated infrastructure, and guided the selection and design of a number of key infrastructure components.

## 4.6 Design Requirements

### 4.6.1 Runway Location

The location of the proposed parallel runway at Brisbane Airport is to the west of the existing 01/19 runway (refer **Figure 4.3**). The new and existing runways will be separated by a distance of 2,000 m, placing the proposed runway as close as practicable to the western boundary of the Airport and the Kedron Brook Floodway. The design of the new runway optimises the separation distance available between the new and existing runways, providing maximum flexibility in the design of future Airport developments between the runways, such as additional terminal development (refer Chapter A3).

The proposed parallel runway is to be located 1,350 m further north than the existing 01/19 runway, introducing a stagger between the new and existing 01/19 runway and placing the NPR as close as practicable to the Moreton Bay shoreline. The location of the NPR minimises residential aircraft noise and provides increased safety by introducing vertical separation for arriving and departing aircraft on each runway.

### 4.6.2 Design Aircraft and Traffic

ICAO has an international code system to specify the standards for individual Airport facilities, suitable for use by aircraft with a range of performances and sizes. The proposed runway and associated infrastructure has been designed based on an Aerodrome Reference Code 4F. This Code has been chosen as it is suitable to accommodate the next generation of large aircraft, as represented by the Airbus A380 aircraft type, as well as all the current aircraft types. To ensure flexibility of the proposed design, a theoretical aircraft, longer than any currently proposed was developed as the design aircraft for the purposes of plotting the aircraft wheel tracks as it moves on the taxiway or runway system. The design aircraft could be described as a stretched A380, in acknowledgement that historically all commercial aircraft have been extended or elongated to improve efficiency.

The traffic forecasts considered in the design of the airfield are consistent with those used in the assessment of noise and other impacts. The traffic forecasts take into consideration the expected changes in the aircraft arrival and departure frequency and the changes in the aircraft fleet expected during the life of the project (refer Chapter A2). The preliminary design used the aircraft fleet and forecasts in a simulation model to identify the capacity of the runway and taxiway system and verify the location of taxiways and connections.

### 4.6.3 Geometric Design

The geometric design of the proposed airfield facilities is in accordance with the prescribed requirements of the CASA MOS. These standards govern the airfield characteristics such as the dimensions and shape of runway, taxiways and related facilities. The MOS refers to the aerodrome reference code (4F) in prescribing the airfield dimensions that are necessary to safely move the required category of aircraft around the airfield. Below is a description of the main geometric design elements that contribute to the proposed airfield design.

### 4.6.4 Runway Length

The active length of the runway is determined by reviewing the operational requirements of the aircraft for which the runway is intended. The existing 01/19 runway has an operational length of 3,560 m and the proposed runway is to adopt the same length. The 3,600 m runway length is capable of accommodating the requirements of all current aircraft and provides flexibility in accepting different aircraft in the future.

At each runway end, a safety zone is required. Known as the Runway End Safety Area (RESA), this is an additional area over which aircraft could travel in an emergency. It is not included in the assessment of runway length. This area must be provided at the end of the runway strip to protect the aircraft in the event of undershooting or overrunning the runway. Current CASA standards indicate that the RESA must be 90 m in length and free of fixed objects, other than visual or navigational aids which will be designed to be of low mass and frangibly mounted so that they break upon aircraft impact.

### 4.6.5 Runway Width

The required width of the proposed runway is determined in accordance with CASA standards for Aerodrome Reference Code 4F where a 60 m wide runway is prescribed.

In addition to the runway width, runway shoulders are required. For a Code 4F runway, 7.5 m wide shoulders are designed to be flush with the runway surface and equal in width on both sides. The shoulders are designed to be resistant to aeroplane engine blast erosion through the use of a dense graded asphalt surface and are adequate to support an aeroplane running off the runway, without causing structural damage to the aircraft.

The final element which determines the overall width required to operate the runway is the runway strip. The runway strip width is 150 m, with the runway being centrally located within the runway strip. The runway strip is required to provide a safety zone for the aircraft and is designed to be free from all fixed objects other than visual aids (lights) for aircraft guidance. Visual aids, where required, are designed to be of low mass and frangibly mounted to minimise structural damage to the aircraft if impacted.

The runway strip is grassed or vegetated with low slopes away from the runway shoulders towards the natural surface. Drainage channels are provided to ensure stormwater does not pond within the runway strip.

### 4.6.6 Taxiways

To enable the aircraft to manoeuvre between the runway and terminal a network of taxiways is required. The taxiway configuration needs to provide efficient aircraft movement around the airfield, minimising taxi distance and maximising flexibility. There are many elements to the taxiway system, including parallel taxiway, rapid exit taxiways and other link taxiways all of which perform a specific function.

The proposed taxiway layout (refer **Figure 4.6**) provides:

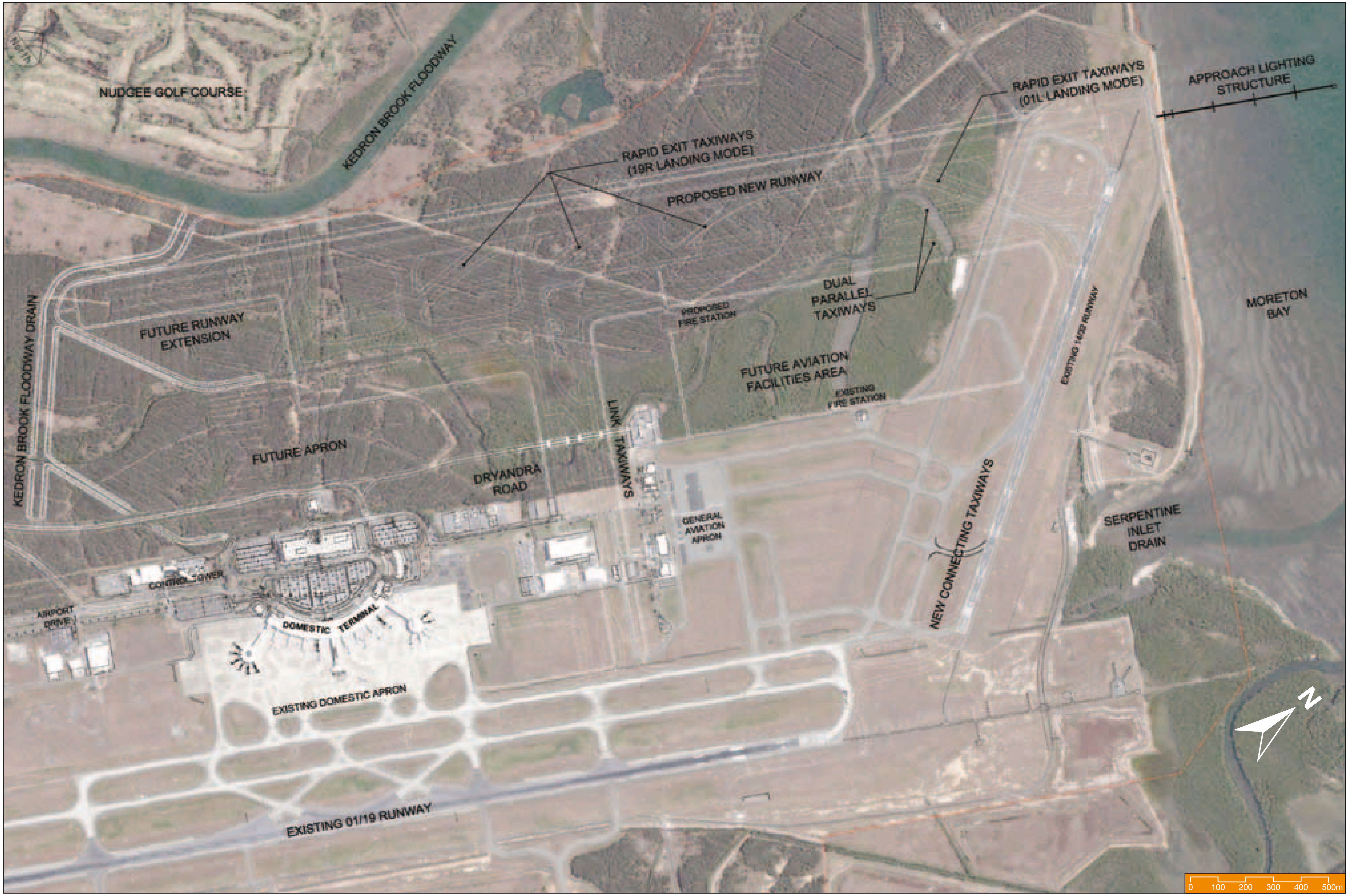
- A dual parallel taxiway, parallel to the new runway;
- A dual link taxiway, connecting the new runway with the existing runway;
- Conversion of runway 14/32 into a link taxiway that connects the northern ends of the new and existing runways; and
- A rapid exit taxiway system connecting the runway and parallel taxiways.

The geometry of the taxiway pavements is a function of the design aircraft's wheel track dimensions and pavement edge clearance requirements. Within the standards, a straight section of taxiway suitable for Code 4F aircraft needs to be a minimum width of 25 m. In addition, the width of any section of taxiway must be sufficiently wide to provide a minimum clearance between the outer aircraft wheels and edge of the taxiway, of 4.5 m. This criterion has determined the overall taxiway shape, particularly on parts of the taxiway where aircraft are turning (refer section 4.6.2).

On curved sections of taxiway, and at junctions and intersections with the runway or other taxiways, the taxiway width is increased to enable aircraft to manoeuvre on the taxiway pavement. The widening is called a 'fillet'. To determine the shape and size of the fillets, aircraft tracks for each aircraft in the current fleet and the theoretical design aircraft were modelled on the proposed taxiway layout to ensure the 4.5 m clearance will be maintained.

In addition to the taxiway pavement, taxiway shoulders are required on each side of the taxiway pavement. The taxiway shoulders measure 17.5 m and are required either side of the taxiway to accommodate Aerodrome Reference Code 4F aircraft. The shoulders are designed to be resistant to aircraft engine blast erosion. Similar to the runway strip, a taxiway strip is provided around each taxiway. The taxiway strip will be grassed and free of fixed obstacles or obstructions.

***Figure 4.6:*** *General Layout Plan.*



### 4.6.7 Rapid Exit Taxiways

Rapid Exit Taxiways (RET) increase overall runway efficiency by allowing arriving aircraft to exit the runway quickly. The geometry of the RET, typically angled at 45 degrees to the runway, allows aircraft to exit the runway while travelling at greater speed, reducing the occupancy time on the runway.

Four RETs are included in the taxiway system of the NPR project. Three are suitable for aircraft arriving from the north (19R landing mode) and one suitable for aircraft arriving from the south (01L landing mode) (refer **Figure 4.6**). These are located to take into account the preferred operating mode of the new runway and different aircraft types in both wet and dry conditions:

- The first RET (19R landing mode) is designed to suit turboprops on a wet runway;
- The second RET (19R landing mode) is designed to suit domestic jets on a dry runway;
- The third RET (19R landing mode) is designed to suit long haul wide body jets on a dry runway (which also coincides with wet runway requirements for domestic jet operations); and
- The fourth RET (01L landing mode) is designed to suit long haul wide body jets on a dry runway and domestic jet operations on a wet runway.

### 4.6.8 Link Taxiway

To enable an efficient connection between the new runway and existing runway, a link taxiway is proposed. The proposed link is a dual link taxiway that will allow for future connections into an expanded domestic terminal apron. Incorporated into the design of the link taxiway is the allowance for a road tunnel which passes under the link taxiway and provides access from the domestic terminal precinct and into the General Aviation area and Future Aviation Facilities Area (FAFA). The vertical alignment of the link taxiway accounts for the tunnel beneath it with a slight vertical curve.

### 4.6.9 Existing 14/32 Runway

The existing airfield comprises two runways and connecting parallel taxiways. The two runways currently service both international and domestic aircraft movements:

- The main runway is 3,560 m long and 45 m wide and is sufficient for large, wide bodied aircraft (01/19 runway); and
- The minor runway is 1,760 m long and 30 m wide and is suitable for a limited range of aircraft (14/32 runway).

At present, aircraft operations on the minor runway (14/32) are restricted by its length and the strength and condition of the existing runway pavement. The operational restriction is defined in terms of an aircraft weight limit. The current aircraft weight restriction limits the 14/32 runway operation to small aircraft, with a maximum weight limit of 56 tonnes.

### 4.6.10 Converting 14/32 Runway into a Taxiway

Construction and operation of the new runway requires the existing 14/32 runway to be converted into a Code F taxiway that links the northern end (19R) of the NPR system to the northern end (19L) of the existing major runway. Converting the existing 14/32 runway into a taxiway requires pavement strengthening and changing the geometry of the existing formation. The construction work proposed includes:

- Relocating services at the site;
- Ground treatment at the northern end of the runway (including vacuum consolidation);
- Installation of drainage culverts beneath the runway;
- A protection structure for the dredge pipeline beneath taxiway links Alpha and Bravo;
- Pavement construction and earthworks to the flanks; and
- Aerodrome ground lighting.

Constructing the required improvements requires the closure of the 14/32 runway for up to 24 months, during which time all air traffic will be required to use the major runway (01/19).

### 4.6.11 Construction Staging

Accepting that the 14/32 runway requires closure for a length of time to complete the construction works, the adopted construction staging is focused on minimising the period of time that the 14/32 runway is closed and ensuring that the closure is executed early in the project when traffic demand is lowest. In addition, sufficient works will be undertaken to allow the runway to be reopened and used as a runway during the construction period for the NPR. Refer Chapter A5 for details on the construction phasing.

### 4.6.12 Aviation Operations

The aviation objective of the staged construction is to provide opportunity for continued use of the 14/32 runway during the construction of the parallel runway project and to minimise the length of time runway 14/32 is unavailable. Following the construction and reopening, the 14/32 runway will be a Code 3C runway, allowing arrival and departure of commercial jets up to Boeing 737-800 and Airbus A-320-200 type aircraft. This will extend the current availability of the 14/32 runway for different aircraft and improve flexibility for Airport operations.

Following the commissioning and opening of the parallel runway, the 14/32 runway would be decommissioned as a runway and opened as a Code F taxiway. The lighting system and navigational aids would be changed to reflect the changing use. All arriving and departing aircraft would be directed to the existing or the NPR.

### 4.6.13 Staged Development of Runway and Taxiway System

#### *4.6.13.1 Runway*

The NPR is designed to have an ultimate length of 3,600 m, however initial development of the NPR involves construction of 3,000 m (refer **Figure 4.6**).

The preferred operating mode for the parallel runway system will involve 01R departures (existing main runway) and 19R arrivals (new parallel runway). Under this operating mode, there will be no operational restrictions for the current aircraft fleet arriving on the NPR or for long haul departures from the existing runway.

Additional runway length (3,600 m) is required for long-haul international departures from the NPR. Construction of the full 3,600 m runway to accommodate long-haul international departures is a long term development plan and may be constructed following development of the future western apron and terminal facilities.

#### *4.6.13.2 Taxiways*

The final design of the new runway system includes:

- Full length, dual parallel taxiway system alongside the runway to service the expected Airport demand; and
- Dual link taxiway connecting the existing runway and new runway;

The full length dual parallel taxiway system is not required in the short to medium term, and as such, construction of it will be staged to provide the minimal taxiway infrastructure to service the runway. Further stages of the taxiway construction will be dependent on the increased Airport demand and future developments within the airfield.

The construction of a full dual link taxiway from the existing runway to the new runway will not be required in the short term and as such, it will not be constructed as part of the initial construction. Further development of the domestic terminal apron may provide the impetus for constructing the duplication of the link taxiway. By providing only a single link taxiway initially, the design can accommodate the existing Qantas Catering building by constructing only the eastern taxiway link as shown on **Figure 4.6**. The staged development will delay relocating this facility until the dual link taxiway is required.

Air traffic control procedures specify standard taxiing routes that avoid the use of common taxiway areas for opposite direction taxiing. These procedures have been allowed for within the staged taxiway design. Each stage of taxiway construction has been simulated to verify the operational performance using a Total Airspace and Airport Modeller (TAAM) simulation model.

## 4.7 Airfield Pavements

Runways and taxiways require specifically designed pavements to cater for the loading from aircraft during landings, takeoff and taxiing. In general, aircraft are heaviest and require the most support from the pavement during taxiing, immediately prior to takeoff. Landing aircraft and aircraft taxiing to the terminal immediately after landing are considerably lighter than the corresponding departing aircraft, owing to the reduced volume of fuel on board the aircraft.

Each component of the taxiway infrastructure or the runway must be designed with these operational considerations in mind including the type of aircraft, expected frequency of aircraft traffic and the environmental considerations specific to the site. Typically, runway pavements at Australian airports are constructed using gravel pavements with asphalt surfacing (flexible pavements) while taxiways are constructed using both concrete pavements (rigid pavements) and flexible pavements, depending upon the specific situation.

### 4.7.1 Existing Runway and Taxiway Pavements

The existing Brisbane Airport runway and taxiway pavements have performed to the satisfaction of BAC (both flexible and rigid pavements). The existing runway is constructed from flexible pavement with asphalt surfacing while the majority of the existing parallel taxiway system is constructed from rigid pavements.

After approximately 15 years of use, the existing runway pavement was resurfaced with asphalt, in line with the design intent. Resurfacing asphalt pavements is required from time to time to correct irregularities in the pavement surface and replace the existing asphalt that has weakened and deteriorated due to exposure to the environment. Since its resurfacing, the pavement has performed as expected.

The existing rigid pavements on the parallel taxiway (servicing the existing main runway) are serviceable and expected to last for a period of approximately 40 years from the opening of the runway in 1988.

Based upon the successful operation of the existing Airport with both flexible and rigid pavements, the new runway will incorporate similar pavements where appropriate. Based upon this experience, a requirement for the design life for each pavement was established:

- Flexible pavements – 15 years between asphalt resurfacing; and
- Rigid pavements – 40 years.

### 4.7.2 Design Considerations

A number of factors were taken into account in determining the preliminary design of the runway and taxiway pavements including:

- Aircraft fleet, numbers and expected operations; and
- Geotechnical considerations.

These factors have informed the design process and influenced the preliminary pavement selection.

### 4.7.3 Aircraft and Operational Considerations

The aircraft fleet used in the preliminary design was estimated based upon the air traffic forecasts developed for the project (refer Chapter A2). The critical aircraft within the forecast aircraft mix differ for each design element. The critical aircraft for the design of the runway and taxiway pavements is dependent upon the wheel loading of each aircraft, which is in turn dependent upon the number of wheels (or bogeys) and the total weight of the aircraft.

The preliminary design of the NPR and taxiway pavements considered both the critical aircraft as well as the forecast aircraft fleet mix and the forecast movements of each aircraft type within the fleet (refer Chapter A2 and section 4.6.2).

Aircraft undertake different manoeuvres on different parts of the airfield and require different performance from the pavement over which the aircraft is trafficking. Of specific interest in the preliminary design were the locations where aircraft are expected to stop and/or turn. Aircraft stopped or stopping and turning exert different loads on the pavement and generally, where these manoeuvres are expected, rigid pavements are required. Rigid pavements offer a greater resistance to scuffing and shearing loads typical of slow moving and turning aircraft. Typically, the parallel taxiway system is subject to high loads, where aircraft can be stopped for extended periods and can undertake large numbers of turning manoeuvres.

By contrast, rapid exit taxiways are areas where the aircraft is travelling at relatively high speed, exiting the runway immediately after landing. As such, these taxiways can only be trafficked by aircraft travelling with lower fuel loads, moving relatively quickly and are suited to flexible pavement construction.

### 4.7.4 Geotechnical Considerations

The natural ground material over most of the runway site is characterised by weak, soft clay material that does not provide adequate stability or support in its unaltered state. Typically, mangrove mud/clay, similar to those found on the runway site, have a very low strength. To enhance the strength and suitability of the site, the existing surface requires significant ground treatment or consolidation prior to pavement construction (refer section A4.8 and Chapter B3).

Flexible pavements rely on gravel or granular materials being placed in layers over the existing surface with a surfacing over the top layer. To provide sufficient strength, each layer must be stronger than the previous layer, with the top layer comprising the hardest and strongest gravel materials. The surfacing material in this case is asphalt. As the in situ soils at Brisbane Airport are weak, a significant depth of granular material is required beneath the pavement, for the pavement to have sufficient strength. As with the existing Brisbane runway, an estimated 2 m of sand material is required between the in situ soils and the base of the pavement materials to provide sufficient strength to support the pavement.

### 4.7.5 Pavement Types

Based upon the above considerations, rigid pavements were adopted for the:

- Parallel taxiway;
- Runway ends;
- Sections of the link taxiway; and
- Taxiway links between existing 01/19 and the upgraded 14/32 runway.

Flexible pavements were adopted for the:

- New Parallel Runway pavement;
- Rapid exit taxiways;
- Sections of the link taxiway; and
- Upgraded 14/32 runway.

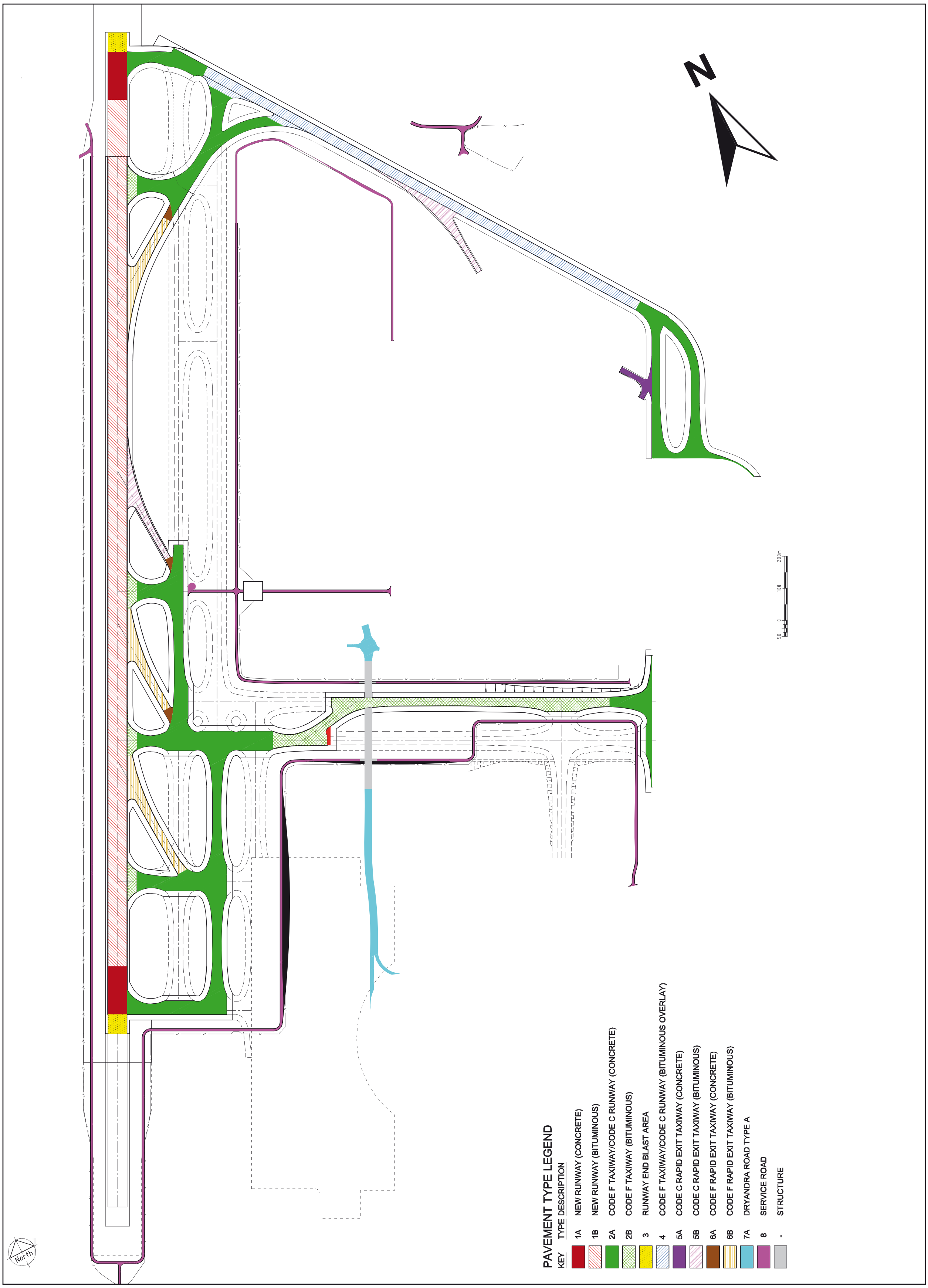
The pavement type layout is presented in **Figure 4.7** showing all pavement types.

### 4.7.6 Adopted Pavement Thicknesses

The runway pavement design adopted 550 mm thick gravel pavement with a 60 mm thick asphalt surfacing. In addition to the gravel pavement, 2 m of sand is required over the existing surface materials to support the pavement materials.

The concrete taxiway design adopted 400 mm thick Portland cement concrete over a minimum of 2 m of sand material.

***Figure 4.7:*** *Runway and Taxiway Pavement Layout.*



## 4.8 Subsurface and Geotechnical Conditions

The new runway site is located in a low lying estuarine environment between Kedron Brook Floodway and the existing Airport development. The majority of the site is unfilled with the exception of an area that was used as a dump for dredge spoil, extracted from the Kedron Brook floodway in the 1980s.

Although the site is considered mostly flat, it is heavily modified with a large casuarina plantation established across the new runway site during the construction of the existing runway and terminal development.

### 4.8.1 Geotechnical Investigations

As part of the preliminary design, geotechnical investigations were undertaken to determine the engineering and geological characteristics of the in situ soils so that these characteristics could be incorporated into the design. Specific geotechnical investigations supplemented existing geotechnical information held by BAC.

Existing geotechnical information included:

- 10 peizocone penetrometer tests from a preliminary investigation in the NPR site;
- 7 peizocone penetrometer tests from various investigations around the domestic terminal precinct; and
- 3 boreholes from previous investigations around the domestic terminal precinct.

Geotechnical investigations undertaken during preliminary design include:

- Drilling and sampling 10 boreholes, generally along the centreline of the NPR;
- 27 piezocone penetrometer tests; and
- A further 9 piezocone penetrometer tests around the northern end of the 14/32 runway.

The piezocone penetrometer tests enabled a probe to be pushed into the in situ materials and the characteristics of the materials to be measured continuously. These tests ranged in depth from 9 m to over 32 m but were generally executed until the probe encountered a hard surface that could not be penetrated.

The results of these tests enable the depth of soft surface soils to be measured. The depth of the surface soils and their strength and engineering properties are critical in the design of ground treatment measures.

### 4.8.2 Ground Conditions

The testing found that ground conditions across the site were broadly similar to other locations in the general vicinity of the new runway site. A broad summary of the ground conditions is:

- Vegetation and topsoil; over
- A ‘crust’ of surface soils approximately 1.0 m deep; over
- Compressible materials (typically sandy clays and clayey sands) to between 7 m and 12 m in depth;
- Compressible silty clays to between 10 m and 32 m in depth; and
- Stiff clay and dense sands below the compressible materials.

The groundwater depth was estimated (based on soil pore pressure response during piezocone penetrometer testing) to be approximately 1.0 m to 2.5 m below ground surface level. Further assessment of groundwater depth was undertaken during acid sulfate soils investigation, and the results of these investigations are presented in Chapter B3.

The presence of the soft compressible materials is understood to be the result of geological processes where the soft silts and muds were deposited on the site when the site was underwater. The soft material filled in numerous surface features including old creek channels and other depressions – the shape, location and extent of which was determined during the investigation. The location and depth of these in filled, subsurface channels is important to the engineering design of the runway.

For a full description of the ground conditions, including testing for acid sulfate soils, refer to Chapter B3.

### 4.8.3 Subsurface Channels

A key characteristic from the geotechnical investigations that influences the design is the level or depth of the compressible materials. As part of the investigation, the depth of the compressible materials was mapped across the site (refer Chapter B3). The investigations indicate that there is a deep relict channel filled with compressible materials to the east of the proposed runway. The channel can be traced to the north, adjacent the end of the existing 14/32 runway.

The depth of soft material in the infilled channel is typically greater than 30 m. The conditions are similar to those encountered on the International Terminal building project where old deep, infilled channels were managed through the design and construction of the terminal building and apron. The ground conditions on the existing runway site are slightly different to those encountered on the new runway site. The existing runway site does have areas of soft infilled material but does not have channels to such depth.

### 4.8.4 Engineering Design Considerations

Factors considered in the engineering design of the ground treatment and filling of the site include:

- Consolidation of the subsurface fills;
- Filling program or construction method; and
- Final settlement (secondary settlement) while in use.

Consolidation of subsurface soils occurs when the ground water trapped in the subsurface soils is squeezed out in response to increased surface loading. This process is particularly relevant to the new runway project site where the consolidation of the soft, wet materials contained within the deep subsurface channels is required as part of the construction process. The evidence of consolidation occurring during construction is the lowering of the ground surface level – commonly called settlement. Settlement generally occurs in two phases:

- Primary settlement (during construction phase of the project); and
- Secondary settlement (during the operational phase of the project).

Generally, it is desirable for a construction technique to be employed that maximises the primary settlement and minimises the secondary settlement. Once the project is constructed, excessive secondary settlement is difficult to manage and can result in excessive maintenance. The total settlement experienced on any site is a function of the subsurface conditions while the secondary settlement is a function of the ground treatment employed during construction.

BAC requested that the design adopt a construction technique with a target secondary settlement of 100 mm. To address this requirement, a number of construction techniques were investigated, including:

- ‘Preloading’ – filling the site to a predetermined level and allowing the ground to settle to the nominated design level over a period of time;
- ‘Surcharging’ – surcharging involves filling the site to a greater level than the final level and allowing the surcharge to remain for a predetermined period, while allowing the site to settle; and
- ‘Surcharging with wick drains’ – as above with the addition of vertical wick drains that aim to accelerate the consolidation process by providing improved subsurface drainage.

In addition to these construction techniques, a more aggressive consolidation technique, vacuum consolidation, was investigated for use in areas with particularly deep subsurface channels. Vacuum consolidation involves the application of a vacuum pressure to vertical wick drains to further accelerate the consolidation process. The use of vacuum consolidation is warranted where consolidation is required quickly and the other measures investigated cannot deliver the settlement in a timely manner.

Once complete, each of these ground treatments aims to accelerate the primary settlement of the site. Further, it is possible for each of these options to be used on different parts of the site, dependent upon the ground conditions. Each of the consolidation techniques is equally valid, depending upon the construction timeframe and ground surface conditions. The more aggressive techniques are effective at improving the drainage of groundwater from the soft, subsurface materials, resulting in shorter timeframes for delivery of primary settlement.

With the exception of preloading, all techniques require the temporary placement of additional sand fill material over the runway site. To increase the applied load and further accelerate consolidation, additional fill can be placed over wick drains in combination with vacuum consolidation. An important consideration in the development of the construction technique is the maximum amount of fill available from Moreton Bay.

### 4.8.5 Construction Timing

In addition to the subsurface conditions, there are construction timing constraints on the project that need to be considered when developing the ground treatment design. Refer to Chapter A5 for a detailed description of the construction methodology and timing.

In summary, BAC requires:

- Construction of the 14/32 runway upgrading over a short period so that the runway closure and impact on Airport operations is minimised; and
- Construction of the remainder of the project in a reasonable timeframe, consistent with the cost effective delivery of the ground treatment components of the project.

These two requirements have influenced the design of the ground treatment.

### 4.8.6 Adopted Geotechnical Design

The ground treatment methods listed above were assessed for suitability on the runway site with a view to establishing the amount of settlement and the timeframe required to achieve it.

Typically, settlements across the site range between 500 mm and 1.5 m with those areas near the deep subsurface channels expecting settlements in the order of 2 m. This primary settlement is combined with a secondary target of 100 mm (measured after 50 years of runway operation).

To achieve these settlements in a reasonable timeframe, a combination of all construction techniques is proposed.

In summary:

- Some areas along the runway centreline can be constructed using preloading only. The elevated ground level in this area, due to the dredge spoil from Kedron Brook Floodway dredging (refer above) has been acting as a preload since the early 1980s, thus reducing the need for further ground treatment in this area.
- The majority of the parallel taxiway requires surcharging with wick drains to varying surcharge heights from 5.5 m to 6.5 m above existing ground level. The deeper areas of soft material require more aggressive treatment to drain groundwater from the subsurface materials.
- The connection of the link taxiway to the existing parallel taxiway will require surcharge to a height of 5.5 m. This area was partially filled (to a low height) during the construction of the existing runway and has since undergone some consolidation.
- An area suitable for vacuum consolidation is identified at the northern end of the 14/32 runway. The need to minimise closure of the 14/32 runway results in a more aggressive ground treatment technique being adopted in this area.

The proposed ground treatment plan will allow the project to be delivered to the construction program provided in Chapter A5.

## 4.9 Airport Drainage

The NPR project is located at the lower end of Kedron Brook catchment, bounded by Moreton Bay to the north and adjacent waterways including Kedron Brook Floodway and Landers Pocket Drain. The site of the NPR is currently subject to inundation during large regional flood events and through regular tidal cycles. The flooding context of the NPR area and the interacting waterways is discussed further in Chapter B7 Surface Water Hydrology and Hydraulics.

Substantial drainage infrastructure will be constructed as part of the new runway project to provide suitable flooding immunity to new and existing infrastructure on the site (refer **Figure 4.9a**). The drainage infrastructure constructed will include:

- Major tidal channels (at the discharge locations from the Airport);
- Secondary channels (connecting non-tidal channels to major tidal channels);
- Local non-tidal channels;
- Detention storage and vegetated buffer areas; and
- Hydraulic structures.

The site of the NPR is currently extensively modified from its original condition, although it remains undeveloped. The site does not include an engineered drainage system, but includes a number of remnant and modified tidal channels that drain the existing Airport development and the flood waters that inundate the site from the Kedron Brook drainage system.

### 4.9.1 Major Tidal Channels

The Kedron Brook Floodway Drain and Serpentine Inlet Drains are major tidal channels that will be constructed in association with the NPR project. These major tidal channels provide flooding immunity to the NPR and maintain existing flooding immunity to existing infrastructure, reduce the impact of the NPR on regional flooding on- and off-Airport, and enhance the environmental amenity of the new runway project.

#### *4.9.1.1 General*

Alternatives for the provision of the major tidal drainage channels were investigated during the preliminary design. The considerations that informed the chosen locations included:

- The existing development on the Airport and the locations of existing drainage outfalls from the General Aviation area and the domestic terminal precinct;
- Environmental considerations, including the location of flora and fauna areas with high conservation value;
- Site geotechnical conditions and the areas of the site where large settlements are expected, specifically the area beneath the proposed runway immediately adjacent to the existing 14/32 runway;
- The desire to use the major tidal channels during both the construction and operational phase of the runway to limit the disturbance to existing creeks and drains; and
- The size, location and geometry of the proposed taxiway and runway.

The domestic terminal precinct and general aviation area generally drain towards the runway site through a series of culvert outfalls. During construction and during the operation of the NPR, drainage to existing facilities must be maintained at all times. The locations and size of drainage outfalls informed the locations of the major tidal drainage channels.

The NPR will be located in areas of poor soil conditions that will be subject to significant post-construction settlement (refer Chapter B3 Geology and Soils). Use of drainage structures beneath the NPR, in areas where high settlements are expected, is likely to cause unacceptable surface undulations along the runway as the soft, compressible natural material settles away from any rigid drainage structures. In addition to geotechnical constraints, the provision of the 150 m wide runway strip (refer section 4.6.5) requires the installation of very long cross runway culverts which would prove difficult to maintain and may prove difficult to secure. Accordingly, cross-runway drainage is not proposed.

The flat topography of the site places a limitation on the change in channel bed elevation from the top of each drain to the point of discharge, which ultimately limits the length of drains. Accordingly, major tidal drainage channels are required at each end of the NPR to reduce the total length of drainage branches. The site is effectively broken by the link taxiway into two similar sized catchments, each draining to one of the major tidal drains.

Consideration of these factors and the likely discharge locations leads to the provision of major tidal channels around the southern end of the NPR and beneath the 14/32 taxiway to Serpentine Inlet.

### *4.9.1.2 Kedron Brook Floodway Drain*

The Kedron Brook Floodway Drain (refer **Figure 4.9a**) is located at the southern end of the NPR. The alignment of the drain is from west of the existing domestic terminal building, around the southern end of the NPR, joining Kedron Brook Floodway opposite Nudgee Golf Course. Kedron Brook Floodway Drain is needed to:

- Divert the existing Landers Pocket Drain from entering the NPR site;
- Intercept regional overland flow that travels through the area between Airport Drive and Kedron Brook Floodway during large regional flood events (refer Chapter B7); and
- Provide a discharge location for existing Airport drainage that currently discharges into the Landers Pocket Drain, Serpentine Creek and Jacksons Creek system, and for drainage from the southern end of the NPR.

The alignment of Kedron Brook Floodway Drain places the channel as far north as practicable to minimise the total footprint of the NPR project, while allowing for the full 3,600 m NPR length and associated Runway End Safety Areas (RESA). The lower end of Kedron Brook Floodway Drain skirts the new runway end to its confluence with Kedron Brook Floodway to avoid encroaching on Lewin’s Rail habitat located to the south of the NPR (refer Chapter B5 Terrestrial and Marine Ecology). By locating the Kedron Brook Floodway Drain adjacent the runway end, the drain can be used as a discharge for the supernatant water from the reclamation process (refer section 4.24) and the discharge of construction stormwater, removing the need to construct additional drainage for construction purposes.

The Kedron Brook Floodway Drain is designed to provide a low energy environment that limits opportunity for scouring and erosion on its bed and banks during flood events. The entry into Kedron Brook is designed to provide an environment where the velocity of flows in the drain is similar to the velocity of the water in the Kedron Brook Floodway, in order to minimise turbulence and the associated scouring and erosion.

### *4.9.1.3 Serpentine Inlet Drain*

The location of Serpentine Inlet Drain was selected following investigation into the likely outfall of operational stormwater, construction stormwater and supernatant from the new runway site combined with the constraints placed upon drainage by the runway geometry and geotechnical constraints (refer section 5.9.1.1). The Serpentine Inlet Drain (refer **Figure 4.9a**) is located alongside the existing remnant channel entering Serpentine Inlet at the northern end of the Airport. Based upon surveys of the Airport site prior to development, the Serpentine Inlet Drain is proposed in a similar location to the original Serpentine Inlet Creek mouth, which was severed by the construction of the existing runway. On the southern side of Serpentine Inlet and at the outlet to the existing airside drain, is a deeper channel from Serpentine Inlet out into Bramble Bay. Apart from this deeper channel, the remainder of the Inlet is relatively flat and shallow and with large areas exposed at low tide. Immediately adjacent to the proposed drain outlet is a series of sand bars that provide habitat to mangroves and other marine plants. Parts of these sand bars are elevated above normal tidal range. A small stormwater channel discharges from the existing fire fighting training area to Serpentine Inlet, parallel to the proposed Serpentine Inlet Drain. This small, existing channel is well vegetated with mangroves and will be maintained throughout construction of the Serpentine Inlet drain. The proposed Serpentine Inlet Drain will terminate at the existing shoreline and outlet at about the same invert level as the intertidal flats that make

*Figure 4.9a:* Drainage Layout Plan.

up the Inlet. Further excavation of the Serpentine Inlet Drain into the intertidal flats at its outlet will not improve the efficiency of the drainage and will further disturb the Inlet and modify existing habitats. On this basis, additional excavation at the outlet is avoided in the proposed design.

The channel alignment is from the east of the existing 14/32 runway to Serpentine Inlet and is needed to provide a discharge location for existing drainage catchments of the general aviation areas at the northern part of the site that currently discharge to the Serpentine and Jacksons Creek systems and to provide a discharge point for drainage of the northern end of the NPR (refer **Figure 4.9a**). The Serpentine Inlet Drain is sized to account for future development within the FAFA and is sufficient to cater for large storm event runoff from this area. The Serpentine Inlet Drain is designed to be a low energy environment with low flow velocities to minimise bed and bank scour. The drain outlet, if required, will also be provided with a diffuser structure to reduce flow velocities entering Serpentine Inlet to ensure that impacts on flora and fauna living in Serpentine Inlet are minimised (refer to Chapter B5 Terrestrial and Marine Ecology).

#### *4.9.1.4 Major Tidal Drain Geometry*

The low elevation and flat topography of the NPR site and the tidal characteristics of the drainage receiving waters place a constraint on the invert level of Kedron Brook Floodway Drain and Serpentine Inlet Drain. In addition, the invert levels of existing drainage from the Airport development places a constraint on the inverts of any new drainage channels. As a result, the invert level of each drain needs to be below mean sea level, and will therefore be tidally influenced during the normal tidal cycle. The invert levels of the two major tidal channels have been designed at approximately Mean Low Water Neap (MLWN) level (0.545 m Airport Datum) to promote tidal flows within the waterways that can support ecosystem function. Localised channel deepening occurs upstream of the outlet of each channel to provide hydraulic stability at the confluence of the drains and the receiving environments.

The geometry of the major tidal channels is shown in **Figure 4.9b**. The channels have a 30 m wide base width, with approximately 15 degree bank slopes from the channel invert level to top of bank. The bank slopes of the channels have rock protection to reduce scour of bank materials and promote bank stabilisation. The rock protection has a 1 m toe extended into the channel bed to provide a defined channel profile.

The bed of the major tidal channels includes structural lining (rock protection) around the outlet and downstream of the outlet from the sediment ponds used during construction (refer section 4.24). The lining of major tidal channels will minimise the scour of bed material in the tidal channels that may potentially result from extended release of supernatant water from the sediment ponds. Tidal flow and stormwater flow will not cause appreciable scour in the major tidal channels, and the channels will remain unlined upstream of the outlet from the sediment ponds.

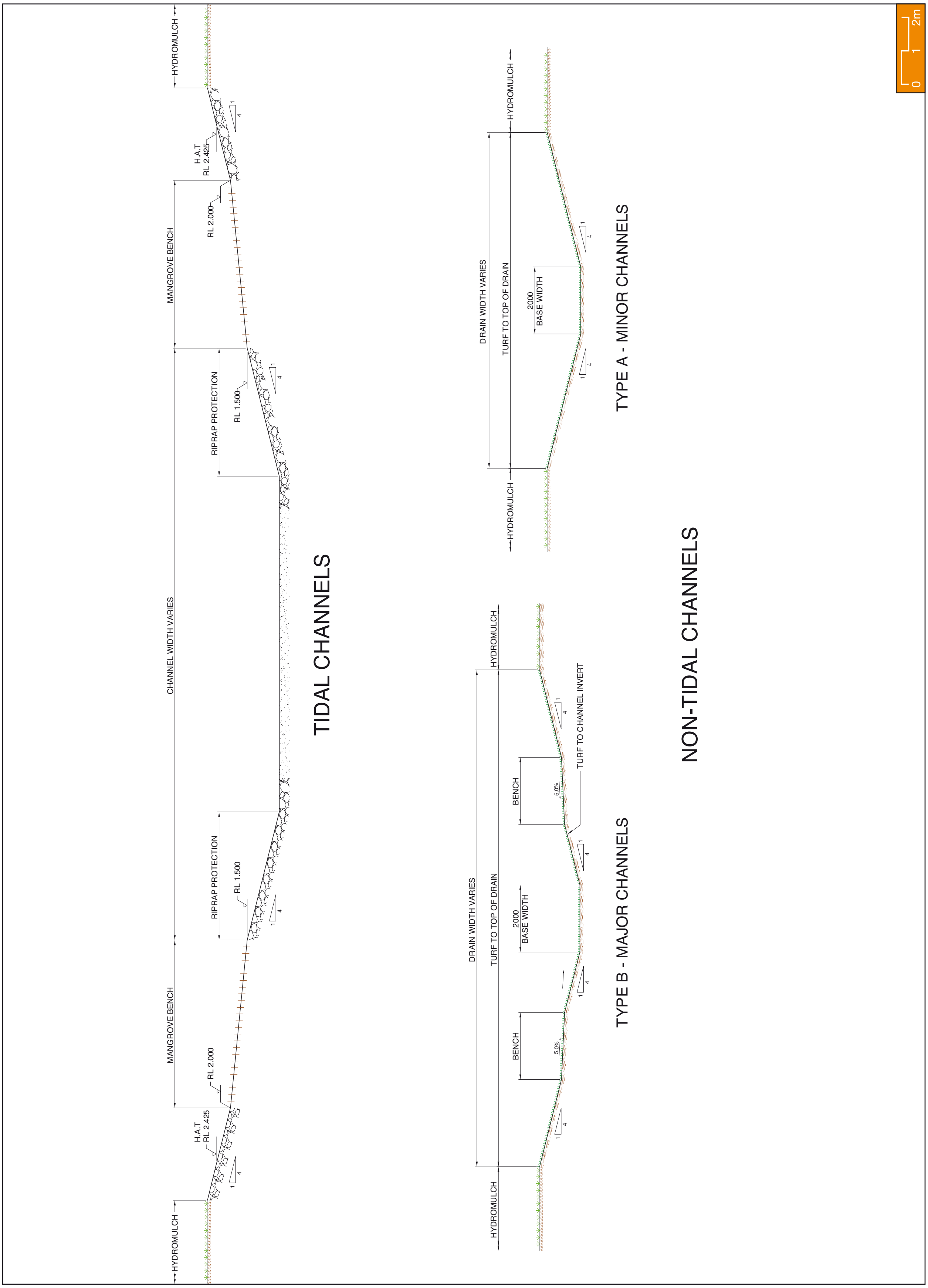
The Kedron Brook Floodway Drain and Serpentine Inlet major tidal channels include 10 m wide benches above the channel invert level for establishment of mangrove communities. The mangrove benches assist in stabilisation of the tidal channels and incorporate environmental amenity. Mangrove benches are designed between elevations of 1.5 m and 2.0 m (Airport Datum), known to be suitable for Grey Mangrove and River Mangrove colonisation. The rock protection applied to the channel banks will assist in controlling the colonisation of mangroves on the channel banks and in the invert, required for the hydraulic capacity of the channel.

### 4.9.2 Secondary Channels

A number of secondary channels are used to connect local drainage from existing Airport developments and the NPR project to either of the two major tidal channels. The secondary tidal channels (refer **Figure 4.9a**) are required to provide a number of functions in the drainage system, including:

- Connecting local non-tidal drainage branches to major tidal channels; and
- Providing stormwater treatment function through the filtration action provided by the vegetated channel lining.

**Figure 4.9b:** *Typical Drainage Channel Details.*



The secondary channels are typically short sections of tidally influenced channel connecting the local non-tidal drainage branches to major tidal channels. The secondary channels commence at the downstream side of the tidal control gates (refer section 4.9.5), and have a bed level between approximately 1 m at the upstream end and 0.545 m (Airport Datum) at the downstream end (connecting to the major tidal channels). The non-tidal local channels join the secondary channels at the upstream end.

The geometry of secondary channels forms a transition between the local non-tidal upstream channels and the major tidal channels downstream and is based on providing the hydraulic capacity for drainage of existing Airport infrastructure, the new runway and future Airport development. The secondary channels include mangrove benches similar to those featured in the major tidal channels, although the bench width is reduced (typically 5 m). These benches extend upstream in the secondary channels until the channel bank level exceeds approximately 2 m (AD).

### 4.9.3 Local Non-Tidal Channels

Development of the new runway requires construction of an engineered drainage system to provide rapid and effective drainage of runway and taxiway infrastructure. Local non-tidal drainage channels are used for drainage of the runway and taxiway area and for drainage of existing facilities that currently drain through the site of the new runway.

Local non-tidal drainage channels are used throughout the NPR project as collector drains for secondary channels and ultimately major tidal channels. Local non-tidal channels (refer **Figure 4.9b**) have a number of functions that include:

- Providing direct drainage of local catchments associated with the NPR project;
- Providing drainage of existing drainage catchments that drain to the Landers Pocket Drain, Serpentine Creek and Jacksons Creek systems;
- Providing drainage for future Airport developments; and
- Providing stormwater treatment function through the filtration action provided by the grass channel lining.

The geometry of local non-tidal channels is based on hydraulic requirements of local catchments and varies according to the local catchment discharge. Trapezoidal geometry is used throughout the minor drainage system, and the base width is varied to accommodate flow. Toward the lower end of minor drainage channels, small low flow inverts are designed within larger trapezoidal channels to maintain flow velocities above siltation velocity but below scour velocity.

Local non-tidal channels are grass lined to provide treatment of stormwater through filtration of solid particles and particle-bound contaminants. Significant flow length through the grass lined drains provides significant treatment potential for stormwater pollution.

### 4.9.4 Detention Storage and Vegetated Buffer

The drainage system around the NPR, includes detention storage between the runway and taxiway pavements and within the footprint of the NPR and taxiway system (refer **Figure 4.9a**). These areas form large basins that are used for temporary storage of stormwater runoff during rainfall events. Discharge of runoff from the storage basins is controlled by culvert structures that pass beneath the taxiway pavements to the local non-tidal drainage channels.

Detention of stormwater reduces the peak discharge from the runway and taxiway area which reduces hydraulic impact on downstream waterways, including the receiving waters at Kedron Brook Floodway and Serpentine Inlet. Use of runoff storage between runway and taxiway pavements is consistent with the drainage scheme of the existing 01/19 runway.

### 4.9.5 Hydraulic Structures

Hydraulic structures used in the drainage system for the NPR include:

- Culvert structures to control discharge from detention storage areas to local non-tidal channels; and
- Hydraulic gates at the interface of major and secondary tidal channels.

Culvert structures are used commonly throughout the drainage system for the NPR to control discharge from the detention storage areas. The culvert outlet structures use predominantly pipe culverts to maximise flow velocity through the culverts to reduce siltation within the structures.

The interface between secondary channels and major tidal channels is controlled by hydraulic gates (flood flaps) that reduce salt water intrusion to the secondary drainage system and the local non-tidal system. A reduction in salt water intrusion is favourable to maintain vegetative lining of open channels. Flood flaps at the interface between major drainage systems and the secondary channels also addresses security requirements for the NPR, providing reduced access to the airfield through drainage infrastructure.

It should be noted that hydraulic gates do at times allow tidal waters to enter the secondary channels drainage system. It is anticipated that this ingress of tidal waters will not adversely impact upon the function of the drainage system. It may result in edge effects with estuarine vegetation establishing within the limits of the tidal ingress.

### 4.9.6 Water Quality During Operations

Chapter B8 Water Quality discusses the application of different water quality objectives to the NPR project. The preliminary design approach towards water quality management focuses on optimising treatment within the drainage design without affecting the function of the NPR. The preliminary design of stormwater infrastructure was informed by an assessment of potential stormwater contamination sources and the stormwater quality from existing aviation infrastructure, and identified a low potential for stormwater pollution from NPR and taxiway stormwater runoff.

The proposed NPR will be constructed with the following ‘treatment train’ approach to optimise water quality treatment function within the drainage system design:

- The runway is grooved with narrow grooves (approximately 5 mm – 10 mm) at regular intervals (approximately 50 mm) and the pavement is flush kerbed with the grass verge. These grooves drain stormwater in a disperse manner to the grassed verges;
- Taxiway pavements are flush kerbed with the grass verge. This results in disperse flow shedding from the pavement into the grassed verges;
- The grassed verges act as filter strips to the disperse flow from the runway or taxiway drainage;
- The grassed verges drain into the detention storage areas, where settling can occur as well as filtration and infiltration; and
- The detention storage areas drain into the local non-tidal channels, where filtration and infiltration can occur.

#### *4.9.6.1 Grass Verges*

Grass verges act as filter strips which are effective in the removal of coarse sediments. The lateral flow of water from the runway or taxiway pavement will filter across the grass verges. The width of the lateral flow from the edge of the pavement promotes shallow disperse flow which will have greater treatment effect as it flows across the grass verge. Hence, the grass verge will assist in the treatment of water quality.

#### *4.9.6.2 Detention Storage Areas*

The drainage system around the NPR includes detention storage in areas between runway and taxiway pavements and within the footprint of the NPR and taxiway system (refers **Figure 4.9a)**. These areas form large basins that are used for temporary storage of stormwater runoff during rainfall events but maintain standing water between rainfall events. They will be designed to discharge gradually after rain events to maximise sediment settlement potential and infiltration effects.

As these detention basins are designed with relatively short detention periods, they will not promote fauna attraction. The vegetation selected will be drought resistant, salt tolerant and will not provide fauna habitat or feeding opportunity.

The detention effect and the vegetated base of the detention basins provide opportunities for the treatment of stormwater pollutions. The detention effect will allow some settling of sediment. The vegetative base and the wide shallow flow (some 50 m to 100 m wide) to the culvert outlet will also provide some filtration treatment function for stormwater pollution. The sand material that will be used for the reclamation filling will also allow infiltration to occur during the period that the detention basins are ponding water. This will also assist in the treatment of water quality through the filtration function of water passing through a sand media.

#### *4.9.6.3 Local Non-Tidal Channels*

Local non-tidal channels are grass lined to provide treatment of stormwater through filtration of solid particles and particle-bound contaminants. The sand material that will be used for the reclamation filling will also allow infiltration to occur during the period that the local non-tidal channels are flowing with water. Flow length through these grass lined drains provides adequate treatment potential for the management of any stormwater pollution.

It should also be noted that the hydraulic gates (flood flaps) will control the discharge from the local non-tidal channels. This will potentially mean that small events may not have sufficient flow to open the hydraulic gates (flood flaps). This will result in water ponding for short periods in the local non-tidal channels and will maximise the infiltration treatment of these systems.

## 4.10 Dryandra Road Tunnel

### 4.10.1 Existing Dryandra Road

Dryandra Road is a two lane road that links the existing general aviation area with the domestic terminal precinct. It provides access to a number of commercial operations along its length, namely a large area occupied by rental car companies to the north and the Qantas Catering and valet car parking area to the south. Dryandra Road also provides access to the existing security operations located at ‘Gate 1’ and is used by all vehicles prior to entering the protected ‘airside’ area of the Airport. The general aviation area houses a number of related aviation facilities including couriers and the Royal Flying Doctor Service. Access along Dryandra Road is unrestricted to the public and at present its capacity is adequate for its use and the road surface is in fair condition.

### 4.10.2 Dryandra Road Alignment

The current access to the Airport is via Airport Drive, from the Gateway Motorway. BAC is currently undertaking planning to provide an additional access from the Gateway Motorway to the domestic terminal and have called the project the Northern Access Road (refer to Chapter A1).

In addition to the Northern Access Road, current Airport planning includes an extension of the Domestic Terminal apron (to the north of the existing domestic terminal apron). Long term development of Brisbane Airport includes a new apron and terminal located west of the existing domestic terminal building.

To suit the apron layout and the car parking and road network necessary to support an additional western terminal building and apron, the alignment of Dryandra Road must be moved further to the west. Refer to **Figure 4.3** for the alignment of Dryandra Road.

### 4.10.3 Future Land Use and Demand

The construction of the NPR involves the construction of a major link taxiway between the existing runway and the new runway. The link taxiway will enable taxiing aircraft to move from the new runway to the existing domestic terminal while providing for future growth of the domestic terminal precinct. A large area of the runway site is allocated for future aviation facilities. The FAFA area is bordered by the link taxiway, general aviation area and 14/32 runway and new runway, and may include long term aviation related developments including:

- Long term passenger terminal facilities;
- Long term major aircraft maintenance facilities; and
- General aviation facilities.

The FAFA will have vehicle access via Dryandra Road. Accordingly, Dryandra Road may require widening to four lanes to increase its capacity and will require a connection into the FAFA, grade separated from the link taxiway. Dryandra Road and the tunnel into the FAFA have been designed to be four lanes to cater for all future planned development.

To provide access into the FAFA, a tunnel structure is required on Dryandra Road that is capable of providing for aircraft movements on the link taxiway over the road. In setting the vertical alignment of the road and the vertical alignment of the taxiway, it is necessary to consider surrounding land uses, immediately adjacent to the road and taxiway. With the current planning for extensions to the existing terminal aprons on either side of Dryandra Road, the vertical alignments for both road and taxiway were determined to maintain maximum flexibility for future aviation development.

## 4.10.4 Engineering Design

### *4.10.4.1 Considerations*

The structural engineering design of the Dryandra Road tunnel takes account of:

- The existing geotechnical information including the presence of deep areas of highly compressible soils (refer to Chapter B3);
- The depth of the water table (located approximately 1 m below the existing surface) and the buoyant forces on the tunnel floor;
- Proximity of existing infrastructure (specifically the GA apron); and
- The constructability of a tunnel under such conditions.

The high ground water table in the area of the proposed tunnel requires careful assessment of the buoyant forces on the tunnel that will act on the tunnel floor and try to force the structure out of the ground. The tunnel requires sufficient structural mass to resist the buoyant forces, which is particularly critical on the approach ramps to the tunnel where there is no tunnel roof. On the approach ramps, ground anchors that hold the tunnel down were considered.

Construction in soft soils, below the level of the water table requires a specific construction approach to prevent the construction area becoming inundated with ground water. Typically, construction below the water table requires the installation of a barrier such as sheet piles to prevent the inflow of ground water and complex pumping systems to ensure that any ground water that does penetrate the sheet piles is managed.

Constructing the tunnel also requires the excavation of highly compressible, soft materials that are difficult to excavate and unstable when exposed. The excavation for the tunnel is also in close proximity to the existing GA infrastructure and as such, will need to be stable and safe in order to protect the adjacent infrastructure.

After considering these constraints, several structural options were considered including the use of secant piles (interlocking piles), temporary sheet piles to stabilise the excavation and top down construction using diaphragm walls. Diaphragm walls enable the contractor to commence construction by excavating and constructing vertical tunnel walls through the existing surface and then constructing the tunnel roof. Once the walls and roof are in place, the contractor can commence construction of the tunnel floor, starting at the approaches and moving towards the middle of the tunnel. The tunnel floor connects with the tunnel walls forming a watertight structure within which the contractor can safely work. The walls and floor form the permanent structure, reducing the amount of temporary works required to enable construction. This top down construction was successful at the Breakfast Creek tunnel on the Inner City Bypass and is proposed for the approved Tugun Bypass project beneath the runway at Gold Coast Airport.

### *4.10.4.2 Adopted Design*

Although there are opportunities for staging some infrastructure required for the runway project there are few opportunities to stage the construction of the tunnel structure. The first stage of the Dryandra Road tunnel will include:

- Sufficient length to accommodate both north and south taxiways that comprise the ultimate link taxiway; and

- The ultimate tunnel structure to accommodate four lanes of Dryandra Road.

Above the tunnel, the pavements for the link taxiway connecting the new runway with the existing runway will be constructed in two stages and the roadworks adjoining the tunnel structure may be staged depending upon traffic demand.

The adopted design is a diaphragm wall tunnel, constructed on the new alignment of Dryandra Road with the following specifications:

- 440 m long tunnel structure (including approach ramps into tunnel);
- 800 mm thick external diaphragm walls, installed to depth suitable to ensure the walls found against firm material underlying soft compressible clays;
- 800 mm thick central diaphragm wall acting as a divider between the two traffic flows, installed to depth of diaphragm walls;
- 900 mm thick tunnel roof, capable of supporting the loading from wide-bodied aircraft that will use the link taxiway; and
- Prestressed anchors installed in the approach slabs to resist the buoyant forces from the ground water acting against the tunnel floor slab.

The design will provide flexibility for future development of the domestic terminal apron and will provide some opportunity for providing for increased traffic demand as a result of the ultimate development of the FAFA.

## 4.11 Perimeter Roads

To enable the regular maintenance of the airfield, security inspections and response to emergencies, a series of perimeter roads is required around the airfield to cater for vehicle traffic. The majority of use of the perimeter roads is by the security officers who patrol the fence line of the existing airfield and will patrol the fence line adjacent the NPR.

The perimeter roads proposed will be 5 m in width and are designed to cater for fire tenders and mid sized commercial traffic. The road surface will be sealed with bitumen seal to prevent erosion and provide a safe, all weather running surface suitable for all vehicles.

## 4.12 Security Fencing

The security of the airfield is paramount to maintaining safe, reliable Airport operations. As part of the security provisions for the new runway, a security fence will be provided to delineate the boundary between ‘airside’ and the publicly accessible areas (landside) on the Airport. The current design includes for a security fence measuring 2 m in height with a three barb extension, constructed from chainwire fencing materials.

The fence will be located between Kedron Brook and the new runway and between the FAFA and the parallel taxiways. The fence will be continuous with limited gates or crossing points and will be monitored during operation of the runway and regularly inspected by Airport security staff.

Access beyond the security fence will be required to allow BAC to continue to manage the remainder of the site west of the NPR. Access beyond the security fencing will be via controlled gates and will require cooperation with security staff. Other parties, such as the Brisbane City Council (BCC), that may have legitimate reasons for gaining access to the site west of the runway will be permitted to access via the perimeter road and controlled gates. All access will require cooperation with BAC security and will require prior arrangement and possibly an escort.

Security provisions on Australian airports are subject to change, and may require the construction of a different style of fence or the utilisation of different monitoring processes. At the time of runway opening, the fencing and security provisions installed will reflect the current requirements of relevant government agencies.

## 4.13 Airport Lighting

### 4.13.1 Approach Lighting

Approach lighting on the runway centreline is provided to enable use of the runway during periods of low visibility. Approach lighting provides guidance to pilots on approach to the runway, reduces the risk to the travelling public and improves overall Airport efficiency during inclement weather. There are several standards of approach lighting that are applicable to the new runway project and each of the different standards provides a different limit to the acceptable operating conditions.

The existing runway at the Brisbane Airport operates with an approach lighting system at both ends of the runway. This enables the use of the Airport during inclement weather and low visibility. The lighting design for the new runway provides for:

- Category 1 approach lighting;
- Category 2 supplementary and touchdown zone lighting; and
- Category 3 edge, centreline and threshold lights.

Overall, the lighting system is designed to support low visibility operations to be ICAO Category 2 capable.

At the southern end of the runway, the approach lighting is located over an area designated for sand filling as part of the runway project. The lights are located on small structures slightly above the level of the filled surface. At the northern end of the runway, the lighting structure is designed to extend into Moreton Bay. The lighting structure that extends into the bay will be located on a marine structure, similar in form to a jetty or pier.

The approach lights themselves are directional lights and are directed into the flight path of the approaching aircraft. The lights will generally not be visible from the land. The lights are connected to the airfield lighting control system and are provided with a main power supply and supplementary power supply in case of emergency.

The installation of approach lighting may not be required as improvements in technology relating to aviation navigation advance.

### 4.13.2 Approach Lighting Structure

The approach lighting structure, if required, will measure approximately 660 m from the Moreton Bay shoreline and is supported by piles, driven into the seafloor. To avoid unnecessary disruption to the coastal processes at the shoreline, the structure is designed to be constructed using a crane that 'walks' along the structure from one set of piles to the next, supported by steel beams that span between the pile bents.

The main component of the structure measures 3.8 m wide, 660 m long and is located above both the 1 in 1,000 year storm surge level (2.8 m AHD) and the 1 in 1,000 year significant wave height (Hs = 2.3 m). To complete the lighting array, there are several barrettes that project perpendicular to the centreline of the runway by up to 25 m. These barrettes are also fitted with directional lights that project into the flight path of approach aircraft.

The structure will be secured and will be patrolled regularly by Airport security. The structure provides for access by a light commercial vehicle for inspections and for maintenance.

### 4.13.3 Ground Lighting System

Ground lighting on the airfield provides visual clarity for pilots as they guide aircraft across the airfield. Ground lighting systems are generally integrated into a complex control system that enables air traffic control to direct aircraft onto the correct taxiway by turning on or off the relevant lights. The approach lighting system (refer above) is integrated into a ground lighting system that includes lighting on all areas of the new runway, including:

- Undershoot and touchdown zones at each end;
- Runway edge, centreline and thresholds;
- Lead on lights and sensing loops;
- Taxiway centreline and edge lights;
- Stop bars and runway guard lights; and
- Movement Area Guidance Signs (MAGS).

The majority of these lights are located either in the pavement (i.e. taxiway centreline lighting) or close to ground level (MAGS). The proposed lighting system will be incorporated into a complex control system that incorporates both approach lighting and ground lighting.

The control system that controls the lighting will be operated out of two Aerodrome Lighting Equipment Rooms (ALERs). These rooms house the control equipment, power facilities and standby power facilities required to operate the ground lighting and the approach lighting. The ALERs are located adjacent the northern and southern ends of the new runway. Each ALER is air-conditioned and is expected to have a maximum electrical load requirement of 800 kVA, of which 500 kVA is required to run the control equipment.

### 4.13.4 Construction Staging

The lighting design adopted during the preliminary design is consistent with the current best practice for airfield lighting. It may be necessary to adjust the lighting design at the time of construction to reflect current CASA or ICAO practices. In addition, it may be possible to stage construction of the lighting system with some associated modifications to the operation of the airfield.

## 4.14 Seawall

### 4.14.1 Existing Conditions

The northern boundary of Brisbane Airport coincides with the western shoreline of Moreton Bay. At a point along the shoreline approximately north-west of the NPR centreline, the remnant Cribb Island Jetty forms a structural divide between eastern and western parts of the shoreline boundary. The eastern part of the shoreline boundary is located very close to the northern extent of the NPR.

The existing seawall to the east of the Cribb Island Jetty is roughly constructed from dumped rubble, and currently provides minimal protection of aviation infrastructure from erosion caused by wave and tide effects. BAC has undertaken monitoring of the existing seawall and has identified some erosion to the east of the Cribb Island Jetty. The existing seawall does not provide a geotextile layer between the sand fill materials of Brisbane Airport and the rubble used to construct the seawall. As a result, sand materials behind the seawall may be eroded and the aviation infrastructure supported by the sand fill may be gradually undermined.

A new seawall will be constructed east of the Cribb Island Jetty to the mouth of Serpentine Inlet during construction of the NPR (refer **Figure 4.3**). The seawall will prevent erosion of existing sand fill materials placed during construction of the current Brisbane Airport infrastructure and protect the NPR from erosion caused by wave and tide action.

### 4.14.2 Proposed Seawall Alignment and Construction

The alignment of the new eastern seawall follows the alignment of the existing rubble seawall from the Cribb Island Jetty to the mouth of Serpentine Inlet, a distance of approximately 1.5 km.

The seawall is a graded rock structure, placed on geotextile over the existing ground. The crest of the seawall will be constructed to approximately 3.6 m (AD) to provide protection of the NPR and existing infrastructure during storm tide events.

Assessment of the existing rock materials undertaken during preliminary design showed the rock materials of the existing seawall would be unsuitable for use in construction of the new seawall. Quarried rock will be used for construction of the new seawall, and the existing seawall materials will be used as fill in other parts of the NPR construction (following removal of steel scrap and concrete rubble contaminants).

## 4.15 Rescue and Fire Fighting Services

A new rescue and fire fighting facility will be located adjacent the midway point of the 3,600 m runway, in the FAFA (refer **Figure 4.3**). The new runway requires a dedicated fire station in order to comply with the required response time to an emergency on the new runway of three minutes (CASA). The fire station will provide car parking facilities for staff and have public access to the back of the fire station.

Existing and proposed response procedures are discussed in Chapter D8.

## 4.16 Services

### 4.16.1 Introduction

The construction of the NPR will require existing services to be relocated and both temporary and new permanent services to be installed. The construction staging will govern the sequence in which service installations will occur, commencing with services related to the 14/32 runway followed by services within the proposed link taxiways and finishing with the new services required to operate the new runway.

### 4.16.2 Existing Services

There are a number of existing services that are within the footprint of the new taxiway and runway pavement and will be affected by any ground treatment, specifically where large ground settlements are expected. To ensure that the Airport can continue to operate during construction, these services need to be relocated prior to consolidation as they will be damaged by excessive settlements. There are three main areas where existing services will be affected and require relocation:

- The western end of the 14/32 runway;
- Dryandra Road; and
- The link taxiway, adjacent to the General Aviation Area (GAA).

For all locations, the service design and construction sequencing is paramount to providing continuous supply to all Airport users and to ensure that the Airport remains operational during construction.

#### *4.16.2.1 14/32 Runway (Western End)*

The existing services located at the western end of the 14/32 runway include water, electrical and telecommunication cabling which supply the radar facility from two independent supplies. These services will be replaced with new services in a new service corridor from the GAA, beneath the 14/32 runway and then parallel to the existing perimeter road on the northern side of the 14/32 runway. The new services will connect back into the radar station. The design will allow a minimum of 5 m separation between the independent supplies by placing them either side of the perimeter road.

#### *4.16.2.2 Dryandra Road*

The location of the proposed link taxiway severs Dryandra Road and with it all of the existing services to the GAA. The existing services include: electrical, water, sewer and telecommunications, which are located either side of Dryandra Road and supply the GAA, the adjacent developments (i.e. Qantas Catering) and the facilities beyond.

New services will be installed alongside the new alignment of Dryandra Road in a permanent, combined services corridor that links the services in the domestic terminal precinct with the GAA. The combined service corridor will be located alongside Dryandra Road and will continue beneath the link taxiway embankment. Additional capacity for services will be provided through the Dryandra Road tunnel structure to enable future service augmentation, should it be required. During the construction phase, temporary service connections will be provided into any existing infrastructure, such as the existing buildings located at the GAA and Qantas Catering facility. The contractor will ensure that supply of critical services is not interrupted during construction and operations.

#### *4.16.2.3 Link Taxiways*

Existing services currently cross beneath the main runway and taxiways A and B and into the access road to the GAA tenants. These services are located beneath the proposed link taxiway and need to be moved from beneath the taxiway footprint. The proposal is to move these services which include: sewer mains, water and electrical to the north in a new common service corridor and a new crossing under taxiway B, temporarily necessitating its closure during construction.

### 4.16.3 New Services

There are requirements for temporary and permanent new services to be installed within the construction of the NPR. The anticipated loads that the new runway will place on existing utilities infrastructure (i.e. sewer, water, electrical, communications) has been taken into account by BAC in preliminary planning and at this stage, augmentation of existing supplies is not anticipated as part of the new runway project.

#### *4.16.3.1 Temporary Services*

The temporary services required to construct the new runway include electrical, telecommunications, sewer and water supplies to service the two construction camps and batching facilities proposed for the site. The proposed location of the construction camps are within the vicinity of existing service routes, thereby allowing the existing service to be extended to supply these temporary facilities. The demands envisaged by the construction camps can be catered for by the existing network without significant upgrades.

#### *4.16.3.2 Permanent Services*

The major permanent electrical demand of the new runway project is required to supply the airfield lighting. The supply for the airfield lighting is provided to two proposed ALERs from where the power and control systems will be distributed to the proposed runway. Indicative maximum loading requirements for each equipment room is 800 kVA. BAC is able to supply this load from the existing Airport network.

The new fire station requires services which will include: electrical, telecommunication, sewer and water. These services will be diverted from the GAA area along the fire station access road to service the facility. The demand on services of the new fire station can be supplied from the existing Airport capacity.

The proposed Dryandra Road realignment and the tunnel located under the link taxiways will require road lighting and signalling. The electrical demand from the road and tunnel are not significant and can be supplied by the existing network on the Airport.

## 4.17 Landscaping

### 4.17.1 Existing landscape features

Landscape features that dominate the visual experience for Airport users are the planted casuarina plantation and Airport Drive. The casuarina plantation between Airport Drive and Kedron Brook Floodplain contains planted swamp she oaks and marine plants and Airport Drive consists of a linear corridor of planted gardens and maintained lawn areas. The landscape assessment and proposed mitigation is discussed in Chapter B13.

# Part 2 – Temporary Works

## 4.18 Temporary Works – Introduction

In addition to the permanent works required for the operation of the NPR, significant temporary infrastructure is required to enable the construction of the project. As the project will be constructed using a dredge to supply fill material, the majority of temporary infrastructure for the project is centred around the dredge and the reclamation process.

To enable the construction of the project, the successful contractor will provide all necessary infrastructure, including any temporary structures or works. The design and detail of the temporary works is dependent upon the contractor's construction technique and proposed methodology and specifically for this project, the type, style and size of the dredge proposed to undertake the reclamation.

Specifically, to enable construction, the contractor will require:

- Suitable dredging footprint for extracting 15 $Mm^3$ of material for construction;
- Dredge mooring suitable for the dredge to moor while pumping sand on the site;
- Dredge pipeline to carry sand material from the dredge (moored) to the reclamation site;
- All temporary structures required to support the dredge pipeline; and
- Large settlement ponds on the site to manage the supernatant water that is delivered to the site during the reclamation process.

This section outlines the likely designs of temporary works on the site based upon reasonable assumptions on the type and size of the dredge (refer to section 4.19). Minor temporary works such as Contractor access roads are discussed in Chapter A5.

## 4.19 Dredge Selection

### 4.19.1 Introduction

Dredging describes the operation of extracting materials from the ocean/river bed and recovering the material for another purpose. Dredging is currently used routinely in the greater Brisbane area for varied tasks including extracting material from Moreton Bay for use in construction and for maintenance/deepening of existing channels leading to the Port of Brisbane. There are a number of different dredging methods that can be applied, depending upon the size of the project and the constraints under which the dredge can work, including operational, environmental and economic constraints.

The dredging industry is a specialised industry that is predominantly based overseas in South East Asia, the Middle East and Europe. Most of the major dredging contractors have carried out work in Australia previously and some maintain marketing offices in Australia and specifically in Brisbane. The international market for dredging work is buoyant with large projects in the Middle East (specifically Dubai) and Singapore presently accounting for significant numbers of the international dredging fleet. The Brisbane Airport project will compete against these international projects to secure a suitable dredge to carry out this project.

An assessment of the dredging work methods was undertaken to establish the most likely dredge method for the new runway project. The assessment also includes an assessment of the dredging plant that might be available within the proposed construction timeframes (refer Chapter A5) to complete the project. This assessment of dredging plant informs the design of all temporary infrastructure required to support the dredging and reclamation process as all temporary infrastructure is dependent upon the type, style, size, capacity and operation of the dredge.

### 4.19.2 Previous Dredging/Reclamation at Brisbane Airport

There have been two significant dredging/reclamation projects undertaken on the Brisbane Airport site:

- The first dredging/reclamation was undertaken in the early 1980s by the Australian Government (Department of Works) to establish the current domestic terminal and runway and taxiway system. This project required approximately 16 Mm$^3$ of sand dredged from Middle Banks in Moreton Bay. The dredging method employed for this initial dredging required the use of two dredges and the Boggy Creek rehandling basin. A Trailer Suction Hopper Dredge (TSHD) 'Humber River' extracted sand from Middle Banks and deposited the sand into a rehandling basin constructed in the mouth of Boggy Creek (in the Brisbane River). From this rehandling basin, a Cutter Suction Dredge (CSD) 'Wombat' extracted the sand from the rehandling basin and pumped it directly to the project site in a manner similar to that described as work method two (refer section 4.19.3).
- The second dredging/reclamation was undertaken during the development of the International Terminal (circa 1990) where approximately 4 Mm$^3$ of sand was dredged from Middle Banks and placed upon the current site of the international terminal. As with the previous dredging campaign, the Boggy Creek rehandling basin was used in rehandling sand extracted from Middle Banks. The extraction at Middle Banks was by two TSHD's ('Lelystaad' and 'Resolution') and the rehandling was by a CSD ('Kunara').

Since the dredging/reclamation for the International Terminal Project, the Boggy Creek rehandling basin has been filled with spoil materials with some levels of contamination and it is unsuitable for use as a rehandling basin.

### 4.19.3 Types of Dredging Work Methods

There are two main types of dredging method available to this project. Both work methods have different requirements in terms of temporary works and potential environmental impacts as follows:

1. A large TSHD with direct pumping:

- Extracting the material from the sea bed;
- Storing the extracted material within the hopper of the dredge;
- Sailing to a designated mooring/pump-out site; and
- Pumping the material directly to the project site using on board pumps.

  This dredging work method relies on the use of a large trailer suction hopper dredge that is capable of holding sufficient material within the hopper of the dredge and has sufficient pumping power to pump sand material directly to the project site.

2. A large TSHD with rehandling:

- Extracting material from the sea bed;
- Storing the extracted material within the hopper of the dredge;
- Sailing to a designated rehandling basin that is constructed to contain the dredged material in order that it can be rehandled;
- Dumping the extracted material into the rehandling basin where it is contained temporarily;
- Using a CSD to continuously extract material from the rehandling basin; and
- Pump the material directly to the project site using on board pumps.

  This dredging work method uses two dredges and relies on the establishment of a large rehandling basin in a suitable location, close to the project site. The rehandling basin is an excavated basin within the sea bed and acts to contain all of the dredged material temporarily while the material is rehandled to the project site. This work method allows for the continuous (or near continuous) supply of dredged material from the rehandling basin to the project site.

Both of these options are possible and can deliver the required fill material to the project site. The use of a large TSHD using a direct pump-out to the project site (work method 1) is the preferred method for this project. Direct pumping from a TSHD provides the most efficient method of sand delivery, with the highest production rate and lowest cost.

Direct pumping from a TSHD also avoids the requirement to construct a rehandling basin. An assessment of reusing the previous rehandling basin at Boggy creek was completed and would require relocation of approximately 1.1 Mm$^3$ of marine silts and clays. The environmental issues associated with dredging the marine silts and clays would prove difficult to manage during establishment of the rehandling basin. In addition, the use of a large TSHD is expected to be more efficient and will provide a higher production rate than work method two. The higher production rate will result in a shorter production period and lower cost per cubic metre of material.

On this basis, the use of a TSHD directly pumping to the project site is the preferred dredging work method for this project.

### 4.19.4 Design Dredge

In considering the preferred dredging work method of extraction by TSHD and direct pump-out to the project site and the limited dredging fleet that is likely to be available to complete the works, an assessment of the dredging fleet and the specifications of the preferred vessels was undertaken with a view to selecting a 'design dredge' that would be used in the design of all temporary works.

This approach will require the contractor to confirm the design of temporary works once a dredge is selected during procurement of the dredging/ reclamation.

Within the dredging fleet of TSHD's available to the project, there are a number of different sizes of TSHDs, which generally relates to the length, hopper size and dredging mark (or draught) of the dredge. **Table 4.19** shows the available TSHDs that may be suitable for use on the project. When assessing the suitability of the available dredges, several physical constraints were considered including:

- Hopper volume (which relates to the production rate of the dredge and how long it will take to reclaim the site);

**Table 4.19:** Physical Characteristics of the Dredge Fleet.

| Class of TSHD | Vessel Name | Operating Company | Hopper Volume (cubic metres) | Dredging Mark Draught (metres) | Dredge Pumps kW Discharging | Length Overall (metres) |
|---|---|---|---|---|---|---|
| Jumbo | Vasco Da Gama | Jan De Nul | 33,125 | 14.60 | 16,000 | 200.66 |
| Jumbo TSHD | WD Fairway* | Boskalis | 35,508 | 12-15 | 10,000 | 232.35 |
| Large TSHD | Queen of the Netherlands* | Boskalis | 22,258 | 10-12 | 12,000 | 171.60 |
| Large | Pearl River (new)<br>Pearl River (old)* | Dredging International | 24,000 (new)<br>17,000 (old) | 10.8 | 14,000 | 182.00 |
| Large | Queen of Penta-Ocean | Penta Ocean | 24,000 | 10.5 | 12,000 | 166.70 |
| Large | HAM 318 | Van Oord | 23,000 | 13.00 | 11,000 | 176.00 |
| Large | Rotterdam | Van Oord | 21,656 | 11.33 | 12,000 | 180.40 |
| Large | Volvox Terranova | Van Oord | 20,016 | 11.20 | 12,200 | 164.10 |
| Medium | Gerardus Mercator | Jan de Nul | 18,047 | 11.51 | 14,000 | 152.20 |
| Medium | Nile River | Dredging International | 16,989 | 10.59 | 13,786 | 149.43 |
| Medium | Amsterdam | Van Oord | 16,830 | 10.37 | 10,400 | 159.65 |

*Source: Baggerman Associates*

** TSHD which have worked previously in Australia.*

- Vessel draught (which relates to the dredge's ability to navigate through the existing channels into the Brisbane River); and
- Dredge pumping power (which relates to the dredge's ability to pump the reclaimed material to the project site).

Dredging efficiency is typically optimised by adopting the largest dredge vessel class that can access the reclamation site and that will allow adequate control at the pump-out location to be maintained. This strategy has been adopted for reclamation associated with the NPR.

The 'jumbo' class dredges listed in **Table 4.19** have a dredging mark or draught of around 15 m. The channels leading into the Brisbane River have a minimum declared depth of 14 m (below LAT) and are unsuitable for continuous use of a Jumbo class dredge. If a Jumbo class dredge was used it would be conditional on tidal range and payload and would not prove economical over the life of the project.

The 'large' class TSHD have a draught of around 12 m, which is suitable for continuous use in the channels leading into the Brisbane River. These large class dredges also have sufficient pumping power to pump the dredged material a distance of around 7 km, without the use of a booster station. In addition, their hopper volume provides adequate production rates to complete the dredging and reclamation task economically and within a suitable timeframe.

On the basis of this assessment, a typical 'large' class dredge will be used as the design dredge for the preliminary design of all temporary works on the project.

## 4.20 Dredging Location and Dredge Footprint Selection

### 4.20.1 Background

As outlined in Chapter A3, the Queensland Government undertook a Moreton Bay Sand Extraction Study from 2001-2005 to determine the environmental and economic issues relating to sand extraction in the Bay.

The key findings of the Study were that the direct impacts of large scale sand extraction scenarios such as disturbance to benthic fauna, potential degradation of water quality and impacts on Indigenous cultural heritage and fishing activity were considered to be relatively minor and of a temporary nature. The indirect impacts associated with the long term removal of shallow sand banks considered in the Study – including changes to wave conditions, tidal currents and potential alterations to ecological communities – were also expected to be small.

On the basis of these findings, the Queensland Government indicated it would support a range of proposed sand extraction activities from the total available sand resources in Moreton Bay (approximately 3,770 Mm$^3$) subject to environmental impact assessment processes. The BAC was directed to investigate the Middle Banks area of Moreton Bay in relation to the NPR infrastructure project.

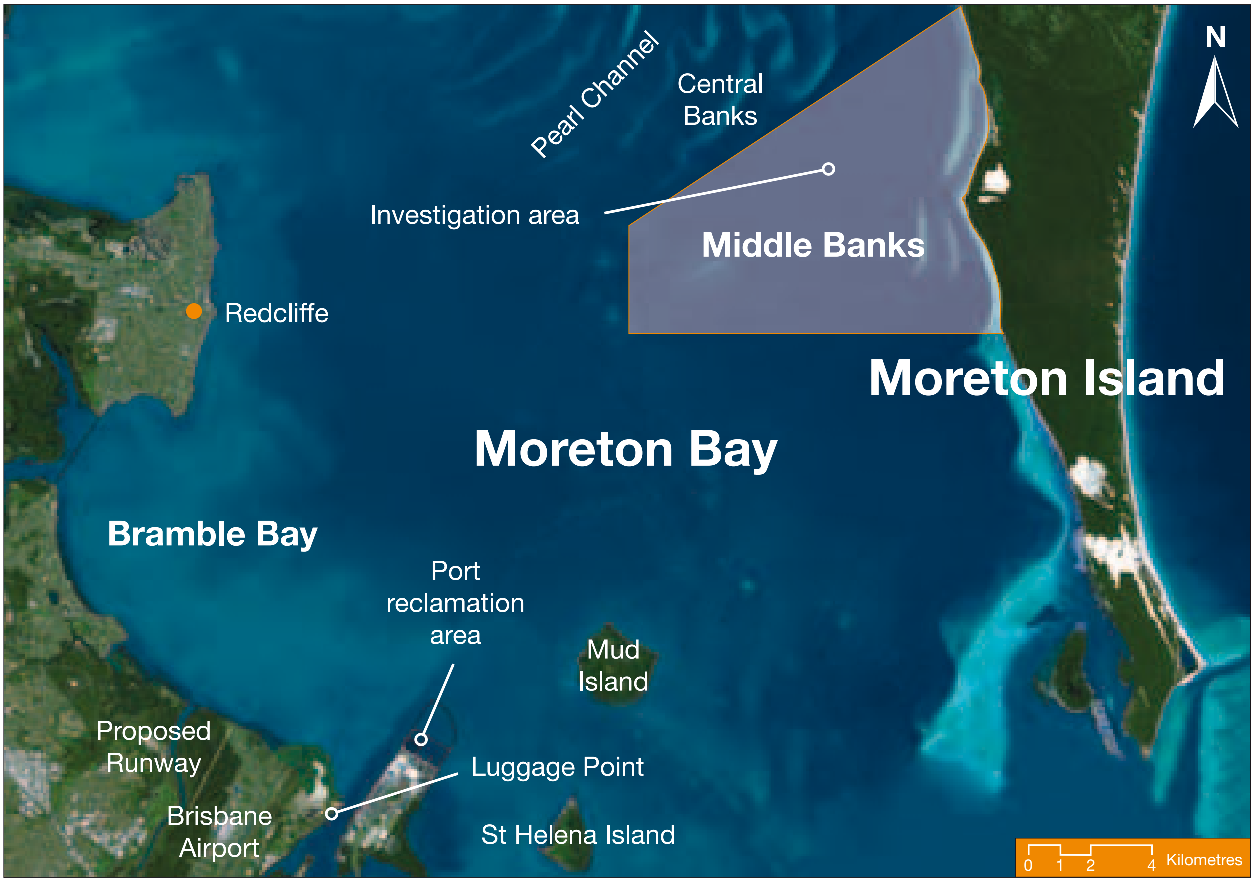
### 4.20.2 Project Requirements and Investigations

A volume of approximately 15 Mm$^3$ of unconsolidated marine sand is required to be placed on the NPR site in order to:

- Consolidate the soft compressible soils found on the project site;
- Provide a stable platform to enable the construction of the runway pavements; and
- Elevate the site to provide flood immunity.

**Figure 4.20a** shows the Middle Banks investigation area nominated in the EIS in relation to other features in Moreton Bay such as Moreton Island.

***Figure 4.20a:*** *Middle Banks Investigation Area.*



A series of investigations were carried out in the Middle Banks area of Moreton Bay in 2005 and 2006 as part of this EIS/MDP process to determine where in the Middle Banks area the required volume of material could be sourced, and to assess the impacts the removal may have on the marine environment. In summary, investigations included:

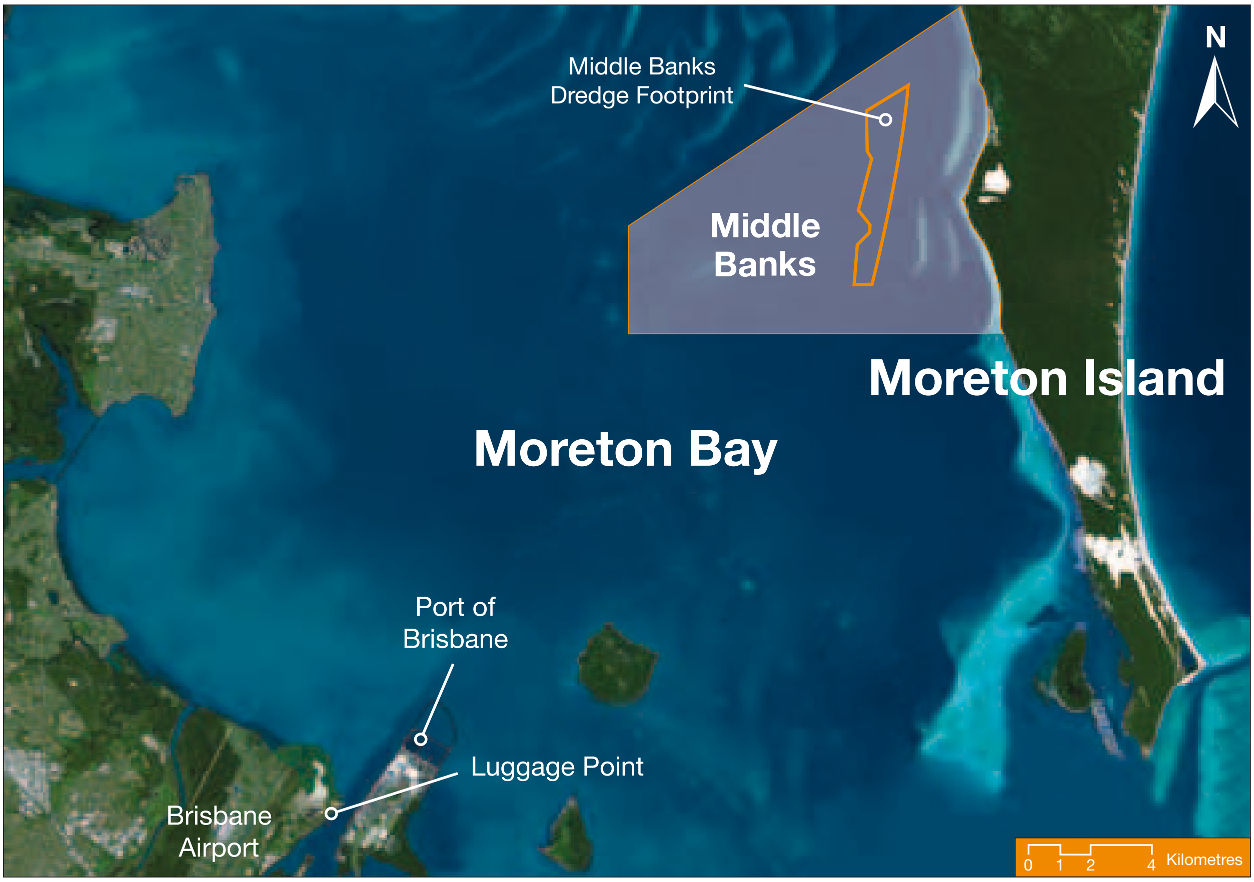
- Bathymetric Survey (25 m spacing) over Middle Banks to confirm ocean depth and ocean surface contours;
- Sub-bottom profiling through seismic surveys to derive an interpreted level of the Pleistocene surface at Middle Banks;
- Offshore geotechnical sampling using continuous marine vibrocoring (16 boreholes sampled to an average depth of 10.4 m);
- Seagrass and benthic habitat survey of Middle Banks using an underwater video system; and
- Water quality modelling to assess the impact of any plume caused by the dredge during dredging.

A detailed description of the findings of each investigation and the resultant modelling or assessment is presented in Volume C.

### 4.20.3 Proposed Dredge Footprint

Based on the information obtained from the investigations, a dredge footprint at Middle Banks has been identified from which the required 15 $Mm^3$ of fill material will be sourced and is shown in **Figure 4.20b.**

***Figure 4.20b:*** *Location of Dredge Footprint at Middle Banks (Source: Arup).*



The footprint has been selected on the basis of the following:

- **Targeting Holocene (clean) sand deposits that will produce superior quality fill material.** The absence of finer silts and clays in the dredged material minimises water quality impacts from turbidity at Middle Banks during dredging and reclamation.
- **Avoiding or minimising impacts to marine ecology.** The dredge footprint has been selected to avoid areas of high environmental significance within Middle Banks to the greatest extent practicable. The overall impacts on marine ecology are minimised by selecting a narrow and deep dredge footprint rather than a shallow footprint over a larger area.
- **Logistical advantages to the dredge contractor.** A long, linear footprint in water greater than 8 m depth minimises the duration of each dredge cycle and minimises the overall time required to complete the dredging campaign.
- **Avoiding potential conflicts with other users of the Bay.** To reduce impact/conflict with other users of the Bay, the proposed dredging footprint avoids the areas within Middle Banks that are currently used by several commercial extractive industry operators (in approved permit areas) and an area along the southern portion of Middle Banks known to be used by commercial fishing trawlers.
- **Maintaining water quality.** Numerical modelling has been undertaken as part of the Draft EIS/MDP to assess and recommend best management practices to minimise impact of turbid plumes on water quality and ecological values.
- **Minimising impacts to coastal processes.** Numerical modelling has been undertaken as part of the Draft EIS/MDP to assess any impacts on physical processes such as waves and tidal currents that may cause erosion or other impacts on nearby shorelines.

- **Avoiding potential impacts on cultural heritage.** Restricting dredging to Holocene age sediments reduces potential impacts on indigenous cultural heritage values that may exist in the older Pleistocene surface.

A full discussion of these factors is contained in Volume C.

## 4.21 Mooring Locations and Pipeline Route Options

### 4.21.1 General

Prior to beginning investigations into potential mooring locations for the dredge, a broad overview of possible dredge mooring locations was undertaken based upon previous experience with dredging at the Brisbane Airport and the constraints placed upon the site in terms of Port operations and existing bathymetry of the Brisbane River and the nearshore areas of Moreton Bay.

To determine potential mooring options the following basic requirements for the dredge mooring were identified:

- Maximum dredge pumping distance between 6 km and 7 km;
- Water depth for independent dredge manoeuvring around 13 m to 14 m (below LAT);
- Protection from prevailing weather conditions would be an advantage; and
- Alignment of the delivery pipeline through areas with suitable geotechnical conditions to allow maintenance access.

Upon considering these basic requirements, it was concluded that the mooring would be limited to sites within the Brisbane River mouth either in or immediately adjacent the main shipping channel as all other near-shore areas did not provide deep water access within the required pumping distance.

Further investigations into likely mooring locations led to the identification of four potential mooring sites and associated sand delivery pipeline alignments from the identified mooring to the construction site.

### 4.21.2 Investigation into Mooring Sites

Investigation of the suitability of the mooring sites was undertaken to identify a preferred location for the dredge mooring and the pipeline route. The investigation was undertaken to identify all the major engineering, dredge operations, environmental and logistical issues with each of the locations. The identification of a preferred mooring location is a balance between the attributes of the mooring location and the pipeline route.

The four mooring location and pipeline alignment options are shown on **Figure 4.21** and are described as:

- Boggy Creek;
- Koopa Channel;
- Juno Point; and
- Luggage Point.

Regardless of the mooring location, operation of the dredge will require construction of a temporary mooring to allow the dredge vessel to moor safely while discharging. The mooring could include a piled structure located in the Brisbane River, in suitable water depth to allow dredge access during all parts of the tidal cycle. Alternatively, use of temporary anchor blocks may also suffice. A final mooring design would need to await nomination of the dredge by the successful dredging contractor after tender. From the mooring to the project site, the pipe route will require an access track and low height embankment for the length of the pipeline. The low height embankment and access track will be constructed from granular materials. Both the mooring structure and access track/embankment will be temporary in nature.

All four pipeline alignments from the mooring facility were designed to have the same destination within the Airport site. This point is known as the convergence point and is located between the end of the existing 01/19 runway and the end of the 14/32 runway. This convergence point is considered the

*Figure 4.21:* *Dredge Mooring Location and Pipeline Routes.*

most appropriate location for the dredge pipeline to cross beneath the proposed taxiway link from the existing runway and the 14/32 taxiway. This crossing point will be carefully designed to ensure aviation operations are not compromised. From this location the pipeline will head north-west to the remainder of the reclamation site.

In the restricted access areas at the end of the runways the pipeline will be clear of the Runway End Safety Areas (RESA) and the Obstacle Limitation Surface (OLS). The pipeline will be specifically designed to ensure conflict with existing services and the existing approach lighting systems is minimised. The potential to increase the pipe wall thickness or the composition of the pipe will be investigated to reduce maintenance access requirements for the pipeline.

Further and more detailed information about existing conditions at each of the mooring locations is contained in the various chapters of Volume B Airport and Surrounds.

## 4.21.3 Mooring Site Assessment

### *4.21.3.1 Boggy Creek*

Boggy Creek estuary is located to the west of the Brisbane River and opposite the Port of Brisbane. The creek is cut off from marine traffic by a pipeline used to transport oil from tankers to the Bulwer Island Oil Refinery. The Boggy Creek location is a sheltered location, removed from the shipping channels. The total length of the sand delivery pipeline from a potential mooring at Boggy Creek and the convergence point on the runway site is approximately 2,400 m.

**_Mooring location_**

Boggy Creek was used during the previous two sand reclamation projects undertaken at Brisbane Airport. The dredging method previously employed required a rehandling basin at the mouth of Boggy Creek. The rehandling basin is a deeper basin dredged into the floor of the creek to enable sand to be deposited temporarily prior to rehandling to the reclamation area. The basin does not allow sand to flow into the river and is surrounded on all sides by the higher river floor. Boggy Creek will require extensive dredging through the shallow river floor surrounding the rehandling basin to provide an access slot for the dredge vessel into the proposed mooring. The amount of spoil generated from capital dredging of the area would be approximately 250,000 cubic metres (m$^3$) of material. Geotechnical analysis of this area shows acidity and heavy metals are present in the upper layers of the marine sediments, as well as soft marine clays from recent deposition during storm and flood events. If dredged, the contaminated silts and marine clays would need to be disposed and stored in a dredge spoil treatment area above high water mark.

**_Pipeline route_**

The sand delivery pipeline from the mooring at Boggy Creek would pass under the existing Bulwer Island oil pipeline. Buoyancy devices would be required to float the sand delivery pipeline between the shoreline adjacent to the vessel mooring location and the dredge vessel itself. The sand delivery pipeline would cross the foreshore and run parallel with the southern boundary of the Luggage Point Wastewater Treatment Plant.

The delivery pipeline would also cross Main Beach Road (Myrtletown), which is the only access for the Luggage Point Wastewater Treatment Plant. This crossing would need to be designed and constructed to allow access to the plant at all times

With the exception of the narrow mangrove-lined Jubilee Creek, the pipeline route does not traverse areas with significant or noteworthy biodiversity value.

**_Summary_**

- The use of Boggy Creek requires capital dredging of contaminated marine sediments to establish a suitable mooring. Storing, managing and stabilising this contaminated material would be difficult and expensive.
- The pipeline route from Boggy Creek to the Airport is suitable and any access and environmental issues associated with its construction can be managed.
- On the basis of disturbing, storing and managing contaminated silts during capital dredging, the use of Boggy Creek is not preferred.

#### *4.21.3.2 Koopa Channel*

Koopa Channel is an old bar cutting located north-east of the entrance channel to the Brisbane River. The site is the furthest from the proposed reclamation site, with a required maximum pumping distance of 7 km, which is at the maximum extent of the economic capabilities of large TSHDs.

##### *Mooring location*

In order to moor a large TSHD clear of the main shipping channel it would be necessary to dredge a slot clear of the channel. This capital dredging would produce an estimated volume of 130,000 $m^3$ of dredge spoil. Geotechnical investigations show the upper layers of the marine sediment (upper 2 m) at the Koopa Channel location contain some heavy metals (Nickel) but lower net acidity due to natural buffering. Marine clays and coarse to medium grained sand were found at deeper levels in the boreholes surveyed at the site. Contaminated material dredged during the establishment of the dredge slot would need to be transferred to a spoil disposal area on land above high water mark. Clean clay material and gravely sand could be stored and re-used on the Brisbane Airport site.

Of the four mooring locations, Koopa Channel is most exposed and vulnerable to weather conditions that may potentially impact on the dredge pump-out operations. The site would require heavier breasting dolphins and additional fore/aft moorings during adverse conditions.

##### *Pipeline route*

The sand delivery pipeline for Koopa Channel would travel in a south-west direction crossing the foreshore at Juno Point. This alignment requires the pipeline to cross an area of land with unsuitable soft soils which would restrict access for pipe maintenance and construction of the associated access road.

A corridor of mangroves would need to be cleared at Juno Point to accommodate the pipeline. The total length of pipeline that would traverse the mangrove areas is about 900 m. The pipeline would also need to traverse Jubilee Creek. The channel crossing would be achieved by using a series of wooden piles and cross members to elevate the pipeline above the creek.

The direct disturbance and indirect impacts on mangroves from installation of the pipeline and access track would be significant with the Koopa Channel option. The intertidal flat area is also identified as a significant wader bird roosting area which would be disturbed during installation of the pipe and during maintenance activities.

##### *Summary*

- The mooring location is exposed and may not allow all weather operation of the dredge. Capital dredging required is extensive and the contaminated dredge spoil would be problematic to manage. Clean materials extracted during capital dredging could be managed on the Airport site with some of the materials potentially suitable for use within the runway project.

- The pipeline route for the Koopa Channel option results in direct disturbance of mangrove habitat and wader bird habitat. The pipeline route would prove difficult and expensive to construct and decommission.

- On the basis of the exposed mooring and environmental impacts associated with the pipeline, the Koopa Channel option is not preferred.

#### *4.21.3.3 Juno Point*

Juno Point is located to the north of Luggage Point outside the main shipping channel. The site is slightly closer to the reclamation site than the Koopa Channel option but still would require a pumping distance of greater than 6.3 km.

##### *Mooring location*

As with Koopa Channel, in order to moor a large TSHD clear of the main shipping channel at Juno Point it would be necessary to dredge a slot clear of the channel. This capital dredging would produce an estimated volume of 220,000 $m^3$ of dredge spoil.

Geotechnical investigations show the upper layers of the marine sediment at Juno Point are similar to Boggy Creek with elevated levels of Tributyl-Tin (TBT) and Mercury (Hg). The soils also show high potential acidity. Marine clays and silty sand were found at deeper levels in the marine sediment. The material removed during the establishment of the dredge slot would need to be transferred to a spoil disposal area on land above high water mark. Clean clay and sand material could be stored and re-used on the Brisbane Airport site.

Juno Point is exposed to adverse weather conditions that may potentially impact on the dredge pump-out operations. This would need to be considered in the design of the mooring dolphins at this location as outlined with the Koopa Channel option.

***Pipeline route***

Two pipeline options from the Juno Point mooring location were explored in the preliminary design (Juno A and Juno B).

The first (Juno A) is directly west over the intertidal mud flats and mangrove area. Similar to the Koopa Channel alignment, this pipeline alignment will cross areas of land known to have unsuitable soft soils that will make the construction and maintenance of the sand delivery pipeline problematic. Placement of the pipeline in this environment would involve the direct disturbance as well as indirect impacts on mangrove communities. The intertidal flats at Juno Point are identified as a significant wader bird roosting area which would be disturbed during installation of the pipe and during manned maintenance activities.

The second option (Juno B) from the mooring at Juno Point is to float the pipeline in a westerly direction towards Luggage Point. Buoyancy devices would float the sand delivery pipeline between the shoreline and the dredge vessel. This alignment will impact a small section of mangroves but would largely minimise ecological impacts. From this location the pipeline will follow the same route along the Luggage Point Wastewater Treatment Plant (described below for the Luggage Point alignment).

***Summary***

- The mooring location at Juno Point is exposed and may not allow all weather operation of the dredge. Capital dredging required is extensive and the contaminated dredge spoil would be problematic to mange. Clean materials extracted during capital dredging could be managed on the Airport site with some of the materials suitable for use within the runway project.
- Pipeline route (Juno A) option results in direct disturbance of mangrove habitat and wader bird habitat. The pipeline route would prove difficult and expensive to construct and decommission.
- Pipeline route (Juno B) could be constructed and any access and environmental issues could be managed during the dredging campaign.
- On the basis of the exposed mooring location, the difficulty in handling the dredge spoil from capital dredging the Juno Point options are not preferred.

### *4.21.3.4 Luggage Point*

The Luggage Point site is situated to the south of Luggage Point, between the treatment plant outfall and the oil tanker wharf. Initial discussions with the Harbour Master indicate that this location for a discharge point will not cause adverse impact to Port of Brisbane shipping operations. The total length of the sand delivery pipeline from the mooring to the convergence point is 2,400 m with a maximum pumping distance of 6 km.

***Mooring site***

The proposed mooring site is located at the edge of the swing basin for the Port of Brisbane and as such the water depth is sufficient for the dredging vessel to moor without additional capital works dredging. Preliminary investigations indicate that the dredge operation at Luggage Point will not adversely interfere with the operations of the swing basin or the adjacent oil berth. The Luggage Point site affords some protection from adverse weather and should allow all weather operations of the dredge.

***Pipeline route***

Buoyancy devices will be used to float the sand delivery pipeline between the dredge vessel and foreshore. The pipeline route will cross the wastewater outfall channels (open concrete structures) and precede north-west over the existing drying beds, thereby avoiding the low lying silt basin to the north-east. A steel structure will be constructed over the existing outfall channels so that the outfall channels are not impacted (refer section 4.23). Initial indications from Brisbane Water indicate that this route will be acceptable and any access/ egress and operational issues can be managed.

Construction of the pipe route may involve disturbance of fill materials placed during previous Airport developments or during operation of the Luggage Point Wastewater Treatment Plant. Specifically, the pipe route traverses an area used to dispose of biosolids from the wastewater treatment plant. The biosolids area is capped and the pipe route will traverse this area with minimal disturbance with the pipeline placed above the existing surface wherever possible. Any disturbed materials will be tested and treated appropriately during this construction of the pipeline. As with the Boggy Creek pipeline alignment, with the exception of the narrow mangrove-lined Jubilee Creek drain, the pipeline route does not traverse areas with significant or noteworthy biodiversity value.

***Summary***

- The use of Luggage Point requires no capital dredging and this is a significant advantage of this proposal.
- The pipeline route from Luggage Point to the Airport is suitable and any access and environmental issues associated with its construction can be managed. Special attention will be required to ensure the BCC Wastewater Treatment Plant can be operated without impediment during the dredging campaign.
- On the basis of the relative ease of establishing the mooring and the suitability of the pipeline route, this option is preferred.

### 4.21.4 Preferred Option

The preferred location for the discharge point of the dredged sand is at Luggage Point (refer **Figure 4.21**). The advantages of this location include:

- No capital dredging required;
- No clearing or trimming of mangroves required except mangroves fringing the Jubilee Creek Drain that will be restored following completion of the dredge pump-out activity;
- Reduced impact on tidal creeks, intertidal flats and public access routes;
- Suitable ground conditions for the pipeline; and
- Relatively sheltered site.

The pipeline route from this location to the reclamation site is the most direct of the options and does not require a booster station. The land is owned by Brisbane Water and initial discussions suggest that the Luggage Point Wastewater Treatment Plant will accommodate this pipeline within their facility.

A more comprehensive comparative analysis of the benefits and disadvantages of the four mooring locations and pipeline routes is contained in Chapter B1.

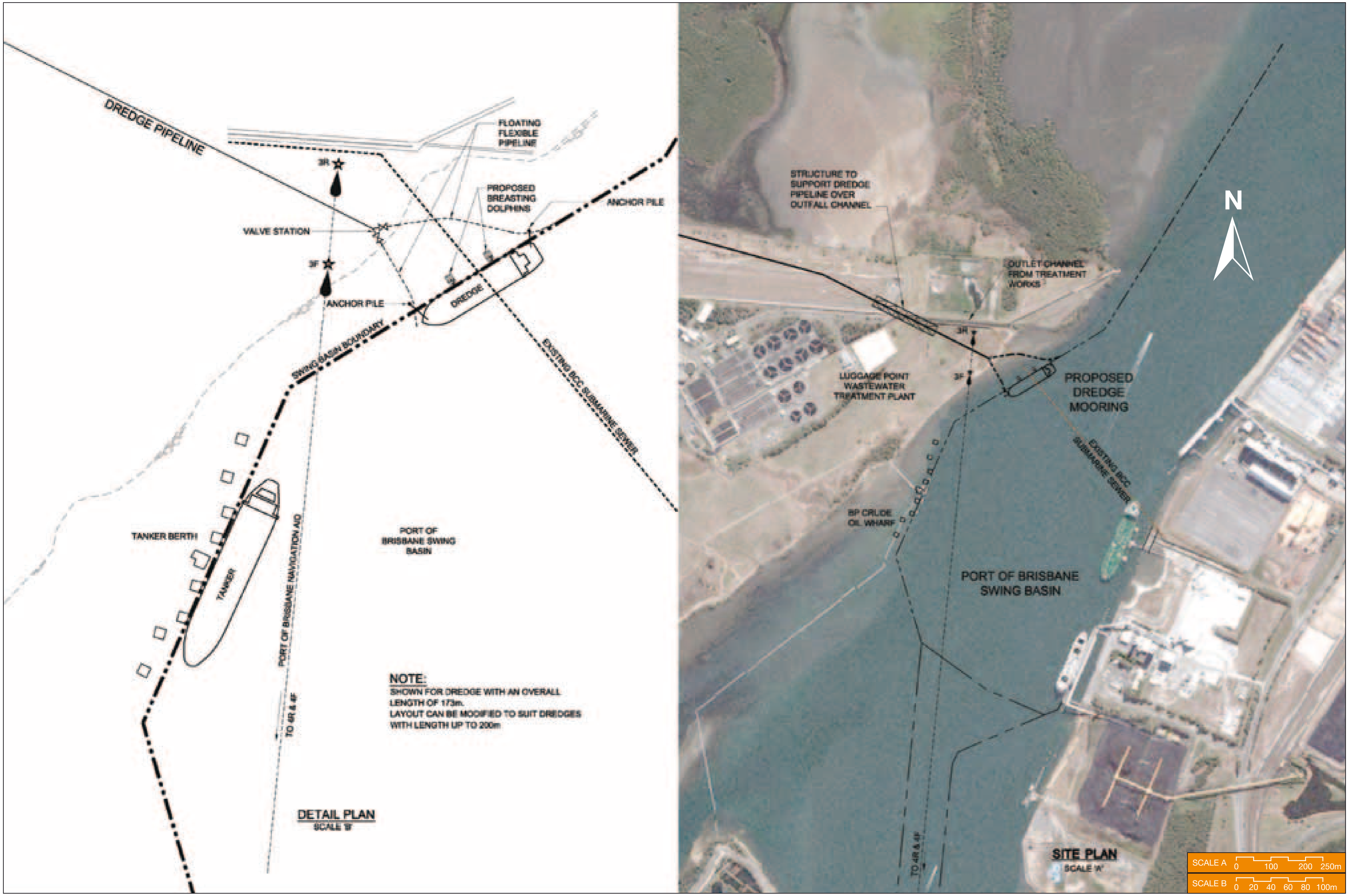
## 4.22. Dredge Mooring Design

### 4.22.1 Dredge Operations

During operations, the dredge will interact with commercial shipping into the Port of Brisbane. Marine safety will be of interest to the Harbour Master who will monitor the dredge operations for compliance with all statutory requirements. Under Queensland Legislation, the dredge will be operated within the Brisbane pilotage area and must either carry a licensed marine pilot or be under the command of a master who holds a pilotage exemption certificate for the area. Traditionally, the majority of ships berth into the current to ensure steerage at low absolute speeds and increase safety during mooring. The mooring will enable the dredge to berth into the current on both ebb and flood tides and under all possible tidal and weather conditions.

The preferred mooring location at Luggage Point is located on the north-west side of the swing basin for the Port of Brisbane. The swing basin has a declared depth, at lowest astronomical tide (LAT), of 14 m which is sufficient to allow a fully laden dredge to moor at any time during the tide cycle. The dredge will be in operation 24 hours per day for the duration of the reclamation period (between 12 and 18 months – refer Chapter A5 Construction). The proposed Luggage Point mooring will only be used as the discharge point for the dredge. All servicing, refuelling and any maintenance works on the dredge will be carried out at a berth in the Port and will be

***Figure 4.22:*** *Dredge Mooring Site Plan.*



NOTE:
SHOWN FOR DREDGE WITH AN OVERALL LENGTH OF 173m.
LAYOUT CAN BE MODIFIED TO SUIT DREDGES WITH LENGTH UP TO 200m

coordinated by the Dredge Captain. No servicing or maintenance works will be carried out at the Luggage Point mooring.

The dredge mooring must be suitable as a temporary structure for use during the reclamation only.

### 4.22.2 Mooring Layout and Operation

The proposed layout of the dredge mooring has been determined by the proximity of a number of existing features:

- The BP Crude Oil Wharf;
- The commercial shipping channel;
- The effluent outfall structure from BCC's Luggage Point Wastewater Treatment Plant;
- The navigation lead marks No. 3F and No. 3R which define the channel in the Pelican Banks Reach; and
- The location of BCC's rising sewer main from the Port of Brisbane to the Luggage Point Wastewater Treatment Plant beneath the Brisbane River.

The dredge mooring is positioned to minimise impact upon the above facilities and to minimise interaction between the dredge during operations/ reclamation. The BCC sewer rising main passes through the proposed site of the discharge berth as shown on **Figure 4.22**. This existing pipeline is a 350 mm nominal diameter polyethylene pipeline between Fisherman Islands and Luggage Point installed by directional drilling during 2000/2001. The approximate location of this pipeline is known based on as constructed plans from BCC, however a survey to establish its exact location will be required prior to construction of the mooring to ensure that the proposed works do not interfere with this pipeline.

The ground conditions in the vicinity of the mooring is underlain Holocene sediments comprising a muddy sand surface layer about 1 m deep and a muddy sand fluvial delta deposit up to 7 m deep overlying a deep estuarine silt/clay deposit. These materials are prevalent in the lower Brisbane River area and are extremely weak in engineering terms. Based upon the preliminary geotechnical investigations and on regional experience, the length of piles to a consolidated Pleistocene basement (firm surface) will be in the order of 30 m.

To accommodate the design dredge, the proposed discharge mooring will be constructed from two breasting dolphins located to suit the particular dredge (refer **Figure 4.22**). The two dolphins will be located at about third points of the berthed dredge. Flexibility in the design will enable dredge lengths up to a maximum of 200 m.

Each dolphin will typically be constructed from twelve 1,000 mm diameter by 16 mm wall thickness steel piles driven to a minimum depth of 16 m or to a suitable set. These steel piles will be placed on a 3 m grid. As these dolphins are temporary structures, no concrete pile caps are proposed and instead twin steel frames will hold the piles in place and transfer the dredge berthing loads to the piles via a twin cone parallel motion fender. These fenders are relatively soft to reduce the magnitude of berthing reactions on the dolphins, in the light of the poor foundations for these structures. A typical dolphin will require a 150 tonne capacity bollard for mooring of the dredge, mounted on the upper transfer frame, and a top platform and access ladder for handling of mooring lines and maintenance.

Lighting the mooring dolphins during the hours of darkness will be to the requirements of the Regional Harbour Master incorporating standard solar powered flashing lights, the details of which will be determined during detailed design. On completion of the dredging operation the mooring dolphins will be dismantled and the steel piles extracted to return the site to its previous condition.

The mooring design assumes the dredge's discharge point is located on the bow of the ship and this discharge point will mate with a floating flexible discharge pipeline when the dredge berths.
A single anchor pile will secure the connection end of the floating discharge pipeline when the dredge is absent. Allowance in the design has been made for the dredge to moor in either direction (upstream or downstream) by including two floating pipelines which connect to the main discharge pipeline via an on-shore valve station. The dredge crew will operate the valve station to direct the flow of supernatant water at the commencement of each pump-out cycle.

BCC has noted that scour and erosion occurs on the shoreline adjacent the Wastewater Treatment Plant as a result of vessel wash, predominantly associated with vessels manoeuvring in the swing basin. To ensure that the dredge does not cause erosion on the shoreline, concrete matting (or similar treatment) protection will be installed on the shoreline to protect it against vessel wash. The detail of this protection works will be determined during detailed design of the mooring.

Bed erosion is also possible below the water level against the edge of the existing swing basin. Some minor bed erosion is evident adjacent the oil tanker berth, possibly as a result of propeller wash from the vessel itself and tugs manoeuvring the oil tankers into place. To combat the possibility of erosion caused by the bow thrusters on the dredge, concrete matting will be considered along the edge of the swing basin, immediately adjacent the location of the thrusters. In a similar manner, if the existing sewer, constructed beneath the Brisbane River, is located in an area where some erosion is possible, concrete matting or other protective works can be installed to ensure that the sewer is not exposed or damaged during dredging.

## 4.23 Pipeline Design and Temporary Structures

### 4.23.1 Introduction

The dredged sand will be transported from the moored dredge to the project site via a continuous steel pipeline. This pipeline will connect to the dredge discharge point on the bow of the ship via one of two flexible rubber floating lines located at each end of the mooring. At the foreshore these floating lines are connected to the main discharge pipeline through a valve station and Y piece. From this Y piece a single steel pipeline will be installed to the project site on an alignment which passes through Luggage Point Wastewater Treatment Plant, over an existing open drain and through part of the operating Airport.

The pipeline selection, installation, maintenance and removal will be the responsibility of the dredging contractor.

Typically, the pipeline specification is as follows:

- An average pipeline diameter of 1,000 mm;
- The pipeline will be constructed from 12 m to 15 m lengths of pipe supplied by truck;
- The pipe lengths will be bolted and the joints sealed by gaskets;
- The pipeline will be most efficient when laid straight, with a minimum number of bends;
- The pipeline will be rotated at regular intervals during the delivery phase by conventional excavators or cranes;
- The pipeline will require a 5 m wide gravel formation and a 5 m wide access track to be constructed along its entire length suitable for installation, maintenance, inspection and rotation of the pipeline; and
- Fencing will be provided along the length of the pipeline with screening where required.

### 4.23.2 Pipeline through Luggage Point Wastewater Treatment Plant

This pipeline alignment crosses into and out of Luggage Point Wastewater Treatment Plan. To allow this pipeline to traverse the plant without causing any impact to the operation of the plant a road crossing and an elevated pipeline structure are required.

The elevated pipeline structure is required to cross the Luggage Point Wastewater Treatment Plant's twin concrete effluent channels which form the southern boundary of the plant. The effluent channels are founded on the natural soil and have experienced some differential movement. To avoid any further movement of the effluent channels the discharge pipeline will be supported above the channels and at a sufficient distance from them to avoid any additional loading.

The discharge pipeline will be generally laid on the ground surface. At the channel crossing, the pipeline will be elevated on embankments to ensure a 500 mm minimum clearance between the pipeline and the top of the effluent channel walls is maintained. Gabion walls at each end of the crossing are proposed to control the movement of fill against the existing works and to limit the free span length. A concrete seat at each abutment will fully support the pipe without requiring pipe stiffening.

The pipeline crossing will be constructed from approximately 48 m of fully welded pipeline, with 25 m of this pipeline being a clear span over the effluent channels. A thicker pipe may be required to allow for pipe abrasion as rotation of the pipe in this location will not be feasible. Bare steel pipe should be acceptable as the pipe is accessible for monitoring and maintenance.

A steel pedestrian bridge with security fence and gate will be required alongside the pipeline for inspection of the pipeline and to enable dredging personnel to cross the effluent channels. Details of a self-supporting pipe arrangement are included in **Figure 4.23**. Alternatively, a pipe bridge could be provided and the standard discharge pipeline supported on this bridge. A cross-section of a possible pipe bridge is also included in **Figure 4.23**.

A Council access road runs along the north side of the effluent channels to the effluent outfall at Luggage Point and active sludge lagoons north of the access road. It is necessary to maintain this access track during the reclamation period and the design allows for a temporary access road crossing which passes over the dredge pipeline.

This ramped road crossing over the pipeline will be located in the vicinity of the sealed road leading to the truck washdown area with the Luggage Point Wastewater Treatment Plant and connect back to the existing access track via a temporary access road. The crossing will be constructed by filling either side of the dredge pipeline with selected fill. This will be capped with gravel and asphalt to form a ramp. This temporary ramp and diversion will allow access to be maintained into the truck washdown area, effluent discharge channels and sludge lagoons.

Following completion of the reclamation operation, the pipeline will be removed, the elevated structure dismantled and the sealed pavement and gravel access track reinstated.

### 4.23.3 Airport Drain Crossing

The pipeline continues from the boundary of the Wastewater Treatment Plant, along the existing ground surface to the existing Airside drain. At this location a significant drainage channel, which drains the eastern side of the Airport, needs to be crossed. This existing tidal channel has well developed mangroves growing on either side.

The pipeline crossing for this drain will be similar to the crossing of the effluent outfall channels. The pipeline, pedestrian bridge and/or pipe bridge will be threaded through the mangroves to minimise the environmental impact and will span between the grassed banks of the channel on each side. On completion of the reclamation process the pipeline will be recovered and the mangroves reinstated.

### 4.23.4 Airport Runway and Taxiway Crossing

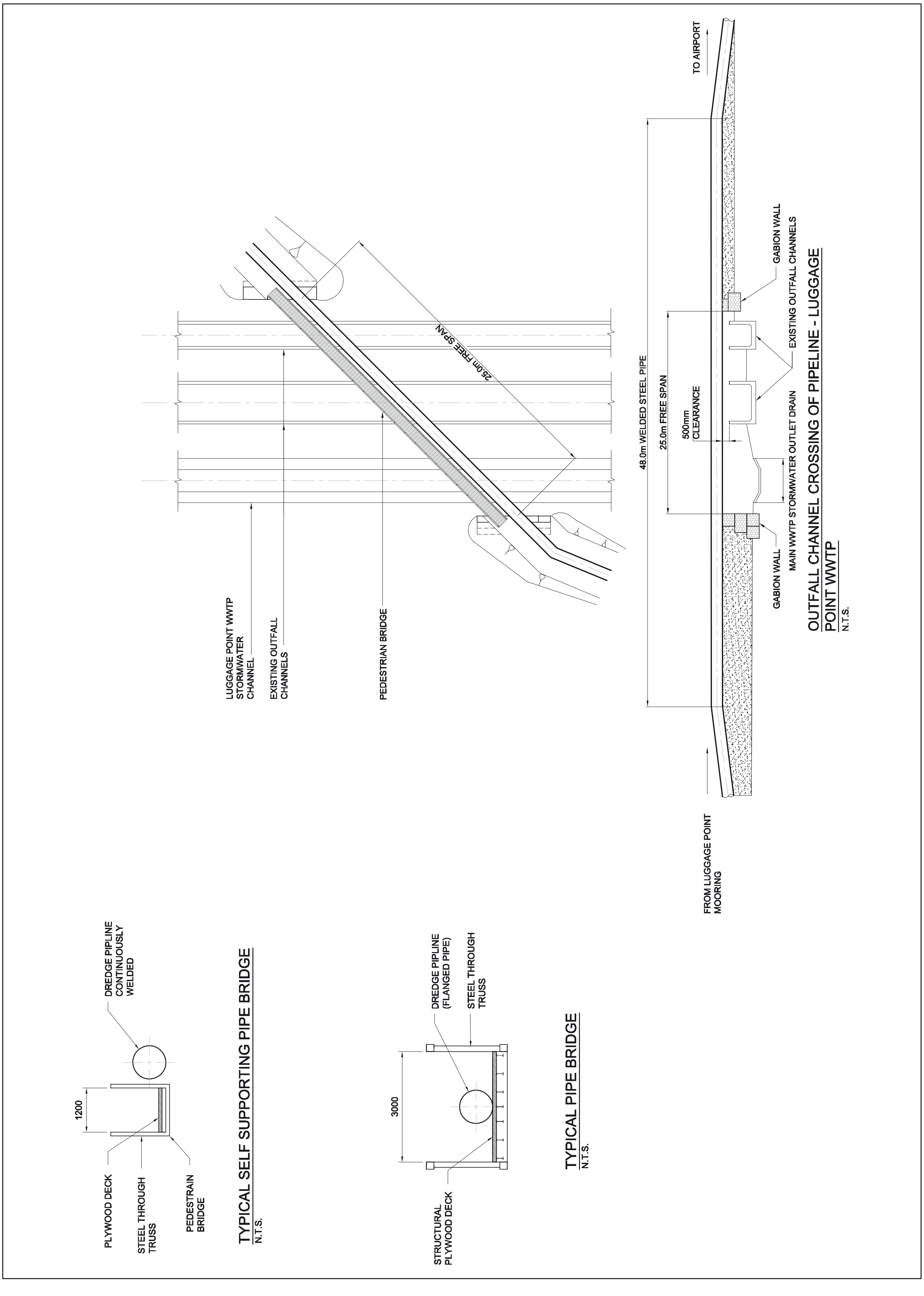
The pipeline alignment continues northwest where it is required to cross the end of the main 01/19 runway approach and pass under two taxiways. Due to the risk of any pipeline incident affecting aircraft operation, no failure of this section of discharge pipeline can be tolerated and access to the pipeline will be restricted to periodic inspections by the contractor.

The pipeline throughout this section will be a straight in alignment and polyurethane lined, flanged steel pipe. It will be installed during a runway closure. An access road will not be provided along this length of pipeline as access to this area is restricted and all surface inspections will be undertaken on foot.

If properly designed, this pipeline will not require maintenance during the reclamation but will require monitoring on the polyurethane lining. Monitoring would be undertaken using a video camera passed through the pipeline. The ability of the polyurethane lining to resist sand slurry abrasion, combined with regular monitoring of the condition of the polyurethane lining, will provide sufficient confirmation of the performance of this pipeline.

Following completion of the dredging programme, this pipeline can be recovered where possible. A short section of the pipeline, installed beneath

**Figure 4.23:** *Luggage Point Wastewater Treatment Plant Outfall Channel Crossing.*



Taxiways A and B might be abandoned and left in place for use as a future service duct. If it is abandoned, the pipeline will be filled with sand or foam concrete to protect against future subsidence.

## 4.24 Sediment Ponds

Hydraulic placement methods used throughout the NPR reclamation will result in large volumes of reclamation supernatant water, the water used to transport sand materials from the dredge vessel to the reclamation site. To assist in managing the quantity and quality of the supernatant water, temporary sediment ponds will be constructed to provide short term storage of reclamation supernatant. The ponds will provide storage to accommodate the interface between the 8 hour dredge discharge cycle and the 6 hour semi-diurnal tidal cycle, upon which the supernatant release is based (refer Chapter A5). The ponds also provide treatment of supernatant water for removal of entrained suspended solids prior to release to receiving waters.

Temporary sediment ponds will be constructed in two locations. The southern sediment pond is located adjacent the Kedron Brook Floodway Drain, to the south of the NPR and discharges to Kedron Brook Floodway Drain.

The northern sediment pond is located adjacent the existing 14/32 taxiway system and the existing perimeter road. The northern pond will discharge supernatant to Serpentine Inlet Drain, which crosses beneath the existing 14/32 runway. **Figure 4.24** shows the location of each temporary sediment pond.

The temporary sediment ponds will be constructed above the existing ground surface level. The construction of the ponds aims to minimise the potential for disturbance of acid sulfate and potential acid sulfate soils. Storage within the ponds is provided by construction of earth bunds along their perimeter. The volume of storage required within the ponds is defined by the selection of dredge equipment and the dredging operations. It is anticipated that the minimum required storage volume required is approximately 230,000 m$^3$, based on preliminary dredge selection (refer section 4.19). The bunds that define storage within the ponds will be approximately 2.0 m high, providing a maximum storage depth of approximately 1.5 m. The earth bunds will be lined with a plastic high density polyethylene material to minimise seepage of supernatant through the walls of the ponds.

The inlet and outlet structures of each sediment pond are constructed within the earth bund along the perimeter of the ponds. The inlets and outlet of each sediment pond are used to control the rate of supernatant flow into the ponds from adjacent reclamation cells and out of the ponds to the Kedron Brook Floodway Drain and Serpentine Inlet Drain receiving waters. Adjustable weir structures will be used at each inlet and outlet to provide control of pond inflow and outflow and maintain suitable storage volume and retention time within the ponds. Adjustment of the weir crest height will be used to control pond inflow and outflow.

Localised erosion of bund material and in situ soils at pond inlets and outlets will be controlled by construction of temporary inlet/outlet protection. The inlets and outlets to the sediment ponds will be protected with rock filled wire mattresses (reno mattresses) over in situ soils and areas of the bund susceptible to erosion. The design of Kedron Brook Floodway Drain and Serpentine Inlet Drain includes rock protection on the base of the channels to further reduce the potential for erosion of bed materials during reclamation for the NPR.

Movement of supernatant in the ponds is controlled by construction of flow baffles within the open water body. The flow baffles extend the flow length within the ponds and increase the hydraulic retention time of supernatant within the ponds. These two functions of the pond baffles jointly improve the suspended solids treatment performance of the ponds by providing increased time for particles to settle from suspension. The baffles may be constructed either by formation of additional earth bunds within the pond perimeter, or by erection of a geotextile fabric cover over a structural frame (welded wire mesh) (refer **Figure 4.24**).

Construction of the sediment ponds is included in the early works phase of NPR development. While the primary function of the ponds is to manage supernatant during reclamation for the NPR, the ponds will be functional during the clearing phase to provide treatment and control of stormwater release. Following completion of hydraulic placement of sand fill, the ponds will be decommissioned. During the decommissioning process the earth bunds (constructed from in situ soil materials or imported fill) will be excavated, the inlet and outlet structures will be dismantled and sand fill will be mechanically placed in the ponds, displacing any water remaining in the ponds. Materials recovered during decommissioning of the ponds, including in situ soils (imported fill) used for bund construction and rock fill from reno mattress and rock protection will be used during subsequent civil works for NPR construction.

A detailed discussion on the operation of the sediment ponds is included in Chapter A5 and a detailed discussion on water quality is included in Chapter B8.

***Figure 4.24:*** *Sediment Pond Location.*