A3

VOLUME A: BACKGROUND AND NEED

Options and Alternatives

Options and Alternatives

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3.1 Introduction

This Chapter of the Draft EIS/MDP presents the findings of assessments of options and alternatives considered as part of the EIS/MDP process. Section 3.2 includes an assessment of feasible alternatives to runway construction such as the use of demand management measures and expanded use of other regional airports such as Coolangatta and Maroochydore. Section 3.3 provides a detailed assessment of runway location options at Brisbane Airport, updating work that was presented in the BAC 2003 Master Plan. A triple bottom line assessment of runway options is provided. Section 3.4 reviews the feasible alternatives to sourcing runway fill and other construction materials. It summarises information detailed in the Moreton Bay Sand Extraction Study on sand fill options and provides new information regarding the sourcing of pavement and structural materials.

3.2 Feasible Alternatives to Runway Construction

3.2.1 No Change Scenario

3.2.1.1 Peak Hour Spreading

It is evident that many airports including Brisbane have daily peaks. If the demand within these peaks could be spread across other hours of the day, the need for additional runway capacity and associated capital expenditure could be reduced. This would be ideal for airlines (as they could improve the utilisation of their aircraft) and airport operators (as they could increase the revenue achieved for their aeronautical infrastructure investment). However underestimating the peak can lead to congestion, delays and ultimately to capacity constraints that restrict growth and development.

The peaks arise due to passenger preferences and a number of airline operating constraints.

Domestic airline peaks arise around 7.00am to 9.00am each weekday morning and around 6.00pm to 8.00pm each evening. For airports such as Sydney, Melbourne and Brisbane these runway peaks are driven largely by domestic business traffic. It is estimated that business accounts for between 60 percent and 65 percent of the domestic traffic and that between one-third and 40 percent of domestic passengers travel from or to Brisbane and return in the same day. As Brisbane's population grows so too will its business traffic. For this reason it is reasonable to expect that the airlines will continue to serve the needs of the higher yielding business passengers with services operating at current peak times.

Further, in the case of Brisbane, a large number of regional flights from elsewhere in Queensland operate to Brisbane carrying business passengers wishing to connect to interstate flights. For this reason the regional airlines service also contribute to morning and afternoon peaks at Brisbane Airport.

International peaks result from a complex array of issues. There are a number of significant influences and constraints affecting airline schedules. These include:

- Passenger preferences to commence or complete their journey at 'friendly' times – not too early in the morning and not too late in the evening;
- Slot limitations at airports in Asia and Europe which will limit when aircraft can arrive at or depart from Brisbane; and
- The hubbing role played by some airports. This means that longer haul flights operating via Asia need to connect with flights in the hub port to carry passengers from an incoming port to their different ultimate destinations. Thus the incoming flight needs to arrive in time to catch a 'bank' of outgoing flights.

As a result of these factors airlines cannot schedule arrivals and departures on an unconstrained 24 hour basis. Rather they are confronted with limited scheduling opportunities or 'windows'.

This is why many Asian flights arrive at Brisbane in the early morning adding to the domestic peak described earlier.

Thus whilst there are some opportunities for airlines and airports to spread their peaks there is a limit and little scope to spread traffic evenly across the operating day.

When demand starts to exceed capacity during peak periods, airlines either have to move flights into the shoulder period, change aircraft to a larger seating capacity aircraft, or simply allow passengers to alter their travel patterns (e.g. travel earlier or later, use alternative airports, or not travel by air). This is not an ideal situation as for many reasons, passengers particularly the business traveller, have a particular time when they must travel. This is discussed further in Chapter A2.

The TAAM[1] modelling for the 2035 scenario with no new runway (Chapter A2 **Table 2.6f**), indicates that delays of between 2.5 to 4 hours were starting to occur. No airline would tolerate such delays and would alter their schedule accordingly by either changing flight times (where possible) or by not scheduling the flights (more likely) leading to loss of airline passengers through Brisbane.

3.2.1.2 Passenger Loss

The hourly, daily and annual capacity constraints of traffic for 2034/35 were applied assuming no additional runway. It is estimated that 35 percent of aircraft movements would be lost in 2034/35. The overall passenger loss is estimated to be around 12 million passenger movements in 2034/35 or 24 percent of the unconstrained demand.

It is forecast that there will be a loss of 3.2 million international passengers and 8.8 million domestic passengers.

By 2035 that would mean a direct loss of just under $5 Billion per annum in passenger spending in the wider economy (in today's dollars).

3.2.1.3 Improvement Options for Existing Runway System

BAC has previously undertaken a review of whether additional airfield infrastructure to the existing runway/taxiway system could provide increased arrival and departure capacity to enable a deferment of the New Parallel Runway (NPR). The enhancements considered were:

- Additional taxiway entrances onto the main runway to facilitate intersection departures;
- Additional rapid exit taxiways to facilitate landing aircraft vacating the runway quicker;
- The construction of the missing section of taxiway on the bravo taxiway system commonly referred to as the 'missing link'; and
- Additional taxiway connection between the alpha and delta taxiway systems to facilitate aircraft operating from the cross runway.

These above enhancements were reconsidered during the current design phase for the NPR and modelled as part of the TAAM investigations. That modelling has resulted in the following outcomes.

Additional Taxiway Entrances

An additional taxiway entrance was considered for departures in both the 01 and 19 runway directions. The intent of this work would be to enable additional departures during busy periods, particularly when there are a number of aircraft queued on the taxiway awaiting departure. Based on the existing aircraft mix at Brisbane Airport during the busy hours, these additional taxiways would not provide any discernible improvement in the hourly departure rate.

In the case of an additional intersection departure taxiway in the 19 runway direction (i.e. towards the city), there would be potential negative noise implications. The current noise abatement procedures would not permit such an intersection departure for jet aircraft.

[1] *Refer Chapter A2 for an explanation of TAAM Capacity modelling.*

Additional Rapid Exit Taxiways

One additional rapid exit taxiway (RET) was considered for aircraft arriving in both the 01 and 19 directions. The intent would be to enable landing aircraft to vacate the runway more quickly potentially allowing for additional arrivals.

The results show negligible improvements in arrival rates confirming the optimum locations of the existing RETs.

Missing Link

Departing aircraft using runway 01 without the missing link have the potential for congestion on the alpha taxiway system. There is also potential for conflict with operations to the International Terminal. The investigations showed that construction of the missing link would enhance the operational efficiency of the taxiway system by providing a complete dual parallel taxiway system, and as a consequence assist in ensuring that the existing main runway does achieve its predicted maximum departure rate of 25 – 27 aircraft in a busy hour.

Alpha – Delta Link

During periods of high demand and the use of the cross runway 14/32, a new link taxiway between the existing taxiways alpha and delta joining at the thresholds of runways 19 and 32 would assist to alleviate congestion when arrivals taxiing from a runway 14 landing may be blocked by a departure queue for runway 19 take-offs.

The investigations show that the provision of this additional link would assist taxiway efficiency but does not add to runway capacity. This link is required as part of the proposed taxiway system for the new runway when the cross runway is closed and converted to a taxiway. This new link has been adopted as part of the new runway design.

3.2.2 Demand Management Scenario

3.2.2.1 Demand Management Options

In the event that the NPR is not constructed when required, a number of demand management options would have to be considered. These fall into two main categories:

1) Economic Management Approaches

There are two main types of economic control:

- **Congestion Pricing**
  Here airlines would be charged a higher fee to arrive or depart during the peak period. This charge would be related to the estimated marginal cost of delay that each operation causes during the peak period. Instigation of this approach would encourage lower value flights to move to shoulder and non-peak periods.
- **Slot Auction**
  This approach would enable the selected authority to trade slots so that airlines operating higher value flights would be able to bid to migrate to the most valuable times of the day.

2) Regulatory Approaches

- **Slot Management**
  A second regulatory approach is slot management. This is usually associated with an overall movement cap. Again this approach is used at Sydney Airport. Slots are allocated to airlines on the basis of the services operated by airlines at the time of introduction of the slot management system. New slots are then co-ordinated to ensure efficient management and reduced congestion at the airport. At Sydney Airport there is a system to protect the slots of Regional Airlines (usually operating the intrastate services) which further reduces overall capacity.
- **AircraftSize Restriction**
  A further approach that could be considered is to provide minimum limits on the number of seats on aircraft operating into the peak period. The intent would be to encourage smaller aircraft to fly to hubs away from Brisbane and then to have passengers join larger aircraft for their on-carriage to Brisbane.

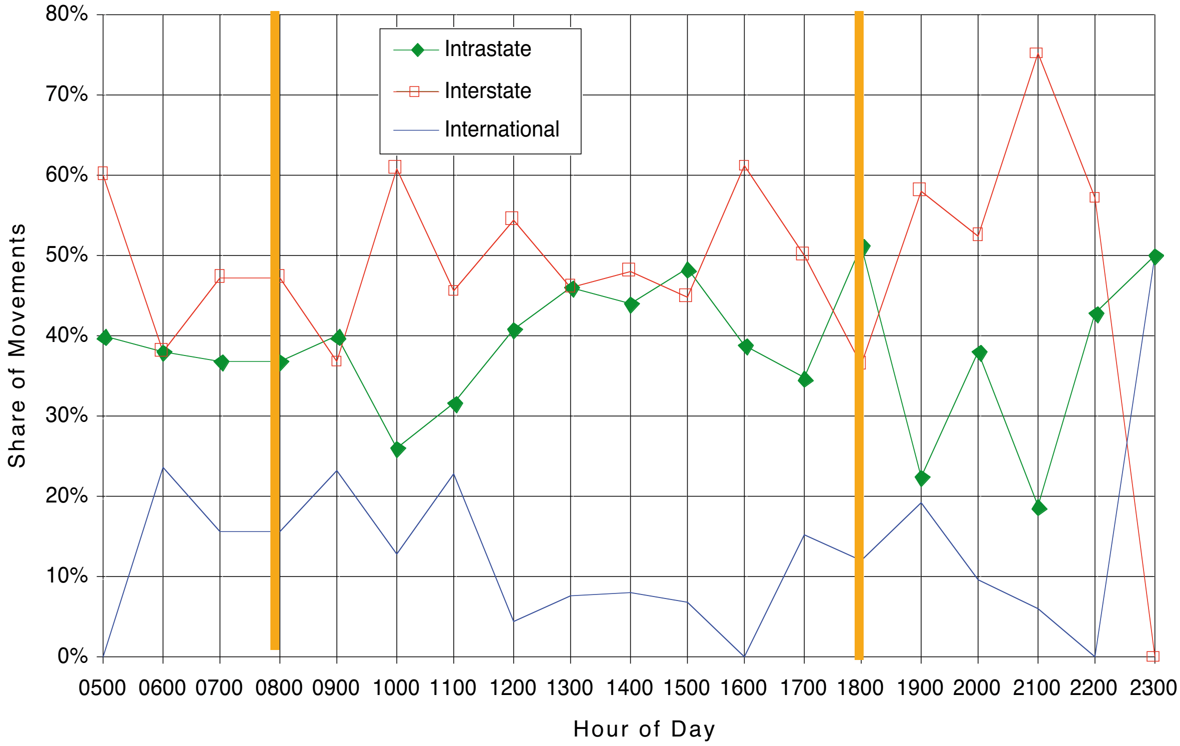
3.2.2.2 *Structure of Demand for Runway Usage at Brisbane Airport*

Figure 3.2 shows the share of movements across the day by market sector (intrastate, interstate and international). The busiest hours of the day are the 0800 and the 1800 hours which are summarised as:

- During the 0800 hour, intrastate aircraft movements account for 37 percent of movements, interstate for 47 percent and international for 16 percent;
- During the busiest hour of the day, the 1800 hour, intrastate aircraft movements account for 51 percent of movements, interstate for 37 percent and international for 12 percent;
- Due to different aircraft sizes and profiles throughout the day, annual passenger traffic have different shares compared with peak hour aircraft movements; and
- Thus the regional (intrastate) movements represent the largest contributor to the busiest hour of the day.

It is important to recognise that many travellers intend flying to/from Brisbane early in the day and returning late in the day to avoid overnight (or additional overnight) stays. This gives rise to the two peak periods. This type of travel is particularly important for intrastate and interstate business travellers.

Figure 3.2: *Intrastate, Interstate and International Shares of Movements Across the Day, Brisbane Winter Weekday 2004/05.*



3.2.2.3 Demand Management Implications

It is evident that the demand management options would have implications for the types of services that could be operated into peak periods at Brisbane Airport. Larger aircraft types would be likely during the peaks and would focus on the delivery of business passengers.

However it is likely that the flight frequencies from connecting cities would be limited compared to the number that would be available if the additional runway capacity was made available. The business market in particular values the additional frequencies.

Queensland is one of the most decentralised states in Australia with a substantial and growing population outside of Brisbane. Many travellers from outside of Brisbane will seek to hub through Brisbane to connect to interstate and overseas services. The pressure for airlines to hub outside of Brisbane would not be well received. This would add to the time for intrastate travel and make it difficult to undertake the desired business activities within a day.

Effectively the constraints that would emerge in the absence of additional runway capacity would largely be felt by intrastate and interstate business travellers. This would introduce inefficiencies into their decision making and increase the need for overnight stays thus increasing overall costs. It is likely that some of the business travel would not take place reducing the overall demand for travel to/from Brisbane.

Ultimately, all the costs of congestion fall on passengers, whether this is through higher airfares or non-price congestion such as inconvenience and delays. The exact breakdown between how much of any level of congestion is incurred as higher airfares or as inconvenience, depends on how well airlines are able to price-ration demand to the available supply.

By 2035, it is estimated that there will be an additional cost of around $28 (two-way) to domestic passengers and $26 (two-way) for international passengers as a result of not providing additional runway capacity at Brisbane, of which three-quarters is estimated to be through higher airfares (price rationing) and the remainder is non-price rationing such as additional inconvenience and altered travel plans.

This equates to an annual cost to passengers in excess of $500 Million in 2035, based on the capacity constrained forecasts of 27.0 million domestic passenger movements (13.5 million two-way) and 11.0 million international passenger movements (5.5 million two-way).

3.2.3 Expanded Use of Other Airports

A number of commercial airports serve the South East Queensland region. These are discussed in the following sections.

3.2.3.1 Gold Coast Airport

The Gold Coast Airport (GCA) is located at Coolangatta and serves the Gold Coast and Tweed (NSW) regions. The Preliminary Draft Master Plan 2006 for GCA (May 2006) indicates that:

- The primary runway (14/32) handles the majority of the aircraft movements. This runway is 2,042 m long and 45 m wide and approvals are in place to extend the runway to 2,500 m; and
- The secondary (cross) runway, (17/35) is 582 m long and 18 m wide and is used for General Aviation (GA) movements.

With respect to the future and growth potential the Preliminary Draft Master Plan indicates that:

- Average annual growth moving forward will represent approximately 5 percent domestically;
- Internationally there is greater potential for growth off a relatively low base. The Gold Coast Airport runway extension to 2,500 m will facilitate direct flights to Asia and therefore an average annual growth rate of 20 percent has been prepared, with the majority of that growth being delivered from 2009–10 onwards;
- Overall forecasting six years from now, Gold Coast Airport predicts a total average annual growth rate of 6.12 percent for both domestic and international passengers; and
- Domestic and New Zealand services will always represent the core business of Gold Coast Airport and represent the majority of passengers.

3.2.3.2 *Sunshine Coast Airport*

Located at Maroochydore, the Sunshine Coast Airport (SCA) is the gateway to destinations such as Noosa, Maroochy, Coolum, Mooloolaba and Caloundra.

There are two runways at the Sunshine Coast Airport:

- The main runway (18/36) is 1,797 m in length and a width of 30 m; and
- The second runway (12/30) is 650 m in length, is 18 m wide and is weight limited for aircraft up to 5,700 kgs.

3.2.3.3 *Archerfield Airport*

Archerfield Airport is located 12 km west of the Brisbane Central Business District (CBD). The Archerfield Airport Master Plan 2005–2025 (November 2005) suggests that the airport is positioned to be a hub for aircraft charter, light aircraft, emergency services and privately operated aircraft in South East Queensland.

Archerfield Airport has a multi-runway configuration with two parallel runways in two directions (40 and 96 degrees magnetic).

The Master Plan includes a long term forecast growth of 3 percent per annum taking movements from 122,960 (during Tower hours) in 2003/04 to 228,742 movements in 2024/25.

3.2.3.4 *South East Queensland Traffic Levels*

Table 3.2a shows that the Brisbane, Gold Coast and Sunshine Coast Airports supported around 19.2 million passenger movements in 2004/05. This is up from 10.7 million a decade earlier (a trend Compound Annual Growth Rate of 5.4 percent over the decade). In 2004/05 Brisbane accounted for 80 percent of the passenger movements as it did a decade earlier although its share peaked at 86 percent in 2001/02.

Table 3.2a: Regular Public Transport Passenger Movements at Brisbane, Gold Coast and Sunshine Coast Airports, 1994/95 to 2004/05.

Years end 30 June	Brisbane	Gold Coast	Sunshine Coast	Total
Passenger Movements ('000s)				
1995	8,509	1,879	269	10,657
1996	9,236	1,993	310	11,539
1997	9,683	1,937	303	11,923
1998	9,737	1,868	280	11,885
1999	9,834	1,864	289	11,987
2000	10,534	1,959	307	12,801
2001	12,467	1,888	238	14,593
2002	11,774	1,736	216	13,726
2003	11,841	2,178	319	14,338
2004	13,780	2,504	431	16,715
2005	15,358	3,142	664	19,164
Share of South East Queensland Passenger Movements				
1995	80%	18%	3%	100%
1996	80%	17%	3%	100%
1997	81%	16%	3%	100%
1998	82%	16%	2%	100%
1999	82%	16%	2%	100%
2000	82%	15%	2%	100%
2001	85%	13%	2%	100%
2002	86%	13%	2%	100%
2003	83%	15%	2%	100%
2004	82%	15%	3%	100%
2005	80%	16%	3%	100%

Table 3.2b: RPT Aircraft Movements at Brisbane, Gold Coast and Sunshine Coast Airports, 1994/95 to 2004/05 Years.

Years End 30 June	Brisbane	Gold Coast	Sunshine Coast	Total
Aircraft Movements ('000s)				
1995	117	27	6	150
1996	126	26	8	161
1997	125	24	7	157
1998	126	23	6	154
1999	129	22	8	159
2000	133	21	10	164
2001	152	20	9	181
2002	125	16	5	147
2003	117	21	5	143
2004	122	21	6	149
2005	137	28	8	172
Share of South East Queensland Aircraft Movements				
1995	78%	18%	4%	100%
1996	78%	16%	5%	100%
1997	80%	15%	5%	100%
1998	81%	15%	4%	100%
1999	81%	14%	5%	100%
2000	81%	13%	6%	100%
2001	84%	11%	5%	100%
2002	85%	11%	4%	100%
2003	82%	15%	3%	100%
2004	82%	14%	4%	100%
2005	79%	16%	5%	100%

Table 3.2b shows the RPT aircraft movements for South East Queensland Airports. In total the three airports accounted for 172,000 aircraft movements in 2004/05. Brisbane's share amounted to 79 percent of the total.

The Gold Coast and Sunshine Coast Airports play an important part in servicing the South East Queensland catchment area, particularly Low Cost Airlines targeting the 'sun seeker' leisure travel market. Even after allowing for continued strong growth at Gold Coast Airport and Sunshine Coast Airport, the overall rapid pace of growth in the region, and Brisbane Airport's role in the business travel market (and full service airlines), ensures capacity expansion at Brisbane is largely complementary to rather than in competition with growth at Gold Coast and Sunshine Coast Airports.

3.2.4 Conclusion

The above assessment identifies that the feasible alternatives to new runway construction will not provide sufficient capacity to meet demand for air traffic in South East Queensland as follows:

- Maintaining the existing runway with no additional capacity will lead to a significant loss of passenger movements (approximately 24 percent) in 2035, with associated economic disbenefits;
- Improvements to the existing runway system will provide only marginal capacity improvements, insufficient to meet future demand;
- Demand management will constrain aircraft movements, particularly to regional centres with associated economic disbenefits for passengers; and
- Other South East Queensland airports will be complementary to Brisbane Airport rather than providing realistic alternatives if a new runway is not provided.

3.3 Options to Runway Location

3.3.1 History of Runway Options Development

Over the past 25 to 30 years numerous runway configuration concepts and options have been considered in various studies conducted prior to commencement of the Phase 1 airport construction works in 1980 and in the preparation of the 1983, 1991 and the 1998 Master Plans including:

- Original 1969 Master Plan;
- Brisbane Airport Advisory Committee (BAAC) – Report 1970/71;
- Parliamentary Standing Committee on Public Works – Minutes of Evidence 1979;
- Parliamentary Standing Committee on Public Works – Minutes of Evidence 1981;
- Parliamentary Standing Committee on Public Works – Report 1981;
- Department of Transport – Preliminary Master Plan 1981;
- Department of Aviation – Master Plan 1983;
- Parliamentary Standing Committee on Public Works – Report 1989/90;
- GHD Pty Ltd – 'Review of Runway Configuration' Report 1990;
- FAC – 'Evaluation of Proposed Runway Development Options' Report 1990;
- Department of Transport and Communication – 'The Impact of Airport Noise' Task Force Report 1991;
- FAC – Master Plan 1991;
- GHD Pty Ltd – 'Runway Development Options' Report 1995;
- FAC – 'Future Airfield Capital Works' Report 1996, and
- Netherlands Airport Consultants (NACO) – Technical Paper No. 8 'Runways, Taxiways and Aprons' 1998.

The 1998 Master Plan included a discussion and summary of Brisbane Airport runway development option assessment undertaken in the studies referred to. That assessment resulted in the adoption of the Q3 concept for Brisbane Airport and delivery of the existing core facilities during the 1980s.

In 1999 BAC continued to evaluate runway development options. This reassessment was influenced by a number of factors including:

- A commitment by BAC to achieve the best possible outcome for the overall community;
- Strong political and environmental issues associated with future runway development at Brisbane Airport;
- The need to develop a firm, stageable and cost effective Terminal Area Development Strategy;
- The impact on immediate commercial development demands influenced by terminal area design;
- The future capital costs associated with delivery of a southern elevated dual taxiway system;
- The flexibility constraints imposed by the southern extent of the future parallel runway on alignment options for the Gateway Motorway Deviation; and
- The cost, functionality, and aesthetic impacts imposed on the Airtrain structure being depressed below the proposed elevated dual parallel taxiway system.

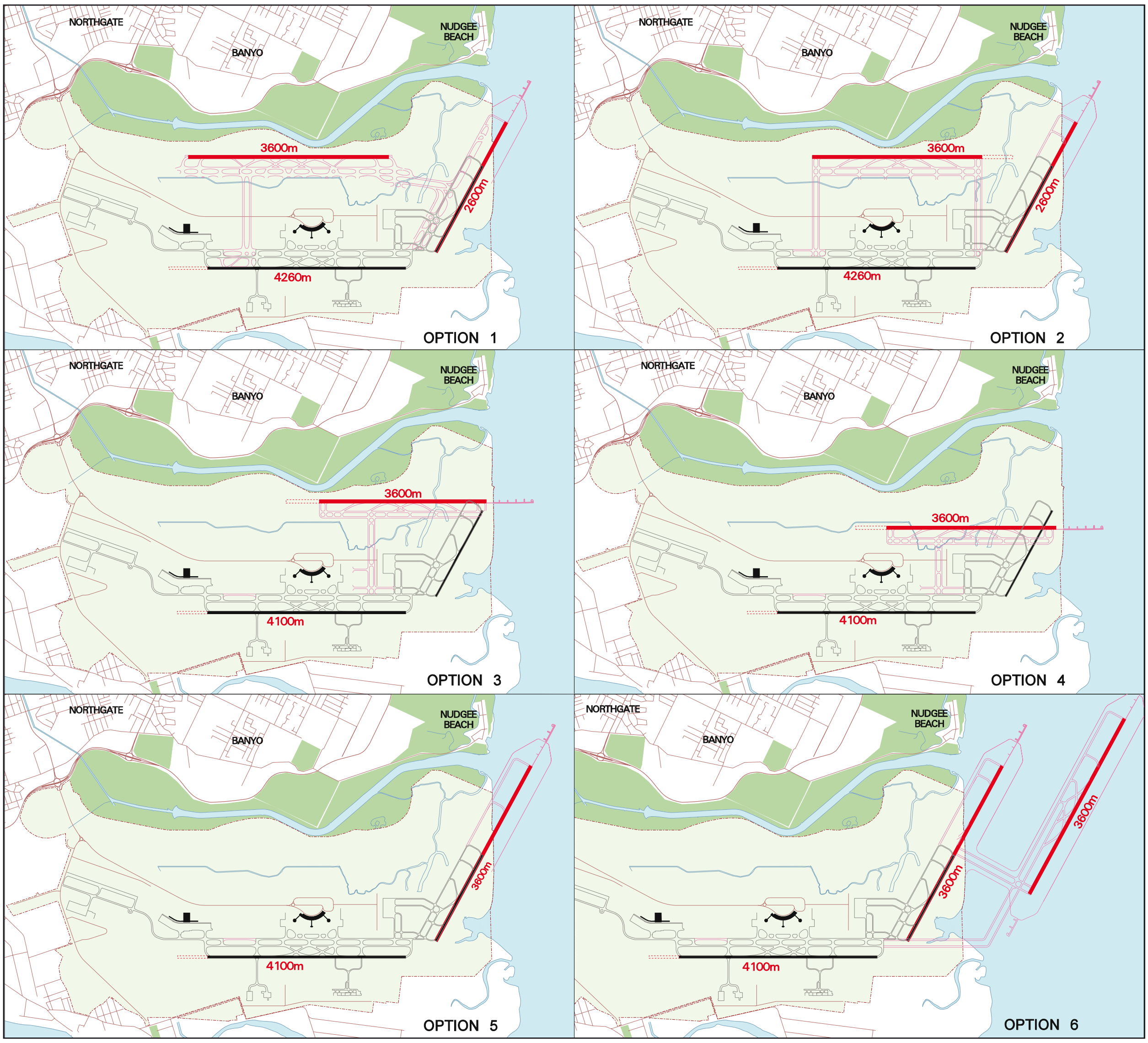
These factors informed the 2003 Master Plan.

3.3.2 Runway Options Assessed in 2003 Master Plan

As part of the BAC 2003 Master Plan, six runway options were assessed (see **Figure 3.3a**). The Master Plan stated that as part of any new runway project process the assessment of these options would be significantly extended in this Draft EIS/MDP.

The Master Plan also stated that "any runway system options that warrant review must be limited to those options that address the existing Brisbane Airport core infrastructure to realistically have any

Figure 3.3a: *Runway Options from the 2003 Master Plan.*



potential for actual implementation." In this regard as part of the preliminary design process, more detailed costing of one of the options has been undertaken (the preferred option identified in the Master Plan). This costing indicates significant recent cost escalation, reflecting the overly tight engineering construction market and the shortage of skilled labour. All the cost estimates for the various options included in the Master Plan would have similar cost escalation.

New infrastructure, not previously considered in the Master Plan, now affects the feasibility of some of the six runway options assessed. These are discussed as follows:

- Option 1 is not now a feasible option. The Gateway Upgrade Project will conflict with necessary clearances for arriving and departing aircraft. Additionally, it is not possible to engineer a solution that allows the linked taxiway to cross both the new Northern Access Road (NARP) and the Airtrain in the current location. Option 1 is therefore not considered further;
- Option 2 is not now a feasible option. It is not possible to engineer a solution that allows the linked taxiway to cross both the NARP and the Airtrain in the current location. Option 2 is therefore not considered further; and

- Option 6 was estimated, in the 2003 BAC Master Plan, to be of the order of six times the capital cost of the other five options ($1,920 Million compared to $285 Million to $315 Million). Additionally, there are a number of other significant impacts and issues associated with the runway extension and duplication for this option which:

    a) Extends into the Ramsar and Marine Park with the greatest impact on the ecology of the area;

    b) Will require compensation and/or land to be resumed in Nudgee Beach as a result of aircraft noise; and

    c) Will have the greatest impact on the behaviour of Kedron Brook Floodway and the coastal processes within Moreton Bay adjacent to the Airport.

BAC would therefore not build this option, particularly in light of likely cost escalation. Option 6 is therefore not considered further.

This Draft EIS/MDP therefore assesses in more detail the impacts and implications of Options 3 to 5 from the 2003 Master Plan, refer **Figures 3.3b to 3.3d**.

Table 3.3 provides a triple bottom line analysis of each of the remaining three Master Plan Options and considers the environmental, social and economic implications of each.

3.3.3 The Preferred Runway Option

Option 3, or the 'Staggered Runway Concept' is the preferred runway option which locates the New Parallel Runway as far towards Moreton Bay as practical – a total of 2.35 km closer than in the former Federal Airport Corporation (FAC) and Department of Aviation (DoA) Master Plans, while retaining the capacity and operational efficiencies of a wide spaced parallel runway system.

The concept provides improvement in the potential for Opposite Direction Parallel Runway operations by providing a runway stagger towards the preferred arrival runway, increasing effective separation standards.

It provides greater flexibility and stageability of terminal development solutions with the creation of a contiguous development zone previously bisected by an elevated dual parallel taxiway system.

The concept did result in a penalty of additional taxiing distances for International aircraft utilising the future runway, and additional construction costs associated with construction in areas of very poor geotechnical conditions.

The areas where Option 3 was considered to perform better than or equal to the other two options assessed are listed below:

1. Airport and Surrounds

- Land Use and Planning – runway separation provides required area for future aviation facilities including terminals, car parks and surface transport access. Least impact of approach lighting structure in the Ramsar site and Moreton Bay Marine Park;
- Reclamation into Moreton Bay – runway location avoids any reclamation into Moreton Bay;
- Terrestrial and Marine Ecology – Lewins Rail habitat is retained and the approach lighting has minimal impact on the Moreton Bay foreshore habitats for marine life and wader birds;
- Cultural Heritage and Native Title – low risk of impacting cultural heritage materials;
- Surface Hydrology – avoids impacts on the behaviour of Kedron Brook Floodway (including the possibility of having to divert the Floodway mouth to the north of its present location) resulting from the extension to the cross runway (Option 5);
- Coastal Processes – avoids potential significant long term impacts on coastal processes resulting from the extension to the cross runway (Option 5);
- Water Quality – avoids complex reclamation and fill processes resulting from the extension to the cross runway (Option 5);
- Social Impact – avoids impacts resulting from the extension to the cross runway (Option 5) on:
    a) Recreational amenity of Nudgee Beach;
    b) Marine navigation pathways in and out of Kedron Brook Floodway; and
    c) Use of the mud and sand flats of the area by commercial and recreational fishers.
- Ground Based Noise and Air Emissions – provides least impact from ground based noise.

2. Middle Banks

- Hydrodynamics and Coastal Processes – no difference between the options;
- Water Quality – no difference between the options;
- Marine Ecology – no difference between the options; and
- Social Impact – no difference between the options.

3. Other

- Construction – sand placement location does not require booster pumps;
- Operational Flexibility; and
- Operational Capacity – provides greatest capacity and life for the new runway.

Figure 3.3b: *Runway Option 3.*

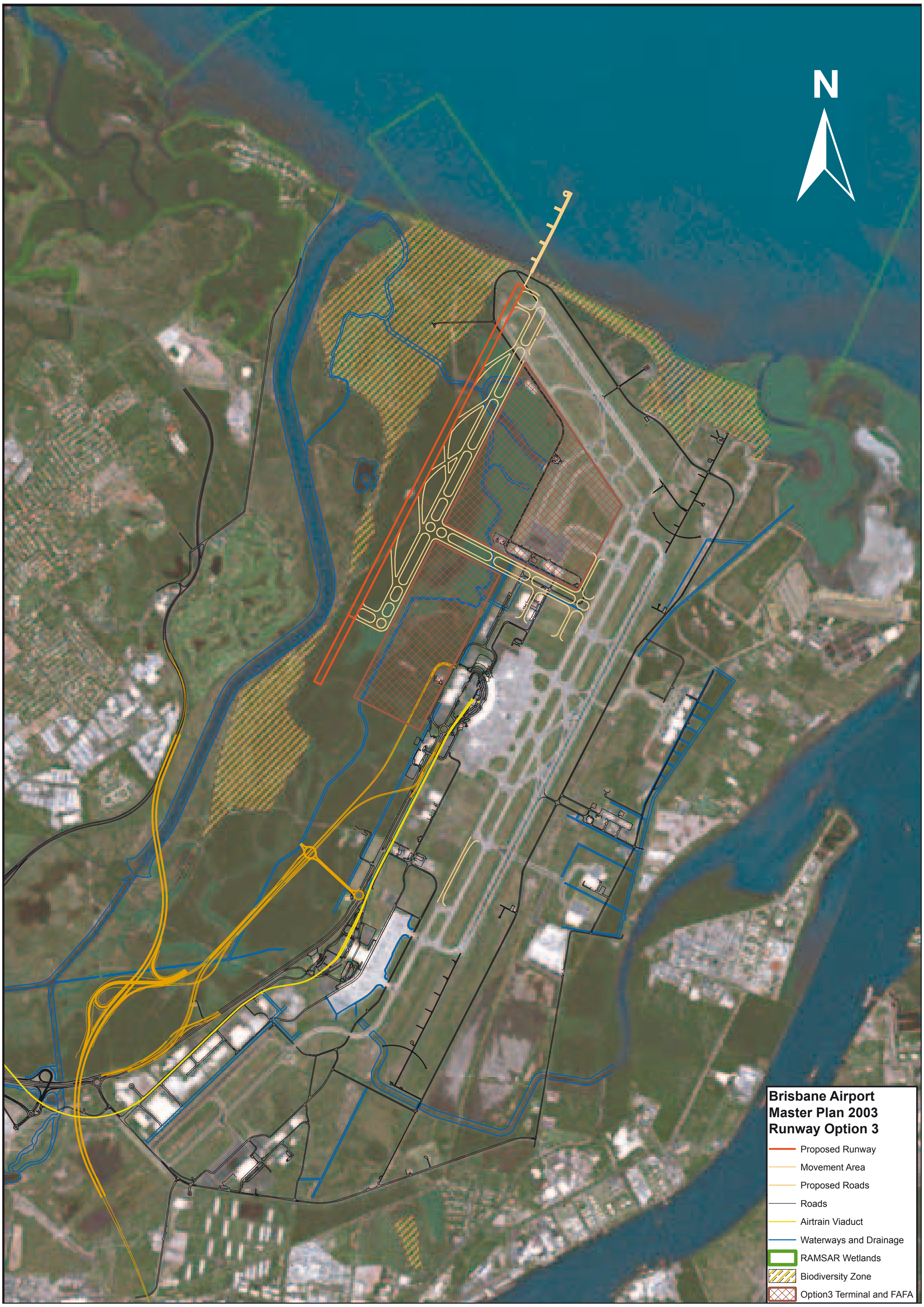


Figure 3.3c: *Runway Option 4.*

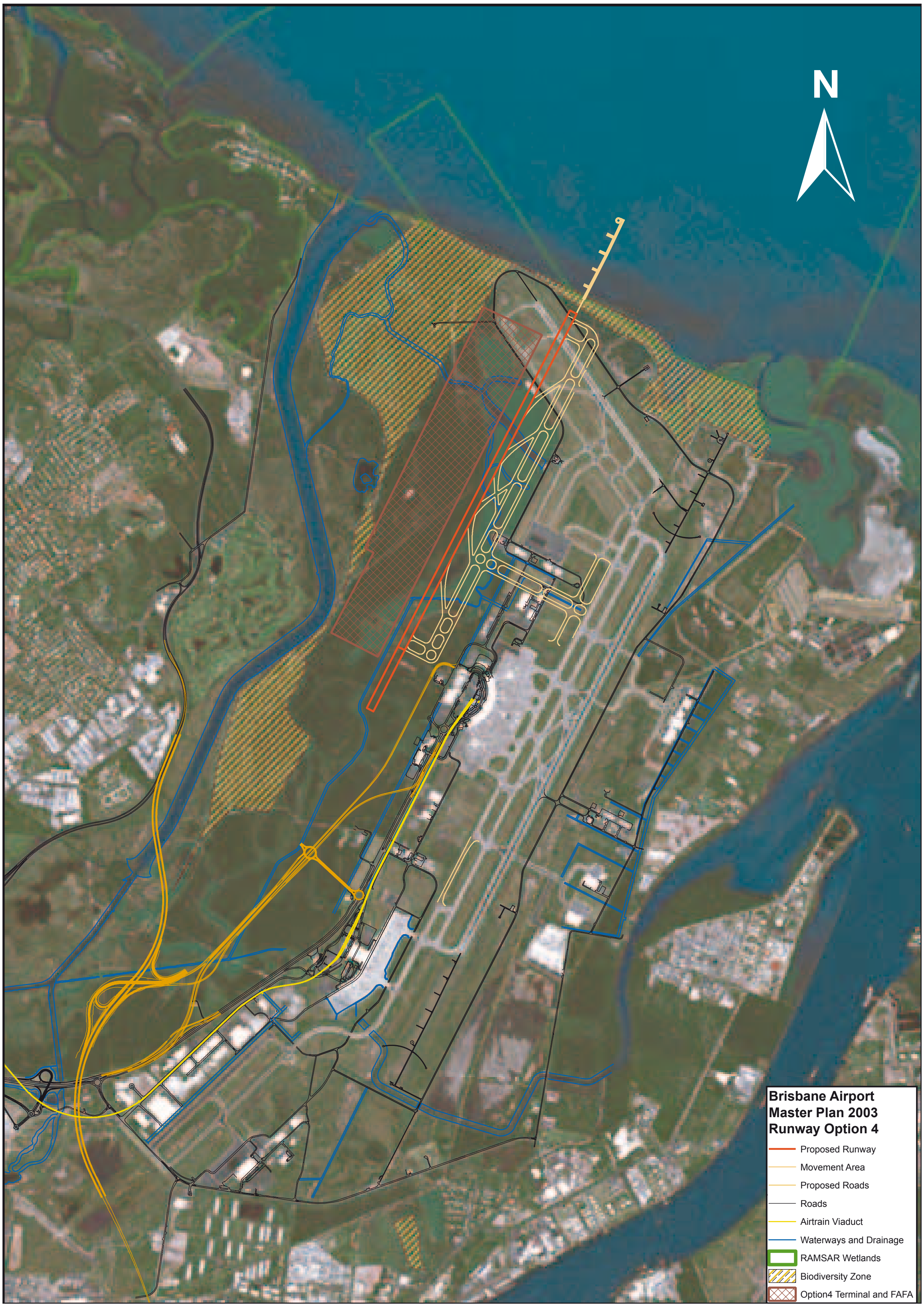


Figure 3.3d: *Runway Option 5.*

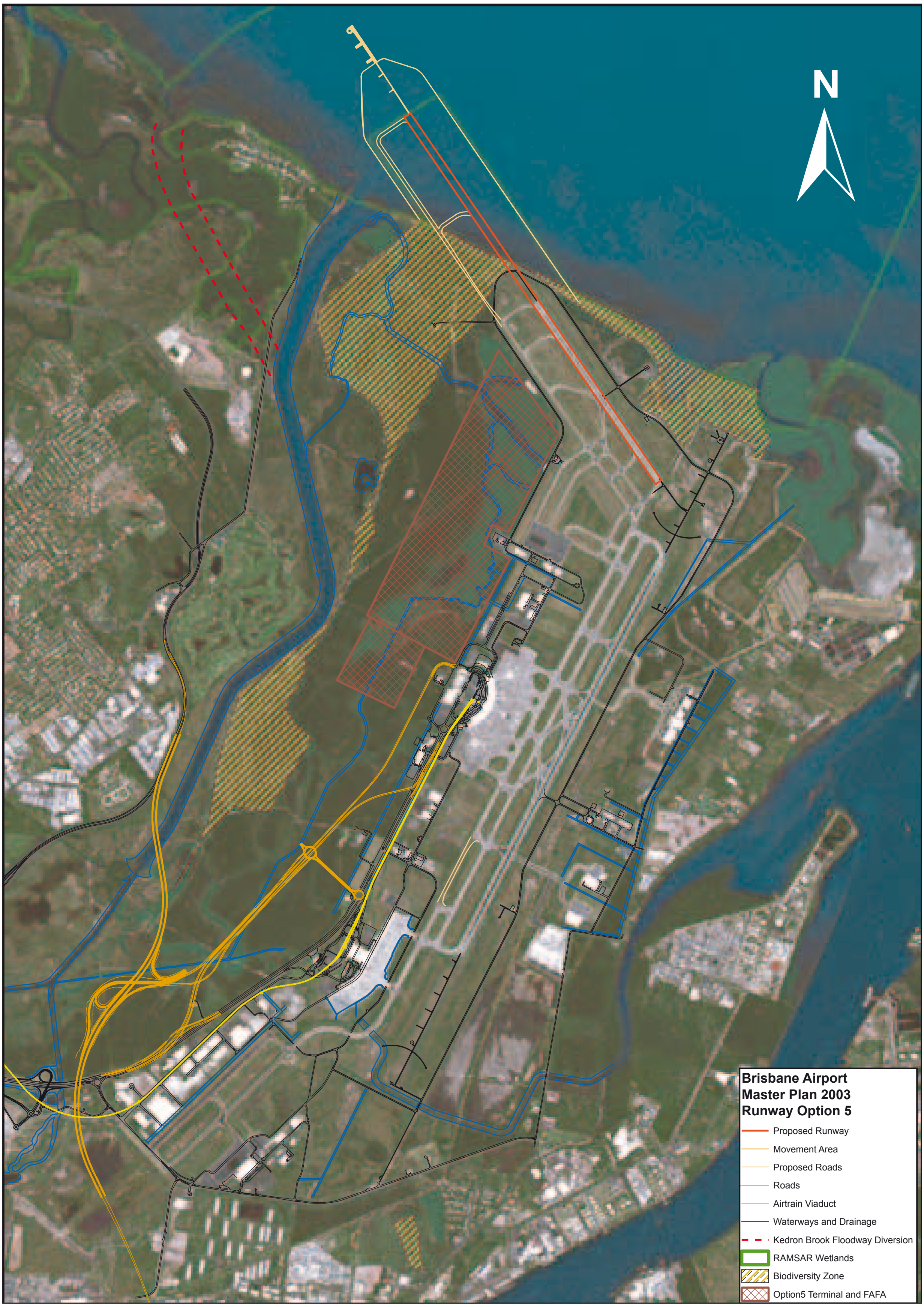
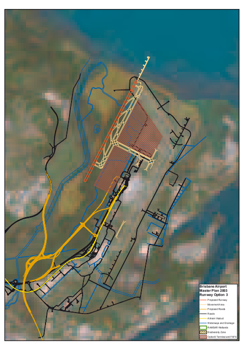
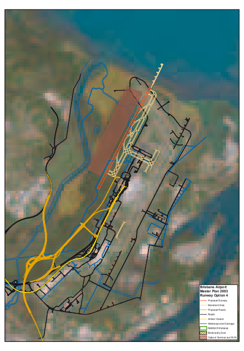
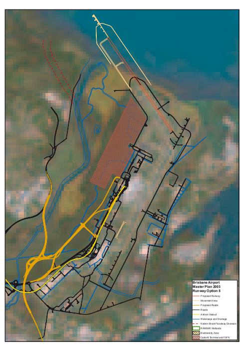


Table 3.3: Runway Options – Assessment of Impacts.

LEGEND	
Best	✓✓✓
Average	✓✓
Worst	✓

	Option 3 Preferred Option	Option 4	Option 5
Description	 Existing 01/19 at 3,600 m. Parallel 01/19 at 3,600 m to W and staggered 2,300 m to N (compared with BAC 1998 Master Plan) with 2,000 m spacing and with 14/32 downgraded. Under this option the area between the runways would be filled and established as a Future Aviation Facilities Area (FAFA) for aeronautical uses such as future terminals and maintenance hangars.	 As per Option 3 with parallel 01/19 @ 1,600 m spacing. Under this option the area west of the NPR would be filled and established as a Future Aviation Facilities Area (FAFA) for aeronautical uses such as future terminals and maintenance hangars.	 Existing 01/19 @ 3,600 m 14/32 - 3,600 m extended to north-west into Moreton Bay. Under this option the area west of the General Aviation Apron would be filled and established as a Future Aviation Facilities Area (FAFA) for aeronautical uses such as future terminals and maintenance hangars.
ENVIRONMENT AND SOCIAL - AIRPORT AND SURROUNDS			
Land Use and Planning	The 2,000 m separation between runways provides opportunity for an adequate development zone (Future Aviation Facilities Area) for future aviation growth including terminals, car parks and surface transport access. Having the FAFA between the runways is the most efficient from a terminal operation perspective and allows efficient access to aeronautical facilities from surface transport infrastructure. A portion of the approach lighting structure is located in the Ramsar site and Moreton Bay Marine Park.	Inadequate development zone for terminals, carparks and surface transport interchange facilities between runways. The FAFA would need to be located to the west of the NPR. This would create a less than desirable location for a new terminal with road access and parking issues. Other aviation related activities such as maintenance hangars would be located nearer to residential communities to the west of the site at Nudgee, Banyo and Nudgee Beach. The approach lighting structure is wholly contained within the Ramsar site and Moreton Bay Marine Park.	The FAFA would need to be located to the west of the General Aviation Area. Aviation related activities such as maintenance hangars would be located nearer to residential communities to the west of the site at Nudgee, Banyo and Nudgee Beach. Runway 14/32 extends into Moreton Bay within the area previously excised from the Ramsar site and Moreton Bay Marine Park. The approach lighting structure extends beyond the excised area and would be located wholly in the Ramsar site and Marine Park.
Preference	✓✓✓	✓	✓✓
Geology, Soils and Groundwater (including Reclamation into Moreton Bay)	Parallel runway alignment located on poor ground conditions requiring ground surcharge component to enable construction of the runway above flood level. Volume of surcharge required is approximately 15 Mm^3 of sand. Actual and potential acid sulfate soils are present and will require treatment and management during construction. No seabed reclamation required. Existing seawall along the frontage of the Airport will be re-constructed and approach lighting will be placed on a series of piled structures out into Moreton Bay.	Parallel runway alignment located on poor ground conditions requiring ground surcharge component to enable construction of the runway above flood level. Volume of surcharge required is approximately 15 Mm^3 of sand. A large proportion of the NPR alignment occurs over the poorest soils (up to 30 m of marine clay material) on the site with this option. As a result, increased amounts of surcharge and time would be required for settlement compared to other options. Actual and potential acid sulfate soils are present and will require treatment and management during construction. No seabed reclamation required. Existing seawall along the frontage of the airport will be re-constructed and approach lighting will be placed on a series of piled structures out into Moreton Bay.	Volume of surcharge required is approx 12 Mm^3 of sand for FAFA and filling of the runway extension in Moreton Bay. Actual and potential acid sulfate soils are present and will require treatment and management during construction. Runway 14/32 extension requires significant reclamation into Moreton Bay and associated rock armouring/sea-wall structure to support the runway structure.
Preference	✓✓✓	✓✓	✓✓
Terrestrial and Marine Ecology	Loss of mangroves in the remnant sections of Serpentine Creek from filling and surcharging for the FAFA and NPR. Jacksons Creek and some of the Jacksons Channel (the channel connecting Jacksons Creek to the remnant sections of Serpentine Creek) is retained. Lewins Rail habitat south of the Runway is retained with this option. Approach lighting structure (which would be a piled structure to minimise footprint issues on the seabed) would have a minimal impact on the Moreton Bay foreshore habitats for marine life and wader birds.	Some of the mangroves in the remnant sections of Serpentine Creek would be removed as a result of filling and surcharging of the Runway. The remaining mangroves in the remnant Serpentine Creek system and the upstream sections of Jacksons Channel would be filled to accomodate the FAFA. Jacksons Creek and the downstream sections of Jacksons Channel would be retained as per Option 3. Lewins Rail habitat south of the New Runway is retained with this option. Approach lighting structure (which would be a piled structure to minimise footprint issues on the seabed) would have a minimal impact on the Moreton Bay foreshore habitats for marine life and wader birds.	Reclamation of the seabed in order to extend the 14/32 runway would result in irreversible impacts to benthic marine fauna living in the sand and mudflat areas. A section of the important wader bird feeding habitat that occurs along the northern shoreline would be removed and location of the reclaimed runway may cause distrubance to adjacent sand flat areas. Mangrove environments in Jacksons Creek and most of Jacksons Channel are retained as per Option 4. Mangrove areas immediately west of the GA apron (most of the remnant Serpentine Creek mangroves) would be filled for the development of the FAFA. Lewins Rail habitat is retained with this option. Approach lighting structure impacts same as other options although not connecting to the foreshore.
Preference	✓✓✓	✓✓✓	✓
Cultural Heritage and Native Title	One known site of low significance would be covered by sand fill by this option. Potential for uncovering archaeological remains for indigenous or non-indigenous material is considered very low. Native Title Notification requirements under the *Native Title Act 1993* would apply when applications for permits are sought.	One known site of low significance would be covered by sand fill by this option. Potential for uncovering archaeological remains for indigenous or non-indigenous material is considered very low. Native Title Notification requirements under the *Native Title Act 1993* would apply when applications for permits are sought.	Two cultural heritage sites (including one burial site) would be directly impacted by the 14/32 runway extension. Potential for considerable Native Title negotiation processes associated with the requirement to obtain exclusive tenure in Moreton Bay for the reclaimed land that will be created as a result of the extension of the 14/32 cross runway.
Preference	✓✓✓	✓✓✓	✓
Surface Hydrology	Impacts identified from an assessment of flooding included the potential interception of regional overland flow through the Landers Pocket floodplain area due to the construction of significant fill platforms and the potential for increased stormwater runoff from impervious runway and taxiway pavements. Both of these impacts have been mitigated by the inclusion of a diversion channel (Kedron Brook Floodway Drain) and local drainage detention storage areas, which provide attenuation of peak flows through the local drainage network and reduce the impact of this option on existing drainage systems by reducing the peak discharge from the new parallel runway drainage infrastructure.	As per Option 3.	Reclamation of the seabed associated with the extension of the 14/32 runway would extend across the mouth of the Kedron Brook Floodway and would impact the tidal hydrodynamics at the Floodway mouth (causing increased erosion or siltation). Changes in hydrodynamics at the mouth of the Floodway would likely lead to changes to the behaviour and efficiency of the Floodway in upstream areas. As a result, the Floodway mouth may need to be diverted to an area north of Nudgee Beach as shown in **Figure 3.3d**. The diversion would be through an area of high ecological values that is Ramsar listed. New stormwater drainage infrastructure would not be requried for this option as the existing surface drainage system at the Airport would continue to operate.
Preference	✓✓✓	✓✓✓	✓
Coastal Processes	The only permanent structure proposed to be located in Moreton Bay is the piled approach lighting structure. The structure will not have an adverse impact on coastal processes such as waves and longshore sediment transport. The dumped rock seawall protecting the site from erosion is to be re-constructed and would not have any impact on coastal processes at the site or on adjoining coastlines.	As per Option 3.	Reclamation of the seabed associated with the extension of the 14/32 runway would be expected to have significant and long term impacts on the behaviour of the coastal processes that are occuring in the locality including creating possible erosion effects at neighbouring shorelines. The reclamation would extend across the mouth of the Kedron Brook Floodway and may have an impact on the tidal hydrodynamics at the Floodway mouth (see Surface Hydrology).
Preference	✓✓✓	✓✓✓	✓
Water Quality	During construction, water quality is managed through the use of bunded reclamation cells, sediment ponds and best practice sediment control measures (e.g. silt curtains, geotextile blankets, etc.) This approach will assist in managing the impacts of suspended sediments and nutrients on the receiving waters of Kedron Brook, Serpentine Inlet and Moreton Bay. Discharge of the dredge tailwater from the site during construction will be monitored to enable progress against water quality goals to be periodically assessed and corrective action taken if necessary. Operational management of stormwater quality will employ similar methods to the existing arrangements on-airport with the use of grassed swales and buffer strips prior to discharge via tidal drains.	As per Option 3.	The reclamation process to extend the 14/32 runway would require a different approach to managing water quality than the other options. A rock revetment would need to be constructed around the proposed runway reclamation site prior to the hydraulic placement of the fill. Dredge tailwater from this process would be directly discharged to the surrounding marine environment (with minimal settling time) or would need to be pumped into a land-based sediment pond prior to discharge into Jacksons Creek/Kedron Brook Floodway.

NEW PARALLEL RUNWAY DRAFT EIS/MDP
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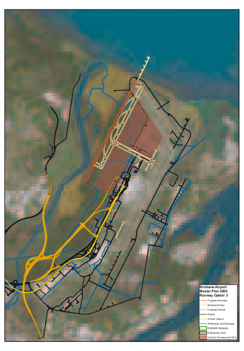
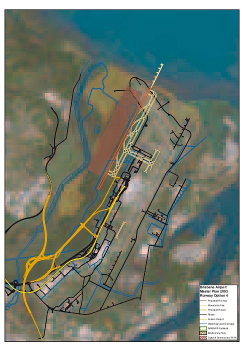
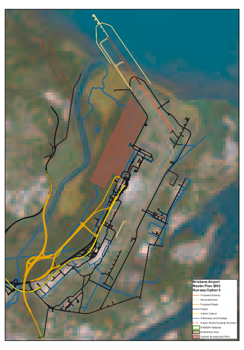
NEW PARALLEL RUNWAY DRAFT EIS/MDP
FOR PUBLIC COMMENT

Table 3.3: Runway Options – Assessment of Impacts.

LEGEND	
Best	✓✓✓
Average	✓✓
Worst	✓

	Option 3 Preferred Option	Option 4	Option 5
Description	 Existing 01/19 at 3,600 m. Parallel 01/19 at 3,600 m to W and staggered 2,300 m to N (compared with BAC 1998 Master Plan) with 2,000 m spacing and with 14/32 downgraded. Under this option the area between the runways would be filled and established as a Future Aviation Facilities Area (FAFA) for aeronautical uses such as future terminals and maintenance hangars.	 As per Option 3 with parallel 01/19 @ 1,600 m spacing. Under this option the area west of the NPR would be filled and established as a Future Aviation Facilities Area (FAFA) for aeronautical uses such as future terminals and maintenance hangars.	 Existing 01/19 @ 3,600 m 14/32 - 3,600 m extended to north-west into Moreton Bay. Under this option the area west of the General Aviation Apron would be filled and established as a Future Aviation Facilities Area (FAFA) for aeronautical uses such as future terminals and maintenance hangars.
Preference	✓✓✓	✓✓✓	✓
Social Impact Assessment (Including Visual and Landscape)	Downstream areas of Jacksons Channel and Jacksons Creek (part of the Airport Biodiversity Zone) are retained. Some visual impact on Nudgee Beach from approach lighting structure.	With less separation distance between the runways, a larger area of mangroves in the remnant Serpentine Creek area (west of the NPR) would be outside the runway footprint compared to Option 3. However, this area would need to be filled to establish the FAFA and new terminal precinct in the future. Reduced visual impact on Nudgee Beach from approach lighting structure. Otherwise, as per Option 3.	The extension of the 14/32 runway potentially impacts the recreational amenity of Nudgee Beach precinct. Potential for high visual impact from the approach lighting structure as it would extend across the line of sight to the Bay islands. Reclaimed runway area and angle of the approach lighting structure will alter current marine navigation pathways in and out of the Floodway increasing travel time and inconvenience (unless re-aligned). Reclaimed area would impact on the use of the mud and sand flats of the area by commercial and recreational fishers. This option retains current configuration of Jacksons Channel although the mangrove area west of the General Aviation terminal would need to be filled for the FAFA and new terminal precinct.
Preference	✓✓✓	✓✓✓	✓
Surface Transport	This option will make best use of the existing and planned road infrastructure at the Airport, allowing high speed access to the terminal precinct via Airport Drive and the proposed Northern Access Road Development. This is the best configuration for future terminal development, co-located between the two runways. Tunnel access would need to be provided under the new link taxiway for the extension of road access through to the FAFA.	An additional major access road would need to be provided around the perimeter of the NPR to access the FAFA and future terminal precinct (situated west of the NPR). This is a sub-optimal configuration and would likely lead to traffic congestion issues when a new terminal is developed in the future. Tunnel access would need to be provided under the new link taxiway for the extension of road access through to the GA area.	Road access would need to be provided to the FAFA and new terminal area (west of the General Aviation apron). Reduced operating capacity of runway system reduces overall road traffic demand to Airport.
Preference	✓✓	✓	✓✓✓
Ground Based Noise and Air Emissions	Minor to negligible construction noise will be experienced at communities surrounding the NPR site. During operation ground-based noise assessed as being considered acceptable.	Construction noise is as per Option 3. During operation, the location of the FAFA and new terminal to the west of the NPR would introduce a noise source from movement of vehicles and the ground running of aircraft that would adversely impact on the communities west of the Airport including Nudgee Beach.	Construction noise involving the reclamation of the cross runway would concentrate impacts on the community of Nudgee Beach. Ground based noise from the cross runway during operation would impact on the community at Nudgee Beach.
Preference	✓✓✓	✓✓	✓
ENVIRONMENT AND SOCIAL - MIDDLE BANKS, MORETON BAY			
Geology, Soils and Groundwater	15 Mm³ of sand is required for this option. A preferred dredge footprint has been identified at Middle Banks that will provide an adequate volume of material while avoiding or minimising environmental and/or social impacts.	15 Mm³ of sand is required for this option. The dredge footprint for Option 3 would be used in sourcing the sand.	The 2003 Master Plan identified that 8 Mm³ of sand fill would be required for the extension of 14/32 into Moreton Bay. However, the Plan did not take into consideration the sand fill that would be required to fill the FAFA and new terminal that is necessary to service the NPR. Based on this, it is considered that at least 12 Mm³ would be required in total to construct the runway and new terminal precinct. The dredge footprint from Option 3 could be used for the sand extraction under this runway option, acknowledging that not all of the area within the footprint would need to be dredged due to the smaller volume required and that the overall dredging time would be reduced.
Preference	✓	✓	✓✓✓
Hydrodynamics and Coastal Processes	No difference between the options.	No difference between the options.	No difference between the options.
Preference	✓✓✓	✓✓✓	✓✓✓
Water Quality	No difference between the options.	No difference between the options.	No difference between the options, except that the dredging would be able to be completed quicker given that a smaller volume of sand is required.
Preference	✓✓✓	✓✓✓	✓✓✓
Marine Ecology	No difference between the options.	No difference between the options.	No difference between the options.
Preference	✓✓✓	✓✓✓	✓✓✓
Social Impact Assessment	No difference between the options.	No difference between the options.	No difference between the options, except that the dredging would be able to be completed quicker given that a smaller volume of sand is required.
Preference	✓✓✓	✓✓✓	✓✓✓
AIRSPACE			
Issues which are not considered to differentiate between options: Air Emissions, Hazard and Risk and Health Impacts			
Noise – Existing Noise – New	Unchanged during peak operating periods – maximum reduction due to increased potential for SODPROPS when implemented. Further minimisation of impact to south of Airport because of increased availability of SODPROPS and significant north-east runway displacement.	As per Option 3. Similar to Option 3 but with greater impact to the south due to reduced SODPROPS availability. Increased noise buffer to the west created by runway displacement but may have negligible beneficial effect.	Changes dependent on dominance of 14/32 runway. Increased impacts on Nudgee Beach, Sandgate, Shorncliffe, Brighton, Redcliffe and Wynnum resulting from increased arrivals on 14/32.
Preference	✓✓	✓✓	✓✓
CONSTRUCTION			
Construction	**Sand Delivery via Pipeline:** Location means that sand placement operations do not require booster pumps. **Construction Materials:** The preliminary design identified that 600,000 m³ of pavement materials would be required.	**Sand Delivery via Pipeline:** This option is the closest to the pump-out location and does not require booster pumps. **Construction Materials:** Pavement material requirements likely to be similar to those for Option 3.	Sand Delivery via Pipeline: This option requires the longest pipeline, and may require booster pumps. Most complex fill/reclamation operation. Access from Moreton Bay will be restricted due to water depth. Construction Materials: Pavement material requirements likely to be similar to those for Option 3.
Preference	✓✓✓	✓✓✓	✓
IMPLEMENTATION, OPERATION AND COST			
Operational Flexibility	This Option allows all aircraft to use the runways independently at all times and potentially to allow reduced minimum standards for over bay operations.	This Option allows all aircraft to use the runways independently. Current SODPROP standards for minimum conditions would apply.	This Option provides very limited operational fexibility with independent operations limited to small aircraft due to the conflicting alignments of the runways. It is also inefficient as all aircraft must taxi through a choke point at the 19 threshold end of the existing runway. It has also very limited ability for over bay operations.
Preference	✓✓✓	✓✓	✓
Capacity	This Option provides maximum capacity.	This Option provides maximum capacity.	Due to the conflicting nature of the alignments, there is little capacity increase at non-peak times and an actual reduction in peak times.
Preference	✓✓✓	✓✓✓	✓
Capital cost	2003 Master Plan cost of $295 Million. Design costs indicate significant cost escalation – current estimated capital cost ~$1 Billion.	2003 Master Plan cost of $285 Million. Cost escalation considered to be similar to Option 3, with similar cost differential.	2003 Master Plan cost of $315 Million. Cost escalation considered to be similar to Option 3, with similar cost differential.
Preference	✓✓	✓✓✓	✓
SUMMARY OF PREFRENCES			
Airport and Surrounds	29	24	14
Middle Banks	13	13	15
Airspace	2	2	2
Construction	3	3	1
Implementation	8	8	3
TOTAL	55	50	35

NEW PARALLEL RUNWAY DRAFT EIS/MDP
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NEW PARALLEL RUNWAY DRAFT EIS/MDP
FOR PUBLIC COMMENT

3.3.4 Introduction to Preferred Runway Design Alternatives

The NPR will require site filling to provide a stable base for the construction of pavements and to elevate the runway and taxiways above the level of major flooding and storm surge. Reducing the amount of fill will reduce the overall cost of the project and investigations into minimising fill were undertaken during 2002 in two parts:

(a) Fill minimisation study; and

(b) Levee study.

The objective of the fill minimisation study was to determine methods of minimising the amount of fill required to construct the New Parallel Runway by identifying areas within the runway/taxiways that high quality fill materials could be substituted with low quality materials while maintaining the required pavement strength and flood immunity. The levee study investigated the potential to use levee banks along the perimeter of the Airport to hold floodwater out of the site and reduce the filling requirements of the new runway. A combination of both flood levees and fill minimisation techniques were considered during the development of the design.

3.3.5 Fill Minimisation Study

The investigations of the fill minimisation study concentrated on identifying potential areas in the development in which high quality fill could be substituted for lower quality fill materials. In addition, the fill minimisation study investigated options for improving and strengthening the existing soil conditions through the use of mechanical or chemical techniques. The study investigated the following techniques and reached conclusions as follows:

1) Use of Concrete Pavement

Concrete pavements require a reduced overall pavement thickness for a given design aircraft traffic mix when compared to a flexible or gravel pavement. Concrete pavements require different raw materials when compared to flexible pavements and are generally more expensive. Flexible pavements are generally better suited to ground susceptible to differential settlement as they are easier to repair. This is a consideration on the runway and rapid exit taxiways where safety is paramount and strict controls apply to the slopes and grades of the pavement. Overall, flexible pavements will allow repairs and regrading to maintain safety standards while this is much more difficult with concrete pavements. The study recognises that there are limitations to the use of concrete pavements on this project.

2) Increasing Subgrade (existing ground) Strength

The engineering strength of the existing ground surface at the new runway site is relatively weak and options to improve the strength of the in situ ground material were investigated. By increasing the subgrade strength it is possible to reduce the overall depth of the pavement (where the pavement is placed directly over the subgrade).

Two methods of increasing subgrade strength were investigated:

(a) chemical stabilisation through the addition of lime or cement; and

(b) incorporating mechanical systems such as geotextiles or geogrids.

The reporting indicates that the strength increase attributed to mixing lime or cement into the subgrade may be marginal and will require large amounts of cement to be effective and as such, is not expected to be cost effective.

In addition to subgrade treatment, investigations into deep soil mixing were undertaken to test the applicability of deep soil mixing to the runway project. Deep soil mixing involves rotary mixing the soft soils beneath the site with lime, to produce a firm foundation upon which to construct the runway, lessening the requirement for controlling and managing settlement. Deep soil mixing would require mixing lime into the in situ soils with an auger type device to a significant depth. The conclusions of the investigations were that the mixing should take place at close centres (around 1.5 m) across the entire site to be effective. It was concluded that deep soil mixing would be uneconomic on this site and would present a risk of differential settlement and would not be considered further.

Subgrade improvement through the use of geotextiles or other mechanical improvements will provide for some strengthening of the subgrade to allow temporary construction access but will not greatly reduce the amount of fill required or reduce the amount of settlement over the site. As such, geotextiles will be used where appropriate during the construction phase but have not been incorporated in the permanent pavement or embankment design.

3) Alternative Pavement Structures

The use of different materials in the overall pavement construction can reduce the thickness of the pavement when compared to traditional construction techniques. An example is the use of cemented basecourse layers in the pavement construction which can reduce the depth of the pavement. Cemented pavement layers are stiffer and stronger than conventional gravel pavements but can be difficult to repair and modify (similar to concrete pavements). Where ongoing maintenance to protect safety standards is possible, alternative pavement structures can be considered.

4). Alternative Fill Material

High quality fill is a structural element in the pavement and is needed to support the loading induced by aircraft on taxiways and the runway. In areas where structural strength is not critical (e.g. runway flanks) the sand fill could be substituted for an alternative fill material obtained from land based sources. The use of alternative fill materials will not reduce the total volume of fill required for the project.

The runway flanks for the NPR are intended to be constructed from excess surcharge sand that has to be removed after the runway and taxiway footprints have been suitably consolidated. Therefore, the use of alternative fill for the runway flanks would mean the importation of additional fill from land based sites resulting in increased costs and more construction traffic on Brisbane's road systems. The use of alternative fill would have no environmental, social or economic benefit for the project.

3.3.5.1 Assumptions

The fill minimisation study was based upon a number of assumptions that required testing during the preparation of the design. The following major assumptions were used:

- Expected settlement of 1.0 m maximum;
- Surcharge to achieve settlement is 1.0 m in place for one year;
- Sand thickness for flexible pavement is 2.6 m; and
- Typical existing ground level of RL 2.5 to 3.0 m (airport datum).

This study was undertaken prior to the any detailed geotechnical investigations that BAC commissioned in 2005 as part of the Preliminary Design Phase for the NPR. The results of these geotechnical investigations show even poorer existing soil conditions than was envisaged. Settlements could be as high as 2 m in places, with surcharge platforms up to 6.5 m in height and needing to be in place for between two and four years. Hence, the results of the fill minimisation study are not relevant as these assumptions are no longer valid.

3.3.5.2 Conclusions

The interaction of subsurface conditions, fill heights, surcharge and settlements is critical in optimising the fill volumes required for the runway. It is concluded that there is no practicable alternative to the proposed use of 15 Mm^3 of sand to achieve fill and surcharge of the NPR site.

3.3.6 Airport Levee Study

3.3.6.1 Introduction

A levee is an earth mound or bund that is constructed in such a way as to prevent flooding and tides from entering the site allowing the site to remain at a lower level, possibly reducing the amount of fill required. A feasibility study was undertaken to examine the potential for using levee banks to provide flood immunity for future developments within Brisbane Airport in place of site filling. The feasibility of the levee and any potential savings in fill volumes is dependent on two considerations, flood immunity and providing sufficient fill material beneath the pavement to provide a stable platform to enable construction.

3.3.6.2 Levee Concept

The site of the NPR is currently subject to inundation during large regional flood events and through regular tidal cycles. The levee system would provide protection from the regional flood events (flooding in Kedron Brook) and storm surge from Moreton Bay by providing a continuous bund or levee around the airport site. A drainage network within the NPR site would control the local (on-airport) rainfall events which would be discharged from the site via gravity flow through culverts under the levees. If the water level external to the site is elevated (i.e. high tide or flooding), pumps would be required to drain the stormwater collected within the levee.

3.3.6.3 Comparison of Fill verses Levee

To ensure that the runway and taxiways remain flood free in a major flood event (i.e. 1 in 100 year Average Recurrence Interval), the runway would need to be constructed to a level of:

- RL 4.1 m AD[2], settling to RL 3.3 m AD over time for the levee approach; and
- RL 4.6 m AD, settling to RL 3.8 m AD over time for the fill approach.

From preliminary calculations the levee option would potentially save up to 30 percent of the total fill demand for the runway site. These elevations, the potential savings in fill material and the potential cost savings are dependent upon a number of assumptions that needed to be tested during the subsequent design of the runway.

3.3.6.4 Assumptions

The levee study was based upon a number of assumptions that required testing during the preparation of the design. The following major assumptions were used:

- Expected average settlement of 0.8 m across the site;
- Settlement of the levees of between 0.1 m and 0.2 m;
- Within the volumes calculated, no allowance has been made for surcharging or ground treatment methods across the site; and
- An improved subgrade strength (of California Bearing Ratio 5 percent) was assumed.

[2] *Based on improved subgrade CBR of 5.0.*

3.3.6.5 Recommendations of Levee Study

The study recommended that, among others, geotechnical investigations and pavement strength requirements needed to be addressed to further develop the levee option. In addition, the study recommended that assessment of the impact of any pump failure be carefully considered as failure of the pumps could result in local flooding of the runway and taxiways during storm events.

3.3.7 New Parallel Runway Design

3.3.7.1 Introduction

Significant geotechnical investigations and analysis, filling design, an assessment of constructability and pavement design was undertaken in 2005 and 2006 as part of the design phase for the NPR. The design investigations found that the assumptions of the previous two studies (fill minimisation and airport levee) were no longer valid and therefore there is no benefit in either alternative method. Based upon this recent design work and geotechnical investigations, broad site filling is the preferred option for the runway construction as this option best integrates flooding, pavement and geotechnical design constraints that are specific to this site.

3.3.7.2 Geotechnical Investigations

Geotechnical investigations were undertaken to characterise the types and quality of materials at the site and to assess the quantity of settlement that could be expected on the site. These investigations determined that the site will settle up to 2.0 m, which is substantially more than the assumption of 0.8 m used in the levee study and 1 m (maximum) used in the fill minimisation study. The NPR infrastructure will not tolerate such settlements during operation so ground treatment techniques will be used to accelerate ground settlement prior to construction (primary settlement). This will be followed by secondary settlement, which will occur after the construction. A target secondary settlement of 100 mm was specified by BAC to minimise future maintenance issues and to ensure that the runway and taxiway remained consistent with the grading and safety requirements.

To complete the primary settlement (to achieve a secondary settlement of 100 mm) a number of recognised techniques are available including preloading, surcharging and surcharging with wick drains (explained further in Chapter A4). With the exception of preloading, all techniques require the temporary placement of additional sand to increase the applied load and accelerate the consolidation. To achieve the required settlement, the surcharge differs across the site but in places is expected to be approximately 6.5 m high and is expected to remain in place for up to 4 years. This timeframe for consolidation of 4 years is a function of the surcharge height and the acceleration techniques proposed. The timeframe is considerably longer than that assumed in the fill minimisation study (around one year). If lower surcharges were used, primary settlement may not be achieved within a reasonable timeframe and hence delaying the project unacceptably. The amount of fill required to achieve this primary settlement including fill material and surcharge material is approximately 15 Mm^3.

3.3.7.3 Pavement Design

The natural subgrade strength of the soils was investigated and a CBR of two was adopted for the pavement design of runway and taxiways. Pavement design indicates that an estimated 2 m of fill material is required between the in situ soils and the underside of the pavement materials to provide sufficient strength to support the pavement.

An estimate of only 1.0 m fill material was calculated in the levee report based on a subgrade of CBR 5.0 percent (improved). To achieve this improved subgrade strength from 2 to 5 percent the fill minimisation study suggests adopting chemical or mechanical subgrade improvements such as lime treatment or geotextiles. While both of these techniques are valid improvements they are not applicable at this site mainly due to the amount of settlement expected on the site. When the site settles up to 2 m, the original ground surface will be covered with 2 m of fill plus additional fill material required to elevate the runway or taxiway above flood levels (typically another 2 m).

In such circumstances, the improvement to the original ground surface will not be measurable through the depth of fill material. As such, subgrade improvement techniques are not proposed in the design.

3.3.7.4 Conclusion

Based on the significant geotechnical investigation and pavement design undertaken subsequent to the fill minimisation study and levee study:

- Concrete pavements will be used on taxiway pavements and will help to reduce the volume of gravel materials brought to the site however flexible pavements will be constructed on the runway surface to enable the airfield to be managed and maintained within the strict grading constraints required for safety;
- Subgrade strengthening will not be considered beneath the runway and taxiways as the quantity of settlement expected at the site prevents any subgrade strengthening from reducing the pavement thickness;
- The use of alternative pavement materials (cemented basecourse) to reduce the pavement thickness have not been considered necessary as the required fill depth to achieve the required pavement strength will be in place as part of the settlement and fill platform;
- Alternative fill options are described further in section 3.4;
- The potential savings identified in the levee system report does not allow sufficient fill material required to accelerate settlement of the site, or the fill material required to fill the site post settlement. Both of these activities are required prior to the construction of the runway; and
- The total volume of approximately 15 Mm^3 of fill is required for three critical tasks:
  - Consolidation of the soft compressible soils present on-site;
  - Provision of a stable platform to enable the construction of runway and taxiway pavements; and
  - Sufficient fill height to provide for flood immunity to the runway and taxiways.

3.4 Feasible Alternatives to Sourcing Runway Fill

3.4.1 Introduction

The proposed NPR project requires a large volume of construction materials for a variety of purposes including filling, surcharging, pavement construction and other general construction activities.

The requirements of each material are summarised in the engineering specification which has been developed for the project and will form part of the construction contract. The specification reflects the use of the material on the project, which determines the engineering and physical characteristics of the material, specifically the strength, shape, durability, chemical stability and size of the material. This in turn can have a bearing upon the origin or source of the raw materials proposed for construction. Generally, the sources of raw materials are:

- Land-based sources (i.e. quarries);
- Marine-based sources; and
- Alternative sources (specifically recycled construction materials).

This section describes the sources of different material types proposed for the project. Specifically, the capacity of the existing land based extraction industry within South East Queensland to supply the materials, the potential environmental impacts resulting from the extraction of materials and the measures that are in place to mitigate these impacts are discussed.

3.4.2 Project Fill and Materials Requirements

A listing of the material types and estimated amounts of construction materials is shown in **Table 3.4a**. The materials are generally broken into two main types:

(a) Fill and surcharge material (sand extracted from Middle Banks); and

(b) Pavement and structural materials.

Table 3.4a: Material Type and Estimated Volumes.

Material Type		Volume (m^3)
(a) Fill and Surcharge	Sand	15,000,000
(b) Pavement and Structural Materials	Sub-base	100,500
	Fine Crushed Rock	188,500
	Road and Bund Material	110,000
	Crushed Rock/Gravel for Seawall	25,000
	Protective Rock/Rip Rap	15,000
	Concrete	97,000
	Asphalt	27,000
TOTAL		15,563,000

The materials will be delivered to the site over the course of the construction period (refer Volume A, Chapter A5) and are not required at the site all at the same time.

Approximately 15 Mm^3 of sand fill material will be required for three critical tasks:

- Consolidation of the soft compressible soils present on-site;
- Provision of a stable platform to enable the construction of runway and taxiway pavements; and
- To provide sufficient fill height to provide for flood immunity to the runway and taxiways.

In addition to this sand fill material, approximately 600,000 m^3 of pavement and structural materials will be required to be imported to the site for the construction of:

- Runway pavements;
- Taxiway pavements;
- Drainage structures;
- Roads and access tracks; and
- Seawall.

Pavement materials such as concrete and asphalt are manufactured from raw materials including gravels, sand and cement powder. The manufacturing process for concrete and asphalt may occur on the project site requiring the component materials to be delivered to the site along with other project materials.

3.4.3 Feasible Alternatives to Fill Materials

3.4.3.1 Introduction

In anticipation of the increased future regional demand for sand, Queensland Government agencies initiated the Moreton Bay Sand Extraction Study (MBSES) in 1999/2000 in conjunction with key stakeholder groups. The study was based on a series of previous investigations of the Moreton Bay sand resource dating back to 1997.

The Study examined the environmental, economic, cultural and social impacts of sand extraction, and various alternatives to bay sand, such as land based extraction and manufactured sands.

The Study was undertaken in two principal phases. The first was a comprehensive review of all available information related to sand extraction both within Moreton Bay and from land based sources, and sought to identify both the current state of knowledge and identify data gaps.

Based on this work, five separate specialist investigations[3] were subsequently undertaken in phase two of the Study including:

- Economic analysis of sand extraction from marine and land-based sources in South East Queensland;
- Sediment geochemistry processes within the northern Moreton Bay sand banks and potential impacts to water quality;
- Benthic fauna and fisheries;
- Indigenous cultural heritage; and
- Numerical modelling of impacts to wave penetration to Moreton Bay.

A scientific panel, established under the auspices of the Moreton Bay Waterways and Catchments Partnership and led by an eminent University of Queensland Professor, assessed key scientific reports making up the Moreton Bay Sand Extraction Study. The expert panel endorsed the scientific integrity of the reports, noting that the scientific studies indicated no major environmental impacts would be expected for the sand extraction scenarios considered in the Study. Sand extraction of 15 Mm^3 from Middle Banks for the NPR project was one of the scenarios that the Study investigated.

[3] *Results of the studies are included in final reports available from the Queensland Environmental Protection Agency (EPA) website: www.epa.qld.gov.au*

3.4.3.2 Land Based Sand Versus Marine Sand

The MBSES Phase 2 identified that at present there is approximately 48 million tonne (Mt) of land-based sand in licensed deposits in South East Queensland, the larger portion of which is located 50 to 75 km from Brisbane Airport. Annual sand demand is approximately 7.6 Mt of which 3.4 Mt is sourced from land-based sites, 2.5 Mt is manufactured from rock, 0.7 Mt is extracted under permit from Moreton Bay for commercial purposes.

Demand for sand from the construction industry is expected to double over the next 50 years, in line with population growth in the region. In addition to the construction industry demand there is also a demand for sand for high quality fill for major infrastructure projects such as the NPR and development of land at the Port of Brisbane. Development at Brisbane Airport will require 15 Mm^3 of sand (27 Mt) over a 12–18 month period, while development at the Port of Brisbane is expected to require approximately 300,000 m^3 per annum over the next 25 years.

At current rates of extraction, licensed land-based sand resources could be exhausted within ten years with new approvals for land based extraction becoming exceedingly difficult. Existing land-based supplies cannot meet the future construction industry demand and certainly cannot provide the volume of high quality fill required for airport and port development. Currently, Moreton Bay extraction is limited to around 800,000 tonnes per annum (tpa). There are only limited licensed sand supplies available outside South East Queensland and few feasible alternatives to fill sand in large quantities. Manufactured sand was identified as the most promising alternative to natural sand from land-based or marine-based sources, but the material is expensive and not suited to all applications.

Extraction of sand from Northern Moreton Bay currently occurs through the operation of licences by five extraction companies. Permit areas for sand extraction include Spitfire Bank, Yule Bank, Central Banks, Middle Banks and South West Spit. The total permitted extraction volume is 465,000 m^3 per year but the actual volume extracted is substantially less than this (depending on demand) and has recently been approximately 340,000 m^3 per year.

In 1998, a detailed resource assessment of sand in northern and central Moreton Bay was undertaken which identified a total available sand resource of approximately 3.8 billion m^3. However, while areas containing suitable sand resources have been identified, a range of environmental, social, cultural and economic factors may affect the acceptability of extracting sand from specific areas. Further, while sand occurs in areas of Moreton Bay other than the northern delta, these other sites are not considered suitable for extraction. The MBSES examined a range of environmental, social, cultural and economic issues associated with potential sand extraction. For marine extraction the most significant issues are considered to be hydrodynamics, sediment geochemistry, water quality, ecological processes, fish and fisheries and cultural resources.

In contrast the significant issues associated with land based extraction are groundwater and surface water; noise; air quality; traffic and transport; social considerations and cultural resources. Existing land based sand extractions were identified at 13 localities in the South East Queensland region in the Study, ranging from the Tweed River in the south to Maroochydore in the north and the Upper Brisbane River and Lockyer Creek in the west. For each of these localities the Study identified: permit operator, resource characteristics, environmental issues, annual production, life expectancy and operating constraints. Overall, the findings of the Study were that these existing operations have a limited life span and are heavily committed to existing demand. They have little potential to meet future increases in demand either for the construction industry or for high quality fill.

The Phase 1 Study identified that the combination of land and marine sources is the optimum way of meeting potential future demand and reinforced that existing land sources alone cannot meet future demand for large volume fill and extractive industry requirements.

The Phase 2 Study also investigated the economic impacts of four proposed scenarios for extraction of up to 36 Mt of sand from Moreton Bay, either on a once-off basis, or over a twenty year period. This comparison showed that the marine extraction scenarios were clearly cheaper than the land-based scenarios, with none of the land-based scenarios being less costly than any of the marine scenarios. The relativity between land-based and marine-based costs arose from the nature of sand production technology. Land-based sand would need to be quarried, processed and transported by truck in approximately 30 tonne loads to fill placement sites. Marine sand on the other hand would be dredged in situ and transported in large quantities by the dredger vessel for pumping or trucking ex wharf to the final placement site. Given these differences in technology, land-based sand production for delivery to Brisbane Airport was assumed to have costs of approximately $27 per tonne including extraction and transport, compared with between $9 and $12 per tonne for large scale marine sand extraction.

These conclusions were supported by the key findings of the Scientific Panel engaged to review the MBSES which stated that:

"The supply of large volumes of fill material from land-based sources is generally not practical due to:

- *The environmental and social impacts of high rates of extraction from existing licensed supplies and the associated delivery by road.*
- *Exhaustion of a large proportion of available land-based sand resources thereby putting further pressure on the extractive industry to develop new, more distant sites.*

The existing land-based extraction operations have a limited life span and are heavily committed to existing demand. The prospects for developing new extractive sites in the region and/or developing substitutes for natural concrete sand (other than manufactured sand) are considered to be poor.

There is a wide range of environmental and social issues associated with land-based sand extraction operations. The haulage of sand product on local roads from land-based sand extraction operations is usually the most contentious issue with local communities and generally the greatest source of complaint.

Economic analysis has shown that, including non-market external costs, the supply of sand from land-based sources is significantly more costly than sand extracted from northern Moreton Bay.

Overall, the study has shown that the sand resource in northern Moreton Bay offers a viable source for supplementing diminishing land-based sources when all environmental, social and economic factors are considered."

A Sand Extraction Strategy was completed by the Queensland Government in late 2004 to coincide with the release of the Study. The Strategy defines a coordinated approach for sand to be extracted from northern Moreton Bay to address significant regional demand for sand. In particular, the Strategy set out that (underlining added):

"From a total available sand resource in Moreton Bay of approximately 3,770 Mm^3, the Government has made a decision that over the next 20 years it will support:

- *Extraction of up to 40 Mm^3 (less than 1.1 percent of the total sand resource) of sand for development of Australia TradeCoast projects, <u>including the expansion of the Brisbane Airport</u> and the Port of Brisbane.*
- *Extraction of up to 20 Mm^3 (less than 0.6 percent of the total sand resource) of sand for use within the construction sector.*
- *Locating the majority of future sand extraction to supplement a major shipping channel straightening project in the northern part of Moreton Bay.*
- *In addition to sand extraction to supplement channel straightening, <u>increased sand extraction will be allowed in the Middle Banks area of the bay (subject to environmental impact assessment), with priority to be given to the Brisbane Airport Corporation.</u>"*

3.4.4 Sourcing Pavement and Structural Materials

This section relates to the civil works of the project. Pavement and structural materials are granular materials that have specific chemical and physical properties that make them suitable for use in the runway construction. Different engineering specifications will apply to each material, depending upon its use on the project. Pavement and structural materials will be generally sourced from local land-based quarries within South East Queensland.

In addition to raw materials extracted from quarries, there are other opportunities to include recycled materials in this project such as:

- Re-using gravel materials that are currently on the site; and
- Re-using fill or gravel materials that are surplus from other construction projects occurring at the same time.

The construction of the new runway will require reconstruction of a number of existing perimeter roads, public roads and the 14/32 runway. The existing roads and cross runway comprise various gravel materials that are expected to be suitable for use in the construction of elements of the NPR. Wherever possible, gravel materials will be recovered prior to construction commencing and stockpiled at the site ready for re-use. As with raw materials, any recovered materials will be subject to an engineering specification prior to re-use. The condition of the recovered material will determine how the material can be reused during construction.

Materials surplus to the needs of other projects occurring at the same time (specifically those projects with excess earthworks) can potentially be recycled and reused in elements of the NPR. As with raw materials and materials recovered from the site, any recycled materials will be subject to engineering specifications prior to use on the project.

3.4.4.1 Ability to Supply

The Queensland Department of Natural Resources and Water (DNRW) has approved the extraction of 605 million tonnes of hardrock resources within South East Queensland (DNRW, unpublished data). The runway development will require approximately 1.2 million tonnes (600,000 m^3) of pavement and structural material from this hardrock resource which equates to less than <0.20 percent of that available within South East Queensland. Therefore it is concluded that there are sufficient hardrock resources within South East Queensland to supply the runway project without jeopardising future supply in the region.

From a comparison of rock amounts required by the runway development in relation to that produced in 2003–04, the extractive industry presently operating within South East Queensland has the capacity to supply the runway development within the required timeframes (refer Chapter A5). **Figure 3.4a** shows that the project requirements for pavement and structural materials are a small proportion of that produced by quarries in South East Queensland during 2003–04 (latest data available from DNRW). In summary there is no obvious need for the expansion of existing quarries to service the runway project as the demand for NPR can be met by existing supply.

Figure 3.4a: *Comparison of Material Amounts Required by the Runway Development in Relation to that Produced Within South East Queensland During 2003-04 (DNRW, unpublished data).*

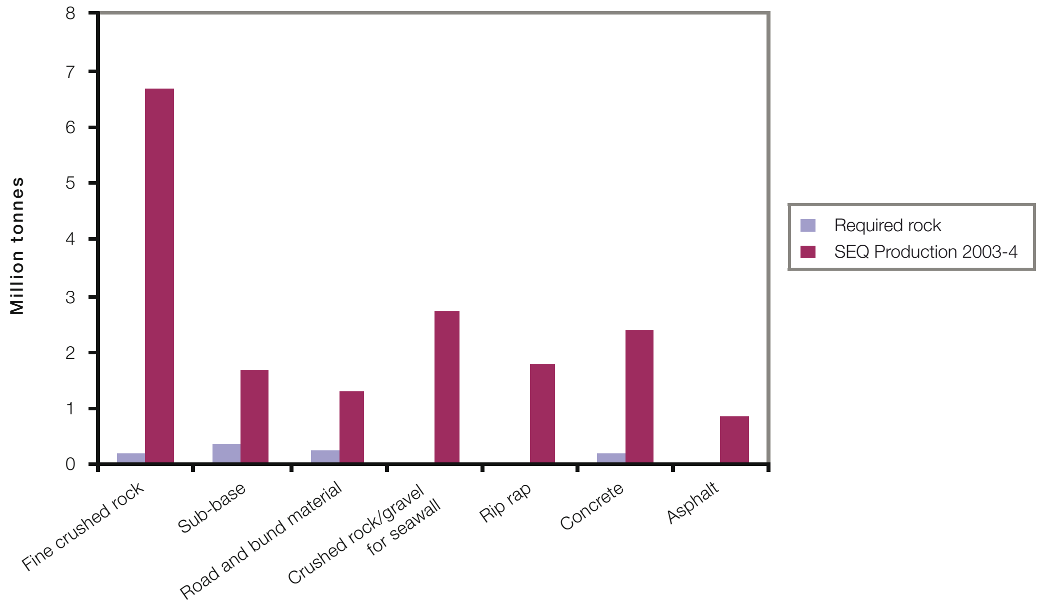
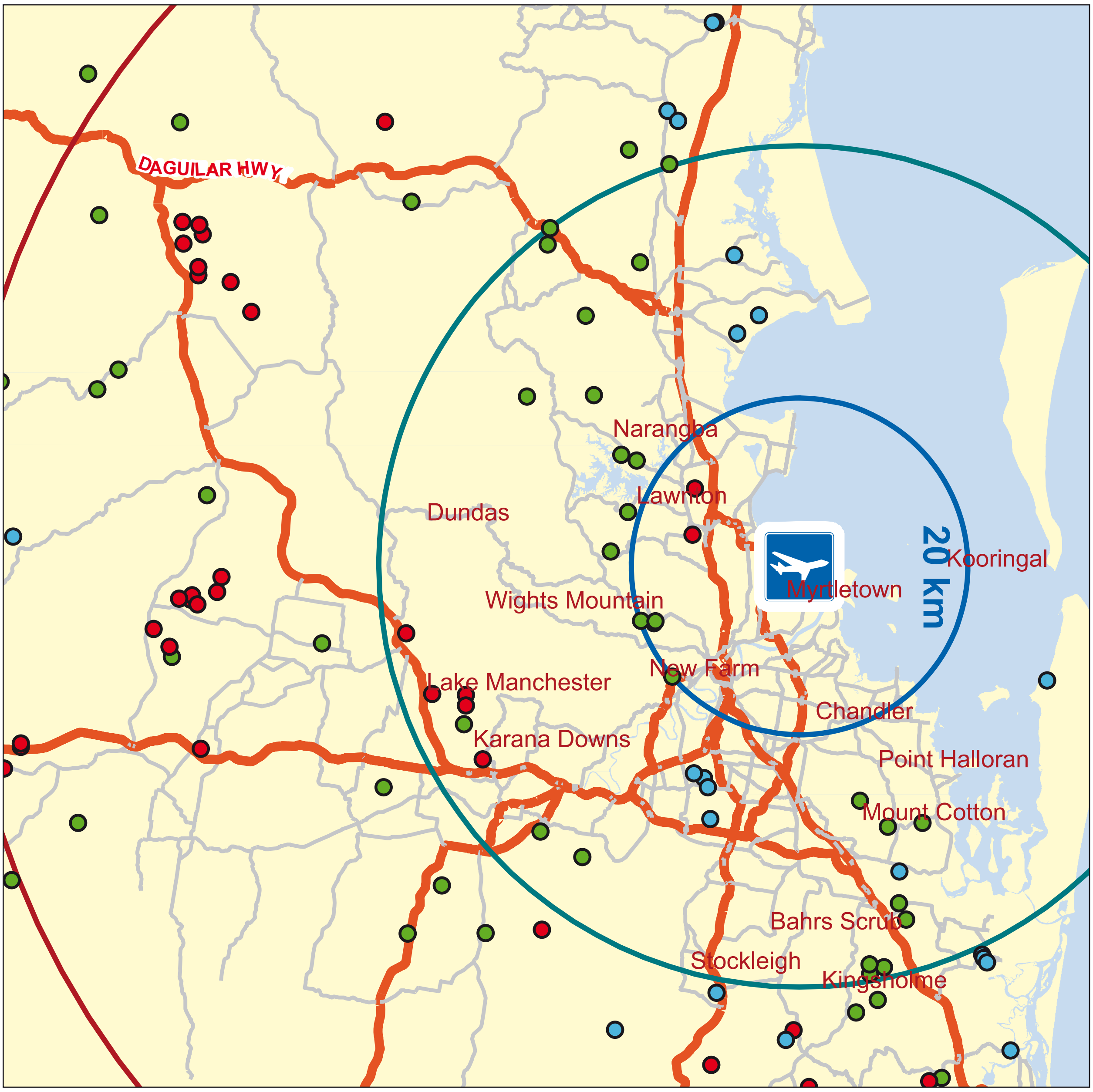


Figure 3.4b: *Quarry Sites within 150 km Radius of Brisbane Airport.*



3.4.4.2 Selection of Suppliers

The construction of the runway project will require the supply of various materials to the site to suit the contractor's construction requirements. In selecting the supplier to provide pavement and structural materials to the project, the contractor will consider a number of factors including:

- The ability of the supplier to provide the specified materials;
- The ability to deliver the materials to the site in the required timeframe;
- The price to supply the specified materials; and
- Environmental performance of suppliers and their ability to consistently meet the licence conditions applying to their various facilities (e.g. operating hours).

As there is a range of pavement and structural materials required for this project, it is likely that the contractor will source the materials from a range of different suppliers to ensure that the correct materials can be supplied to the site when they are required.

There are 190 operating, licensed hardrock, gravel and sand quarries currently operating within South East Queensland (DNRW, 2006). While not every quarry can produce all of the materials required for the project, all of these quarries produce some materials that will be suitable for use on the runway project and as such, it is not possible to limit discussions to a single supplier for this material. Of these licensed quarries, 130 are situated within 100 km of the Brisbane Airport (refer **Figure 3.4b**). Selection of individual suppliers will be carried out by the contractor however it is reasonable to expect that the majority of pavement and structural materials will be sourced from within 100 km of the Brisbane Airport as the cost to supply materials increases with haulage distance from the supplier to the Airport site.

3.4.4.3 Transportation during Construction

There are a number of quarries located within the area surrounding Brisbane and the Airport Site as shown in **Figure 3.4b** that could be used for material supply by the contractor during construction. It is expected that several different quarries will be used to supply the amounts and variety of pavement and structural materials required for the project. Transport of pavement and structural materials to the runway site will be by road. The raw construction materials, approximately 600,000 m^3, will be transported by haulage vehicles, typically rigid truck and dog trailer, to the NPR work site along major arterial and motorway routes during the construction period.

Table 3.4b provides a summary of the timeframes over which materials will be required on the site. The majority of these materials will be delivered to the site following filling and surcharging of the site from mid to late 2012.

Table 3.4b: Summary of Timeframes for Delivery of Materials During Construction.

Material Type	Approximate Duration (months)
Sub-base	18
Fine Crushed Rock	18
Road and Bund Material	7
Crushed Rock/Gravel for Seawall	6
Protective Rock/Rip Rap	6
Concrete	13
Asphalt	10

Heavy vehicles travelling from the western quarry locations will travel along the Warrego Highway, Ipswich Motorway, Logan Motorway or Pacific Motorway prior to the Gateway Motorway. Those travelling from the northern quarry locations will travel along the Bruce Highway and the Gateway Motorway and those travelling from the southern quarry locations will travel along the Pacific Motorway and the Gateway Motorway. A high standard of direct motorway access will be used by construction traffic to access the site from the Gateway Motorway. Two interchanges, Airport Drive and Northern Access Road, will facilitate access to the construction site from the Gateway Motorway.

The additional heavy vehicle trips generated in the construction phase will be evenly spread out over an approximate ten hour period each day. The following steps were undertaken to derive construction traffic forecasts:

1. Calculations were completed to convert the volume of raw materials into truck loads.
2. Raw material volumes, in cubic metres, were divided by the average load a rigid truck and dog trailer can carry. These were based on the following assumptions:
   a. A rigid truck and dog trailer can carry a load of up to 42.5 tonnes, as outlined by the National Transport Commission National Vehicle Standards; and
   b. The specific gravity of the material being carried by the heavy vehicles is 2.
3. The total number of loads required was then divided by the activity's scheduled duration.

For the purposes of this assessment, it has been assumed that one load corresponds to two truck trips, one laden and one unladen.

The impact of NPR construction traffic will be low in the context of existing heavy vehicle traffic on the Gateway Motorway. In 2004, approximately 106,500 vehicles per day travelled along the Gateway Motorway and in 2005, approximately 59,000 vehicles along Airport Drive. From studies in the area, an estimated 16 percent of total traffic is heavy vehicles travelling across the Gateway Bridge. This equates to more than 17,000 heavy vehicles per day. **Figure 3.4c** shows the daily truck load generation throughout the construction staging. It also gives an indication of other major transport infrastructure projects scheduled to be constructed within the NPR timeframe in the vicinity of the Airport construction site. Exact details of the volumes of construction materials required for these other projects are not contained in publicly available documents.

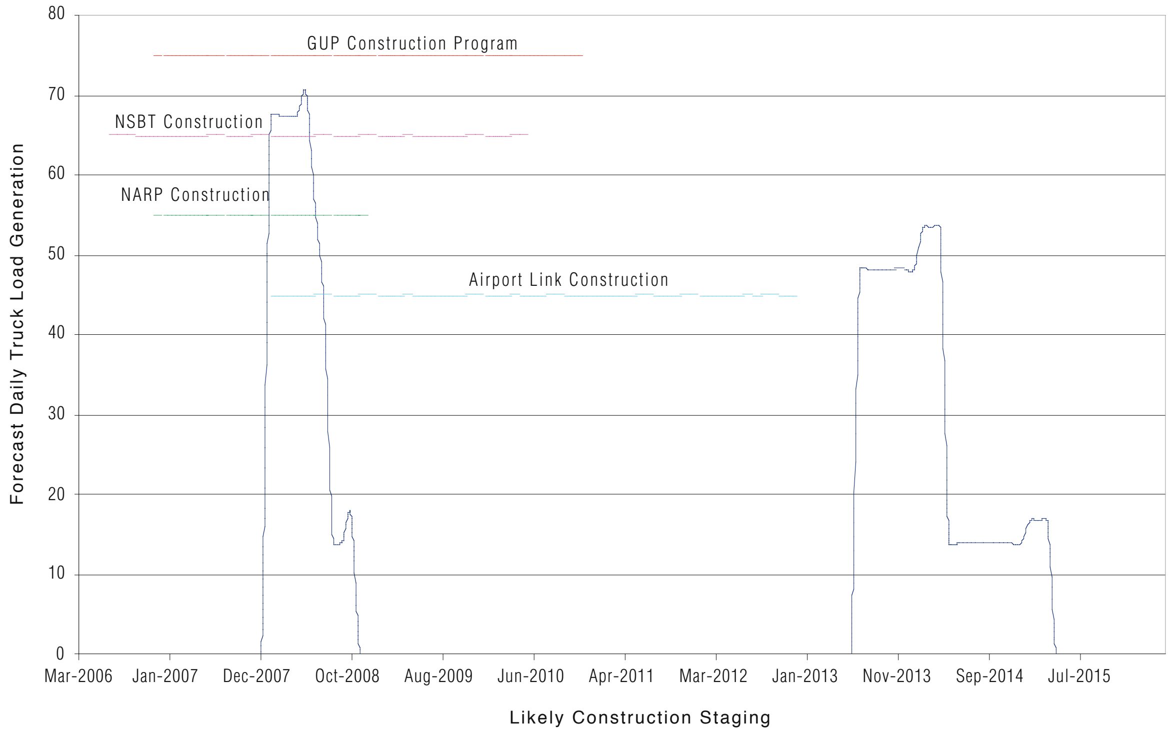
During the construction period, the highest forecast truck load generation will be approximately 70 truck loads extra per day to transport the raw materials to site (refer to **Figure 3.4c**). This is an additional 140 heavy vehicle trips per day assuming no trucks remain on-site. From the quarry locations in **Figure 3.4b**, it can be reasonably assumed that approximately 45 percent of the raw material will be transported from the south, 35 percent transported from the north and the remaining 20 percent transported from the west. Based on these assumptions, the following additional heavy vehicle trips are assumed for the purposes of assessing the impact of the NPR construction traffic:

- 63 additional heavy vehicle trips from the south;
- 49 additional heavy vehicle trips from the north; and
- 28 additional heavy vehicle trips from the west.

This is an overall increase in heavy vehicle trips of generally not more than 1 percent per day throughout the construction period along the Gateway Motorway, Pacific Motorway, Logan Motorway and Ipswich Motorway and the Warrego Highway and Bruce Highway.

The approximate construction timeframes for the Gateway Upgrade Project (GUP), the North South Bypass Tunnel (NSBT), the Northern Access Road (NARP) and Airport Link coincide, in part, with the construction activities of NPR. At present, the proposed programs for each of these projects are scheduled to run parallel to some portion of the NPR. These projects will also be transporting raw materials and could potentially cause some cumulative impacts. However given the increase in heavy vehicle traffic is less than 1 percent, and the proximity of the construction site to the Gateway Motorway, the disruption to the operation of the surrounding road network is likely to be negligible.

Figure 3.4c: *Daily Truck Generation During Construction Staging and Scheduled Project Timings.*



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