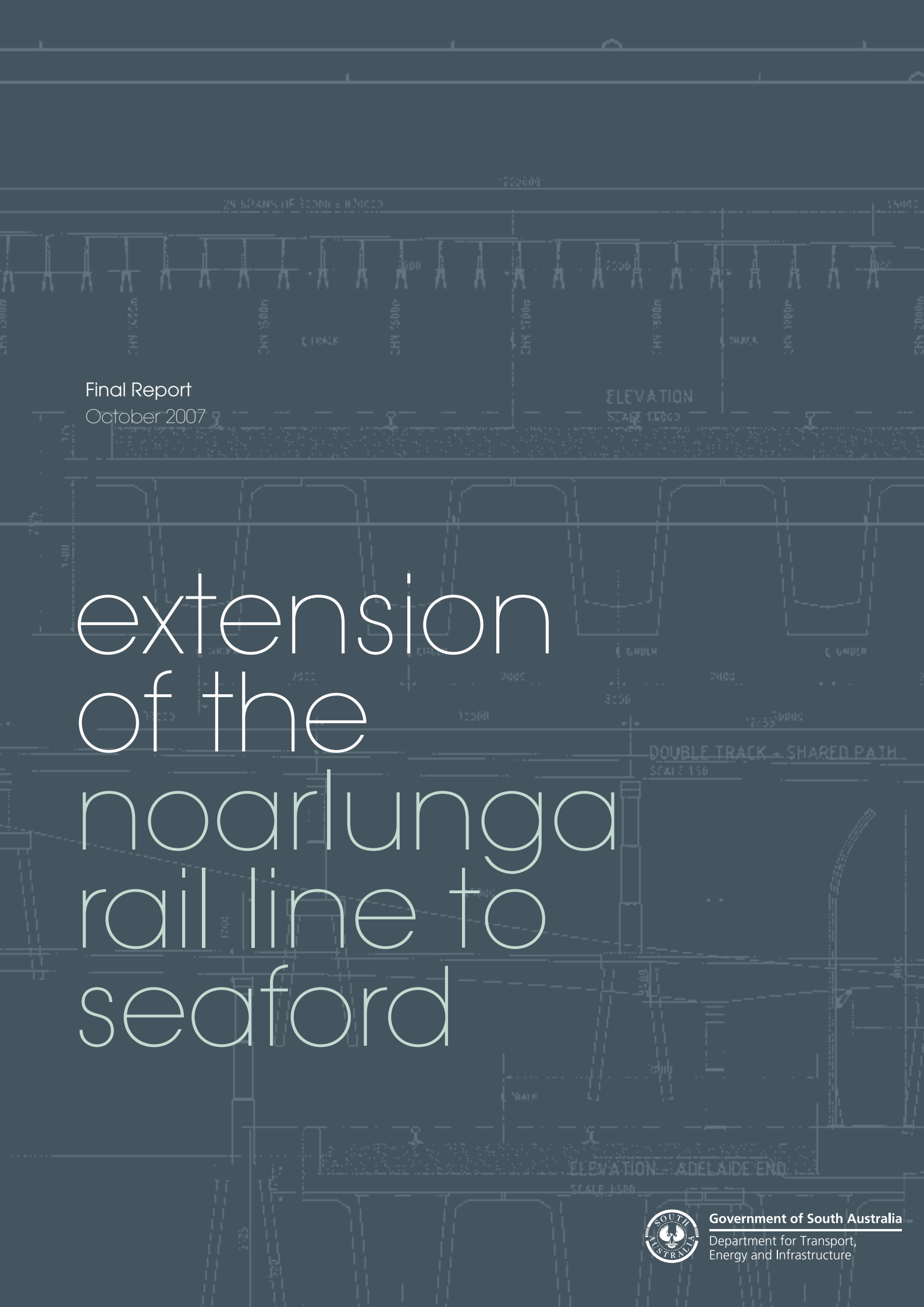

Final Report
October 2007

extension of the noarlunga rail line to seaford

Government of South Australia
Department for Transport, Energy and Infrastructure

Final Report

This report has been
produced by the
Policy and Planning Division
Department for Transport,
Energy and Infrastructure

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EXECUTIVE SUMMARY

South Australia's Strategic Plan is a comprehensive statement of what South Australia's future can be. Its targets aim for a growing and sustainable economy and a strong social fabric.

Some of these targets are ambitious and are beyond the reach of government acting alone. Achieving the targets requires a concerted effort not only from the State Government, but also from local government, regional groups, businesses and their associations, unions, community groups and individual South Australians.

This vision for SA's future requires infrastructure and a transport system which maximise South Australia's economic efficiency and the quality of life of its people.

The ambitious increases in population and strong economic growth reflected in these targets will lead to increasing pressure on the supply of housing, offices, appropriately skilled labour and, critically, transport. Investing in strategic infrastructure for metropolitan Adelaide's transport system and services to increase its capacity, reliability and overall performance will help meet the challenge of rising travel demand.

Strategic rail infrastructure

Development of a rail line to Seaford and further south to Aldinga, Sellicks Beach and even to Victor Harbor has been contemplated for at least 50 years. The *Report on the Metropolitan Area Adelaide 1962* considered a rail extension to Sellicks Beach as an option for major public transport improvements, but eventually recommended the extension of the rail line to Noarlunga.

Initial work on a possible extension commenced in the mid 1970s during the time of the construction of the Lonsdale to Noarlunga Centre rail line, with the most direct route for a rail alignment from Noarlunga to Seaford being defined during the 1980s. Further consideration occurred in the late 1980s during the initial structure planning for the urban development at Seaford. This resulted in a transport corridor being reserved within this development.

In March 2005 the Government released the *Strategic Infrastructure Plan for South Australia* which initiated an investigation into the extension of the Noarlunga rail line to Seaford as part of a suite of infrastructure interventions to encourage the shift to rail transport for passenger and freight movements where justified by environmental, economic or social imperatives.

This report describes the development and evaluation of the extension of the Noarlunga rail line to Seaford to establish its economic and engineering feasibility and its impact on the objectives in the *South Australia's Strategic Plan*.

The proposal incorporates a grade separated double track alignment except for a section of single track rail line over the Onkaparinga Valley.

The forecast for demand for public transport uses the population projections for the Outer South, which are based upon the *South Australia's Strategic Plan* target of increasing the population of South Australia to two million by 2050.

To meet this demand the supply of public transport services were evaluated based upon minor changes to bus services and extending rail services to Seaford.

The National Guidelines for Transport System Management in Australia (2nd edition)

These series of documents were endorsed by the Australian Transport Council (ATC) in November 2006.

They support transport decision-making and serve as a national standard for planning and developing transport systems. They are a key component of processes to develop and/or appraise transport proposals that are submitted for government funding.

The guidelines provide a consistent framework and processes, methods and tools to assist and guide transport planning and decision-making across Australia. A need for the guidelines was identified by the Standing Committee on Transport (SCOT) in 2003.

The Council of Australian Governments (COAG) endorsed the implementation of the Guidelines in April 2007 as part of the COAG National Reform Agenda[1].

The revised second edition includes guidelines on urban transport, which have been used as the basis for this investigation.

A multi-criteria approach was used to appraise the impacts of extending the Noarlunga rail line to Seaford and is based upon the above guidelines. The multi-criteria assessment allows the comparison of options against a range of impact areas which emphasises the six interrelated objectives of the *South Australia's Strategic Plan* which are:

1 **Growing Prosperity**

2 **Improving Wellbeing**

3 **Attaining Sustainability**

4 **Fostering Creativity and Innovation**

5 **Building Communities**

6 **Expanding Opportunity**.

The key results of these studies are:

GROWING PROSPERITY

ECONOMIC GROWTH AND TRANSPORT BENEFITS

South Australia's Strategic Plan's economic objective of growing prosperity provides the following target: T1.1 – Economic growth exceed the national economic growth rate by 2014.

The demand for additional public transport services in the outer southern areas of Adelaide will come from the attraction of this service, being quicker, more comfortable and more reliable compared to travel on a road network that becomes more congested over time.

Reduction in road congestion and quicker more reliable journeys to work and business on public transport will contribute to South Australia's economic growth and enhance opportunities for job creation and industry development.

This initiative will contribute to the better economic performance of South Australia and provide resources to achieve environmental and social goals.

The key transport benefits which would influence economic growth in South Australia are:

- The current analysis of the effects of a rail service to Seaford indicate that a large number of people are expected to use the system with a predicted mode shift from car journeys to public transport journeys of around 2.3 per cent.
- Forecast additional public transport demand of up to 1.5 million public transport trips per annum (5,300 additional weekday trips) compared to continuing with the bus-based system to connect the outer south with the Noarlunga Centre and destinations further north such as Londsdale, the inner suburbs of Adelaide and the City.
- Reduced public transport travel times by up to 80,000 passenger hours and reduced car passenger travel times by up to 400,000 passenger hours because of projected net reductions in highway use that arise from a mode shift away from car use to public transport.

[1] Details of the National Reform Agenda can be found at www.coag.gov.au

- An increase in public transport use of around 10 million passenger kilometres per year. Private transport use would reduce by up to 30 million passenger kilometres per year.
- In sustainability terms extending a rail service to Seaford would reduce the use of the whole transport system by 20 million passenger kilometres per year.
- Extending rail services to Seaford would enable and stimulate more and longer travel on public transport due to less reliance on car travel as the main mode of travel.
- During the peak hours, parts of the road network are close to capacity where additional road vehicles eventually slow traffic flow and increase travel times of other vehicles. Extending a rail service to Seaford becomes an effective congestion relief mechanism improving the capacity of the road network.

EMPLOYMENT AND POPULATION

The population projections used in the MASTEM model correspond to the *South Australia's Strategic Plan's* target T1.22 of increasing South Australia's population to two million by 2050.

Intense, comprehensive development around rail stations can engender synergy between major transit schemes and major urban development schemes. Urban development in Seaford Meadows and at Seaford could be mixed use for local services with rail services to Seaford providing access to a wider range of goods and services at major regional centres such as Noarlunga, Marion and the City of Adelaide.

Policies that include offering incentives and aligning planning policies toward transit oriented development have been successfully implemented in Perth.

Specific benefits of this proposal are:

- Increasing residential density will increase the population within the catchment area for the Seaford Meadows and Seaford Stations. This benefit is valued in terms of journey time savings for people who use the rail service to travel to employment areas further north, such as Londsdale or the city.
- Urban consolidation benefits estimated as the net savings in housing and associated infrastructure cost from higher density Transit Oriented Development (TOD) style of development at Seaford Meadows and at Seaford compared to development on the fringes of the outer southern areas of Adelaide. This benefit has not been monetised because no market takeup analysis has been undertaken to determine if the changes are real increases and not movements from one area to another, such as an increase in development in Seaford at the expense of other areas of Adelaide.
- Property price uplift attributable to new rail extensions and transit oriented developments. There is a body of research that proposes that fixed rail systems provide a scale of investment that may have identifiable impacts on land values over time when compared to bus-based systems, which are less likely to have any measurable impact.

This research proposes that new or improved fixed rail systems increase land values which reflect the pressure for development within the vicinity of fixed rail systems and that these can be considered a value added benefit additional to the journey time benefits accruing from a new rail system. These benefits have not been monetised.

IMPROVING WELLBEING

ROAD SAFETY

New passengers to public transport will benefit from the inherent safety advantage of bus and rail travel compared to car travel. The remaining road users will benefit from a reduction in the number of road accidents due to fewer cars on the metropolitan road network, leading to less congestion and smoother travel.

The contribution of the extension of the Noarlunga Rail line to Seaford to reducing accidents has been calculated on the basis of deriving unit crash cost information for fatal crashes and casualty crashes and then combining them with estimates of crash numbers, themselves generated by combining traffic and crash rate information, to estimate aggregate annual crash costs for base case and project case options.

It is estimated that this proposal will reduce the number of casualty crashes by up to 20 per year and reduce fatality crashes by up to one every three years.

STATEWIDE CRIME RATES

Investment in new public transport infrastructure presents the opportunity to provide public transport passengers with improved secure journeys so that passengers feel safe and crime on public transport is reduced.

This requires ongoing funding for adequate security measures, including monitoring of CCTV cameras and alarms as well as adequate lighting, help phones and communication facilities.

These may be combined with other measures to improve security such as good urban design and locating stations to ensure that they have regular activity overlooking the facilities to provide passive surveillance that deters antisocial behaviour. Providing secure car parks to prevent damage to vehicles and prevent stealing of vehicles improves the security for public transport passengers.

PREVENTATIVE HEALTH AND HEALTHY SOUTH AUSTRALIANS

Extending the rail services to Seaford and linking these with feeder buses is forecast to generate an additional 1.5 million public transport trips per annum created largely due to car drivers and passengers switching to public transport. Each trip has a walking component to and from the destination to access and egress public transport vehicles. Public transport stops are located on average every 500 metres and it is estimated that people transferring from car travel to public transport would walk up to an additional 1.5 million kilometres per year. This active travel will help lessen the health problems caused by obesity.

Transport generates air pollution emissions which give rise to discomfort and adverse health effects, and affects ecosystems, buildings and general amenity. Pollution studies have shown that high levels of ambient air pollution are associated with strong increases in adverse health effects, including premature death, and respiratory and cardiovascular problems. The evidence for these effects is strongest for particulates and ozone and the relationships are widely accepted as causal. Recent studies reveal such effects occur at the levels of ambient air pollution present in urban areas today and are sufficient to trigger these health effects.

Reducing local air pollutants within the outer south of Adelaide will have a direct positive effect on those people working, living in and visiting the outer southern areas of Adelaide.

It is estimated that extending rail services to Seaford represents a significant benefit with a reduction in local air emissions of up to 180 tonnes per annum.

ATTAINING SUSTAINABILITY

GREENHOUSE GAS EMISSION REDUCTION

There is a growing body of evidence that links man-made greenhouse gases with global warming. Greenhouse pollutants produced by road transport are reported in terms of carbon dioxide (CO_2) equivalent emissions. The results of the evaluation indicate that the extension of a rail line to Seaford would decrease the amount of global air pollution emissions from a shift from private car to public transport.

Reducing greenhouse air emissions will have a direct positive effect on everyone.

It is estimated that extending rail services to Seaford represents a significant benefit with a reduction in greenhouse emissions of up to 9,500 tonnes of carbon dioxide per annum.

USE OF PUBLIC TRANSPORT

South Australia's Strategic Plan provides the following target: T3.6 – Increase the use of public transport to 10 per cent of metropolitan weekday passenger vehicle kilometres travelled by 2018.

Transport use is measured in terms of passenger-kilometres travelled on both public and private transport within metropolitan Adelaide.

As such, it is a very useful measure of the effectiveness of policies to encourage a shift from private to public transport.

It is estimated that a rail service to Seaford will increase the use of public transport by up to 0.17 per cent of metropolitan weekday passenger vehicle kilometres travelled.

ECOLOGICAL FOOTPRINT

Reduction in use of the transport network through a modal shift of private car travel to public transport will eventually lead to the reallocation of urban space from the use of cars on a road network to more community space for attractive pedestrian areas and access to local areas through the use of walking and cycling.

BUILDING COMMUNITIES

ACCESS TO EVERYDAY FACILITIES

The community severance impacts of a rail extension to Seaford are based upon forecast changes in traffic flows on the main roads predicted with the passenger demand forecasting model used in this analysis. Community severance is measured in terms of pedestrian delay. Pedestrian delay when crossing a road is mostly the result of the waiting time for a suitable gap in the traffic or for a traffic signal phase which allows pedestrians to cross safely.

The assessment shows that extending rail services to Seaford with connecting bus services is forecast to bring about a significant overall net reduction in cars using the road network because of the modal shift from private to public transport.

NOISE

Traffic is one of the principal sources of urban noise and the train extension to Seaford would provide considerable benefits in terms of reductions in the amount of cars on the network as people shift to using public transport. The reduction in car traffic would lead to a reduction in general traffic noise.

NATURAL ENVIRONMENT

Initial evaluation of the alignment has determined the preference for a viaduct and bridge over the Onkaparinga Valley tidal estuary to minimise the impact on the tidal flats and impact on peak tidal flows and flooding. An earth embankment at this stage is not considered feasible because of the negative environmental impact on tidal flows and a poor foundation within the soft alluvial deposits.

There is an opportunity to restore the flora and fauna within the floodplain compared to what exists currently if the SA Water effluent evaporation ponds are rehabilitated and the 66kV power lines are relocated to facilitate the building of a rail viaduct and bridge over the tidal flats.

EXPANDING OPPORTUNITY

REDUCTION OF BARRIERS: MOBILITY IMPAIRED ACCESS TO PUBLIC TRANSPORT

The new railway stations will be compliant with the Federal Disability Discrimination Act, which provide for easier accessibility for everyone, particularly for those in wheelchairs, parents with prams and mobility impaired passengers. Connecting bus services will be within quick and easy walking distances to rail services.

RESULTS OF THE ECONOMIC EVALUATION

The results of the sensitivity analysis are summarised in the table below and show a variation of results for the economic return of the project that are dependent upon the assumptions made for the estimate of infrastructure costs and journey time savings.

Table 1 Results of sensitivity tests

		Benefit Cost Ratio	Net Present Value $ millions
1	1980s Alignment P90 infrastructure cost estimate, 6% discount, 100% road decongestion benefit	0.7	-71.4
2	Item 1 using a different base case that provides faster train running time between Noarlunga and Adelaide	1.0	-25.6
3	Item 1 using a discount rate of 4%	0.8	-46.8
4	Item 1 using a discount rate of 10%	0.5	-89.4
5	Item 1 using most likely estimate Infrastructure cost estimate	0.8	-41.0
6	Item 1 using 50% road decongestion benefit	0.5	-103.0
7	1980s Alignment P90 infrastructure cost estimate, 6% discount, 100% road decongestion benefit, double track over Onkaparinga Valley.	0.6	-100.6
8.	Westerly Alignment P90 infrastructure cost estimate, 6% discount, 100% road decongestion benefit, single track over Onkaparinga Valley.	0.6	-84.4

No sensitivity testing was undertaken on a range of population projections for the outer south. The preliminary benefit cost ratio (BCR) range is between 0.5 and 1.0.

The P90 value has been derived from the range in cost items within the estimate and represents a 90% probability that the estimate will be within the range estimate. This means that there is a 10% probability that the P90 figure will be exceeded because of these uncertainties.

There is a significant improvement in the economic result if rail services are extended to Seaford after concrete re-sleepering of the Noarlunga to Adelaide rail line. This would provide faster train services and increase the BCR from 0.7 to 1.0.

KEY ISSUES

Key issues raised by this investigation are outlined below:

- **Further development of the proposal is needed to remove uncertainties in the costs.** There are a number of uncertainties and a number of unit rates that are considered to have a low level of confidence in their accuracy. Further planning and design work is required to quantify the extent of road works, to fix the horizontal and vertical alignment and to develop preliminary cross sections within the rail corridor. Preliminary bridge design and geotechnical information is required to remove the uncertainties associated with the type of structure and foundations needed for the viaduct and bridge over the Onkaparinga Valley and their costs.
- **Single track vs double track bridge over the Onkaparinga Valley.** TransAdelaide has expressed the view that the single track layout over the Onkaparinga Valley will affect the reliability of the Seaford to Adelaide rail service. The risk is that this arrangement may affect TransAdelaide's ability to keep to a specific timetable and also affect the effectiveness of connecting bus services.

  Independent studies propose that it is possible to operate the current train timetable with an extension to Seaford incorporating a single track over the Onkaparinga Valley.

  Operational flexibility and reliability of the public transport system is a critical issue in retaining passengers and encouraging new passengers. Understanding whether a single track bridge will compromise this ability is a critical issue for resolution during the project definition phase.

  Further studies are required to investigate the effect of a single track over the Onkaparinga Valley on the reliability of the operation of the Seaford to Adelaide rail line. This information can then be used to decide whether a single track arrangement can be implemented over the Onkaparinga Valley with duplication occurring at some time in the future if passenger demand increases.
- **The Seaford and Seaford Meadows Station are too close.** The Seaford Meadows station is only 1.5 kilometres from the Seaford terminus. Removing the Seaford Meadows station or investigating other options to space stations so that quicker transit running times can be achieved, may attract more passengers.

  Spacing between stations is a balancing act. The stations need to be close enough to be easy to reach from many areas in the outer south either by walking or travelling a short distance by bus. However, there is a need to keep the train moving on the line, since stopping too often will make the trip a slow one and the service will be less attractive for passengers.

  Remove Seaford Meadows:

  Removing the Seaford Meadows station, which is located in a hollow, provides quicker and a more reliable transit time between Noarlunga and Seaford by not requiring trains to both brake and accelerate out of the station against the grade in both directions. There is possibly some advantage, from a public transport perspective, that faster train services on the Seaford to Adelaide rail service will attract additional patronage. Buses would service the Seaford Meadows development and feed passengers into the Seaford terminus.

  Removing the Seaford Meadows station will reduce walking access to the rail service and reduce the opportunity to develop Transit Oriented Development (TOD) style neighbourhoods. The Seaford terminus becomes the main train loading point for the Outer South and there may not be sufficient car parking to

cater for a growing public transport demand and the terminus may become congested with feeder buses.

A Seaford Meadows station may be preferred by developers who have the opportunity to develop TOD-style neighbourhoods that provide high density and premium developments close to and within easy walking distance of the Seaford Meadows station.

Relocate Seaford terminus to Seaford Heights:

There is possibly some benefit in retaining the Seaford Meadows station and relocating the Seaford terminus to Seaford Heights. The stations would then be 2.75 kilometres apart allowing quicker transit time between stations. The Seaford Heights terminus would be located adjacent to the large greenfield residential site of Seaford Heights.

This proposal has the advantage of stations being located adjacent to two large residential catchments of Seaford Rise and Seaford Heights which are within easy walking distance to rail services. There is potential to develop TOD-style neighbourhoods at Seaford Heights, which is a greenfield site, close to the rail terminus further increasing the potential catchment for rail services.

Relocating the terminus to Seaford Heights would require an additional 1.75 kilometres of rail track in a rail corridor that is under the ownership of the Minister for Transport. This increases the scope and cost of the proposal and will reduce the economic result unless rail and bus services can attract more patronage through higher frequency services and quicker train running times along the Seaford to Adelaide rail corridor and/or the population catchment exceeds estimates.

These benefits remain speculative in that no analysis or modelling has been undertaken to quantify the effects of removing the Seaford Meadows Station or relocating the Seaford terminus to Seaford Heights.

- **Seaford Meadows Master Plan needs to be developed.**

  The developer for Seaford Meadows is required, under the development deed, to prepare a master plan for its proposed development, which in turn will inform a review of the Structure Plan with the City of Onkaparinga. DTEI understands that the developer has developed two master plans for Seaford Meadows. One that assumes that a railway station is built with development allowing for bus access to the station and a TOD-style neighbourhood with higher residential densities near the station. The other plan assumes that there is no station and no TOD-style neighbourhood and is developed with standard street arrangements.

  Developers may require a decision from the Government on the determination of a station at Seaford Meadows within the next four years.

- **Links between MASTEM predicted additional trips and population increase are unclear.**

  MASTEM, a passenger demand forecasting model, has not been sufficiently developed to produce automatic outputs that can show the relationship between population increase and public transport demand and origin and destination of specific trips.

  Further work should be done to confirm the benefits of the proposal using updated versions of MASTEM with a number of population scenarios for the outer south and with spatial diagrams to show the origin and destination of trips.

- **Corridor land is State Government owned but titled under different Ministers.**

  The 1980s alignment over the Onkaparinga Valley is on land owned by the Department for Environment and Heritage and SA Water. The remainder of the alignment is on land owned by the Minister for Transport or Commissioner for Highways. No land costs have been included in the estimate to provide for cross-departmental funding transfers to account for the change in ownership of the land.

CONCLUSIONS

The main conclusion reached by the study is that the proposal does not yet justify the major initial expenditure. However, extending rail services to Seaford after concrete re-sleepering of the Noarlunga rail line provides an improved benefit cost ratio and offers the best value for money.

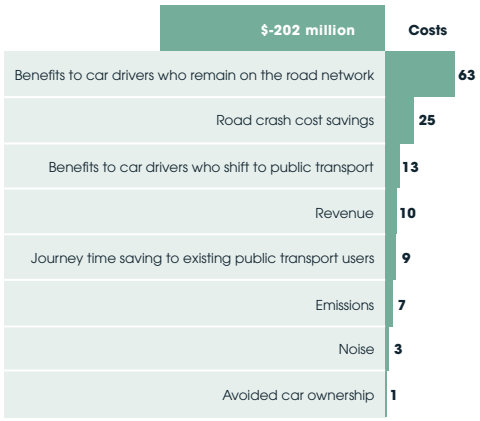
A rail extension to Seaford would provide a range of benefits.

Despite the main conclusion, the results of the multi-criteria assessment show that the majority of the criteria set to evaluate the rail extension to Seaford would be met. Significant benefits would be realised in terms of improving accessibility to and from the outer southern areas of Adelaide as well as improving the environment.

The provision of a rail service to Seaford would encourage a large number of people to use the system. The improved accessibility, especially between the outer south and inner south, would help the people from the outer south areas to have better access to job opportunities located north of Seaford. The rail line would also encourage Transport Oriented Development (TOD) style of neighbourhoods and encourage development within Seaford and Seaford Meadows. The predicted modal shift in journeys of up to 2.3 per cent from private transport is extremely encouraging, given the reliance on private car travel in the outer southern areas of Adelaide.

The results of the preliminary approval and benefit cost ratio are detailed in Appendix A and summarised in Figure 1.

Figure 1 Costs and benefits present value $ millions



Analysis of the benefits of a rail extension show an attraction to a quicker, more comfortable and more reliable service compared to travel on a road network that becomes more congested over time.

The main beneficiaries are car drivers who remain on the highway system. These benefits are achieved by the extension of rail services to Seaford providing a significant shift of transport travel from the road network to the public transport system.

The preliminary benefit cost ratio (BCR) range is between 0.5 and 1.0.

There is a significant improvement in the economic result if rail services are extended to Seaford after concrete re-sleepering of the Noarlunga to Adelaide rail line. This would provide faster train services and increase the BCR from 0.7 to 1.0.

The 1980s alignment, the most direct route from Noarlunga to Seaford, performs better than the Westerly Alignment when compared to the appraisal criteria.

The Westerly Alignment underperforms when compared to the 1980s alignment in a number of key areas because it:

- Is more costly.
- Requires more land from the Onkaparinga River recreation park.
- Requires the demolition of a number of private properties.

A rail extension would offer an attractive alternative to the private car.

Improving the quality of public transport, particularly by reducing journey times through the introduction of extended rail services along a dedicated corridor to Seaford, would provide an attractive alternative for people who currently use cars or would otherwise consider using private cars in the area in the future.

Extending rail services to Seaford shows a net reduction in car passenger kilometres resulting from car drivers and passengers shifting to public transport because of higher road traffic congestion and less distance travelled on the road network. The extension of rail services to Seaford is expected to increase the use of public transport by up to 0.17% of metropolitan weekday passenger vehicle kilometres.

Improvement in rail services between Noarlunga and Adelaide would provide an improvement in the economic result.

Travel time along the Noarlunga to Adelaide rail line is currently affected by speed restrictions. Without intervention[1], further speed restrictions would result in increased travel times that may lead to reduced performance of rail services. Improving this situation through concrete re-sleepering of the rail line will provide faster and smoother train services and extending the rail line to Seaford with these improved train services produces significantly higher benefits. These benefits are generated from the increased attraction to this service, being quicker, more comfortable and more reliable compared to travel on a road network that becomes more congested over time.

Extending rail services to Seaford after concrete re-sleepering of the Noarlunga rail line provides an improved benefit cost ratio and offers the best value for money.

The proposal is technically feasible.

The proposal is feasible within the defined scope of works described in this report. There are a number of uncertainties and a number of unit rates about which there is a low level of confidence in their accuracy. These uncertainties exist because either the unit rate is speculative in nature or because design attributes have yet to be fully defined and the estimator cannot fully quantify their impact because of lack of information or because their likelihood of occurring cannot be ruled out.

Further planning and design work is required to quantify the extent of road and rail works, to fix the horizontal and vertical alignment and to develop preliminary cross sections within the rail corridor.

Preliminary bridge design and geotechnical information is required to remove the uncertainties associated with the type of structure and foundations needed for the viaduct and bridge over the Onkaparinga Valley and their costs.

Consultation with a number of key external stakeholders is also required to secure the rail corridor across the Onkaparinga estuary.

The estimates of capital costs are predictable within certain ranges.

The 2007 range estimate for the cost of infrastructure is between $136 million and $175 million. If the proposal includes a double rail track viaduct and bridge over the Onkaparinga Valley the range estimate is between $170 and $215 million.

An estimated additional 14 railcars would be required, depending on the service levels adopted to meet passenger demand, at a cost of $56 million.

CONCLUSION

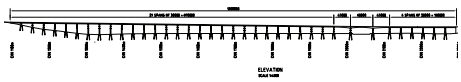
[1]The Government has made funds available over the next four years for concrete re-sleepering and upgrades to rail infrastructure to improve the standard of services and to provide for added passenger safety and comfort.

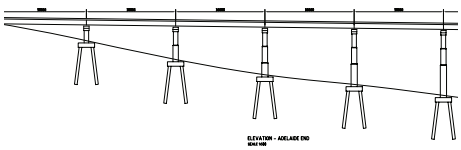
RECOMMENDATIONS

This investigation shows that extending rail services to Seaford provides a benefit cost ratio (BCR) between 0.5 and 1.0. With other benefits assessed by the evaluation criteria the investigation demonstrates that the scheme is worthy of implementation at a future time if rail services are improved and if population estimates for the southern areas of Adelaide remain the same or are higher than current predictions.

It is therefore recommended that:

- The Seaford Rail extension be retained as a potential public transport project.
- The 1980s alignment, the most direct route from Noarlunga to Seaford, be the adopted route for a future rail extension to Seaford.
- The costs and benefits of providing a station at Seaford Meadows or the relocation of the Seaford Terminus to Seaford Heights be reviewed.
- The feasibility and priority for funding of the proposal be reviewed:
  - After concrete re-sleepering of the Noarlunga to Adelaide rail line is complete.
  - If high frequency and high speed rail services and other public transport priorities are approved.
  - Once the population increases in the southern areas of Adelaide.
- The rail corridor over the Onkaparinga Valley be secured in the name of the Minister for Transport.
- A rail corridor to Aldinga be identified.





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INTRODUCTION

South Australia's Strategic Plan is a comprehensive statement of what South Australia's future can be. Its targets aim for a growing and sustainable economy and a strong social fabric.

Some of these targets are ambitious and are beyond the reach of government acting alone. Achieving the targets requires a concerted effort not only from the State Government, but also from local government, regional groups, businesses and their associations, unions, community groups and individual South Australians.

This vision for SA's future requires infrastructure and a transport system which maximise South Australia's economic efficiency and the quality of life of its people.

The ambitious increases in population and strong economic growth reflected in these targets will lead to increasing pressure on the supply of housing, offices, appropriately skilled labour and, critically, transport. Investing in strategic infrastructure for metropolitan Adelaide's transport system and services to increase its capacity, reliability and overall performance will help meet the challenge of rising travel demand.

Development of a rail line to Seaford and further south to Aldinga, Sellicks Beach and even to Victor Harbor has been contemplated for at least 50 years. The *Report on the Metropolitan Area Adelaide 1962* considered a rail extension to Sellicks Beach as an option for major public transport improvements, but eventually recommended the extension of the rail line to Noarlunga.

Initial work on a possible extension commenced in the mid 1970s during the time of the construction of the Lonsdale to Noarlunga Centre rail line, with the most direct route for a rail alignment from Noarlunga to Seaford being defined during the 1980s. Further consideration occurred in the late 1980s during the initial structure planning for the urban development at Seaford. This resulted in a transport corridor being reserved within this development.

In 1999 as part of the development of a range of options to improve public transport the extension was reconsidered, but not pursued due to predicted low patronage at the time. It was recommended to be reviewed when the population had increased.

The Seaford rail extension was again investigated in 2004. At the time the cost estimates were reviewed, along with the opportunities that may arise with the proposed development of the Land Management Corporation-owned land at Seaford Meadows.

In March 2005 the Government released the *Strategic Infrastructure Plan for South Australia* which included reference to an investigation into the extension of the Noarlunga rail corridor to Seaford as part of a suite of infrastructure interventions to encourage the shift to rail transport for passenger and freight movements where justified by environmental, economic or social imperatives.

2

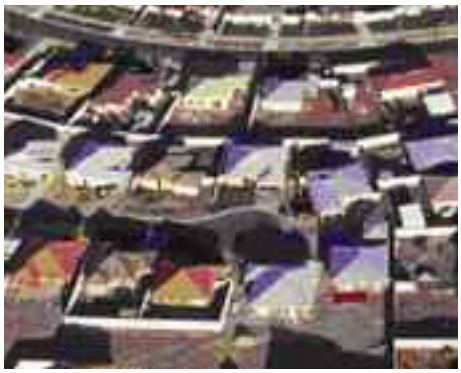
PURPOSE OF THE INVESTIGATION

The purpose of the investigation is to evaluate the extension of the Noarlunga rail line to Seaford through examining the proposal's economic and engineering feasibility and its impact on the objectives in the S*outh Australia's Strategic Plan* (SASP).

This study will allow the South Australian Government to determine its priority against other competing projects and assess the priority for further detailed analysis to progress the development of a full business case for funding.

The key deliverables from the investigation are:

- The preliminary engineering feasibility and concept costs of the provision of rail, viaduct and bridge infrastructure along the existing rail corridor from Noarlunga to Seaford and along a more westerly alignment proposed by the City of Onkapringa.
- The concept cost of future rail passenger services.
- An estimate of future travel demand for an extension of the Noarlunga rail line to Seaford.
- An assessment of the wider economic, safety and environmental impacts.
- An economic evaluation including a preliminary benefit cost analysis of the provision of rail services to Seaford.



3

THE EVALUATION PROCESS

3.1 National Guidelines for Transport System Management

The *National Guidelines for Transport System Management in Australia* (2nd edition) is a series of five documents that were endorsed by the Australian Transport Council (ATC) in November 2006.

The guidelines support transport decision-making and serve as a national standard for planning and developing transport systems. They are a key component of processes to develop and/or appraise transport proposals that are submitted for government funding.

The guidelines provide a consistent framework and processes, methods and tools to assist and guide transport planning and decision-making across Australia. A need for the guidelines was identified by the Standing Committee on Transport (SCOT) in 2003.

The Council of Australian Governments (COAG) endorsed the implementation of the guidelines in April 2007 as part of the COAG National Reform Agenda[2].

The revised second edition includes guidelines on urban transport, which have been used as the basis for this investigation.

3.2 Appraisal criteria

A multi-criteria approach is used to appraise the impacts of extending the Noarlunga rail line to Seaford and is based upon the above guidelines. The multi-criteria assessment allows the comparison of options against a range of impact areas which emphasises the six interrelated objectives of *South Australia's Strategic Plan* which are:

1 **Growing Prosperity**

2 **Improving Wellbeing**

3 **Attaining Sustainability**

4 **Fostering Creativity and Innovation**

5 **Building Communities**

6 **Expanding Opportunity**

The proposal is evaluated using the framework outlined in Figure 2 and is assessed against the evaluation criteria listed in Table 2.

A number of individual studies have been carried out to produce the data necessary for the evaluation. Figure 2 (Assessment framework) illustrates the main outputs for each study, while some details of these areas of work are outlined in more detail later in this report. The results of other studies are contained in other internal working documents.

[2] Details of the National Reform Agenda can be found at www.coag.gov.au

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Figure 2 Assessment framework

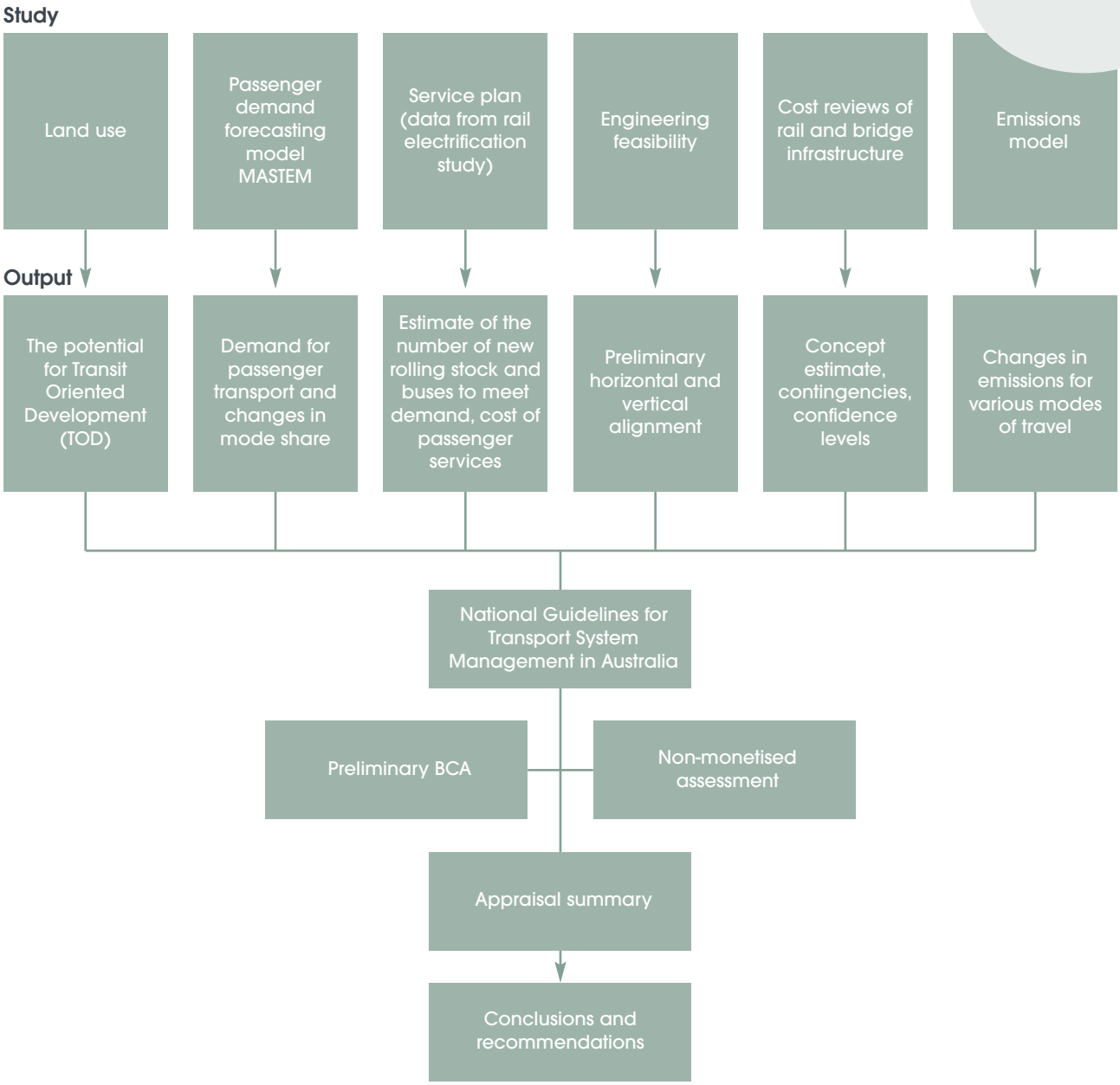

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Table 2 Evaluation criteria

OBJECTIVES	IMPACT AREA	EVALUATION CRITERIA
MANAGING COSTS	Capital and operating costs	• Capital costs • Operating and maintenance costs • Residual value
COLLECTING REVENUE	Revenue	• Ticket system revenue • Incentive payments to contractors
GROWING PROSPERITY		
Economic growth Employment participation	Journey times	• Journey time savings to existing public transport passengers • Time savings to diverted and generated public transport trips • Quality of station facilities and rolling stock
	Resource corrections	• Benefits to car drivers who shift to public transport • Benefits to motorists who remain on the road system • Avoided road damage
Total population	Transit oriented development and integration with land use plans	• Integration with metropolitan land use plan and City of Onkaparinga development plan • Transit influence on property price uplift • Urban consolidation • Avoided car ownership
IMPROVING WELLBEING		
Road safety	Road crashes	• Avoided fatality accidents • Avoided casualty crashes • Public transport crashes
Statewide crime rates	Personal security	• Personal assaults • Acts of terrorism
Preventative health	Healthy weight	• Walking
ATTAINING SUSTAINABILITY		
Greenhouse gas emission reduction	Emissions	• Local air pollution • Greenhouse gases
Use of public transport and reducing Adelaide's ecological footprint	Transport demand	• Transport use and meeting the public transport target • Land-take
BUILDING COMMUNITIES	Access to every day facilities	• Urban separation
	Natural environment	• Noise • Heritage and natural environment
EXPANDING OPPORTUNITY		
Participation by people with disabilities	Reduction of barriers	• Mobility impaired access to public transport

4 BACKGROUND

Over one third of Adelaide's population live in the southern suburbs. The south has significant differences between its outer and inner areas as designated in Figure 3. The unemployment rate in the outer south is higher than the Adelaide average and the proportion of professional workers in the outer south is lower than the Adelaide average. Employment zones within this area are shrinking. Significant growth in residential development has occurred in the outer south in recent years. This is expected to continue for at least the next ten years, with significant development occurring in Seaford, Aldinga and Sellicks Beach areas, up to 50 kilometres from the city centre. Most people in the outer south travel to work in a private vehicle. The outer south also has a large proportion of younger people, with 50 per cent of people under 34 and only 10 per cent over 65.

The inner south has heavy concentrations of people with university qualifications and professional workers, and a substantial number of people (42 per cent) are on above average incomes. A significant proportion of people living in the inner south are aged over 65 years (19 per cent), while just 42 per cent of people are aged under 34.

4.1 Transport in Southern Metropolitan Adelaide

Public transport services in the south use two significant corridors. The first is the Noarlunga dedicated corridor (rail operations) that hugs the south-west coast and services the same region. The second is the centrally located arterial road corridors of the Southern Expressway and South Road, which connect the Darlington area to both the central-south and south-eastern suburbs. South Road currently carries bus services for these suburbs. The Tonsley rail corridor, originally a freight line for Mitsubishi, starts in the Darlington area and connects to the Noarlunga corridor. No formal interchange currently exists between the various road corridors and the Tonsley line.

The passenger catchment for Noarlunga line is constrained by its western location. The central corridors are appropriately located but only provide for on-road operation of public transport and are therefore not dedicated. The South Road corridor is accessible but low-speed, while the Southern Expressway is a freeway-quality high-speed corridor and is an effective measure to alleviate road congestion for vehicles travelling to and from the City of Adelaide and the inner suburbs of Adelaide during the morning and afternoon peak commuter periods. The Tonsley rail corridor currently plays a very small role in the operation of the central corridor.

4

BACKGOUND

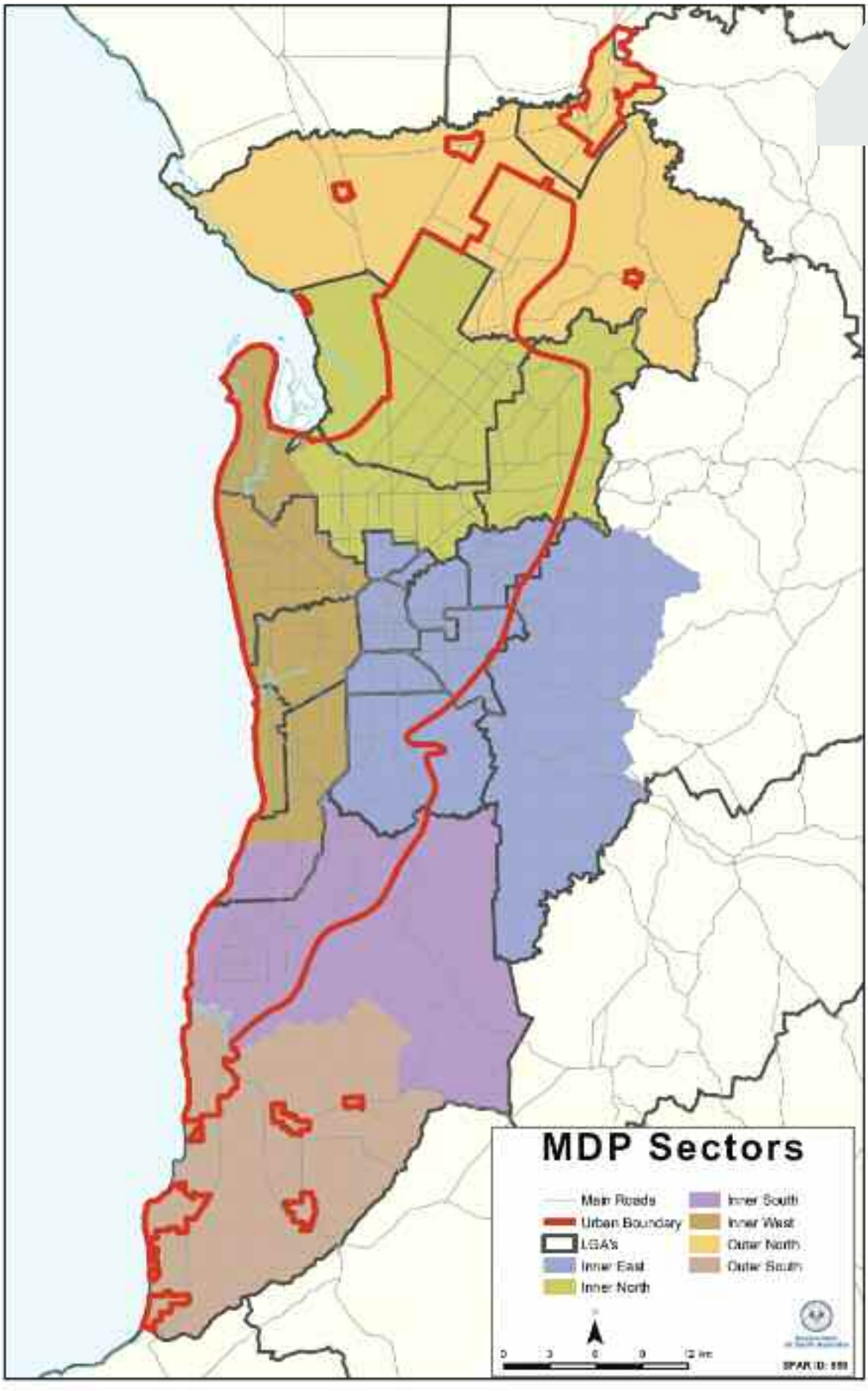
The outer south has suburbs that require service provision over 30 kilometres from Darlington, representing urban fringe growth and low-density development. It has some suburbs isolated by terrain and with convoluted street patterns – making public transport provision, even by bus, challenging.

The Noarlunga line is the second longest Adelaide rail corridor, at 30.2 kilometres from the city centre. Services along the line are currently the most frequent of all the metropolitan train services; however, the average number of weekday boardings per trip is 77, which is 21 per cent less than on the Gawler line.

The current outer south contract area for bus services covers 112.5 square kilometres, which is around 12 per cent of the total area covered by Adelaide Metro bus services.

The south has a series of high volume trip attractors, from Marion centre, to the nearby Flinders University and Flinders Medical Centre, the Aberfoyle Park Hub centre in the south-east, Lonsdale industrial park in the central-south, and the Noarlunga centre and Noarlunga hospital in the far-south.

Figure 3 **Metropolitan spatial plan (reproduced from the *Planning Strategy for Metropolitan Adelaide*, August 2006)**



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4.2 Current patronage profile

Weekday metropolitan Adelaide passenger boardings on the Noarlunga rail line represent around 36 per cent of the weekday boardings made on train services. Patronage on the Noarlunga to Adelaide rail service is high, particularly during peak commuter periods.

Approximately 4.7 million passenger boardings are carried per annum on bus services in the outer south contract area which is around eight per cent of the total annual boardings carried on Adelaide Metro. Bus route lengths in the area are particularly long, averaging 21 kilometres, and the average distance travelled between passenger boardings is two kilometres, which is the greatest of all the bus contract areas.

Weekday patronage by persons entitled to a student fare is higher than average at 30 per cent compared to the overall average for Adelaide Metro of 22 per cent. Weekday boardings by persons validating a concession ticket are close to the average for Adelaide Metro at 45 per cent.

4.3 Travel patterns

Like most other areas, the greatest amount of travel involving the inner and outer south occurs within the respective areas (68 per cent for the inner south and 77 per cent for the outer south). The inner south attracts the third highest number of external trips from other regions while the outer south attracts the second least number of external trips (first is the Adelaide Hills).

Suburbs within the inner south that attract travel to the region include Oaklands Park, Brighton, Edwardstown and Bedford Park. The outer southern suburbs that attract high volumes of travel include Morphett Vale, Woodcroft, Hallett Cove (and surrounding areas), Happy Valley, Reynella, Aberfoyle Park, McLaren Vale region and Noarlunga Centre.

The inner south attracts the majority of its external travellers from the outer south and the west with a significant proportion from the east. A very high proportion of people from the outer south come into the inner south for work (comparable to those travelling entirely within the inner south for work). Education and shopping in the inner south attract people from the outer south and the west with social/recreation and personal business also attracting those from the east.

The outer south primarily attracts travellers from the inner south for work, social/recreation and personal business activities.

Suburbs within the inner south that generate the greatest amount of travel include Clarence Park, Pasadena and Park Holme. The outer south's largest generators of travel include Woodcroft, Morphett Vale, Hallet Cove (and neighbouring suburbs), Happy Valley (and surrounding neighbourhoods), Aberfoyle Park and Flagstaff Hill.

Those residing within the inner south are mainly attracted to the city centre and the west, with a significant proportion attracted to the east and outer south. The number of trips to the city centre and the west are similar for all activities with the city centre being higher for work travel.

Nearly half of all travel coming out of the outer south goes to the inner south followed by the west and then the city centre. Those residing in the outer south undertake all types of activities within the inner south. The west and the city centre attract those pursuing work, social/recreation and personal business activities.

Journey to work data for the Onkaparinga local government area from the Australian Bureau of Statistics is contained in Appendix H.

4.4 Population and land use changes projected for the outer south

The greatest proportion of land available for release in the outer south will come from private developers. Broadacre development will be the dominant form and land supply may exceed demand.

The Planning Strategy for Metropolitan Adelaide defines the future development area in this sector as a narrow coastal corridor west of Main South Road. Urban expansion is intended to occur in response to constraints to development due to environmental considerations, including the management of

effluent and stormwater, and the protection of the marine environment, the coastline, the Aldinga Scrub Conservation Park and the wine producing areas of the McLaren Vale district. Growth in the sector is targeted to the areas of Seaford and Aldinga.

Regional Centre for the southern areas of Adelaide. The Noarlunga Centre is the recognised regional centre for the southern suburbs of Adelaide and was established in the 1970s as a major retail, commercial, services and civic centre and a bus and rail transport node. A number of land parcels are available for development close to the centre. Any residential uses should consider increases in density or special housing needs, such as aged accommodation.

Seaford: The Seaford area consists of an area east of Commercial Road that was acquired by the South Australian Urban Land Trust in the 1970s, and released for urban development in a joint venture arrangement with the private sector in the late 1980s and 1990s. This newer area is adjacent to the older Seaford suburb that was developed during the 1960s and 1970s as a coastal resort area north from Moana and south from Noarlunga. Seaford is a planned new extension of metropolitan Adelaide containing significant levels of physical and some human services infrastructure. The area is still developing and has major areas of broadacre land available for future development, particularly in Seaford Meadows and Seaford Heights.

Ochre Heights: This area of land is to the west of Commercial Road and fronts the coast south from Moana, and is one of the last major broadacre coastal development areas in the Adelaide metropolitan area. It is controlled by one major developer/builder and is projected for land division activity from 2005/2006 onwards.

Sellicks Beach: Sellicks Beach is located at the southern extremity of metropolitan Adelaide. It is an area that has developed around a coastal resort focus with scattered development that contains a seasonal population. As the area has matured a larger proportion of this population has become permanent. The area is separated from suburbs to the north by the Aldinga Scrub and the washpool area, and with the introduction of the urban growth boundary there has been a formalisation of the separation of Sellicks Beach from the southern urban growth of Adelaide. The area of Sellicks Beach now more closely resembles the other separate towns in the Southern Vales (McLaren Vale and Willunga) rather than a contiguous extension of Adelaide.

Aldinga: The majority of the development in this area has occurred from the 1950s onwards, with accelerated growth in the 1970s through to the 1990s. The community has been isolated from services and has significant pockets of low socio-economic status. In recent times, with continued expansion and a higher level of facilities such as retailing, better road access through the Southern Expressway to central Adelaide and the establishment of the Aldinga waste water treatment plant (a build, own and operate venture), it has become more established.

Bowering Hill north of Aldinga: The Government announced in July 2007 that it is considering including approximately 397 hectares of land north of Aldinga within the Urban Boundary primarily for residential purposes

4.5 The current transport system for Southern Adelaide

Encompassing a large portion of the Adelaide population, the south is diverse, with the opportunity to attract a greater number of people to public transport. Public transport challenges include:

- A rail spine that hugs the coast and therefore does not service south-central and south-east suburbs very well (such as Morphett Vale, Woodcroft, Hackham).
- Low population density, with growth expected at the outer fringe (such as Sellicks Beach, Aldinga, Seaford Meadows).
- High traffic densities and slow travel speeds exist at Darlington including Marion Road south of Sturt Road, South Road north of Sturt Road and Goodwood Road. The planned grade separation of the South Road/ Sturt Road junction will provide traffic efficiencies at this location.
- Go zone bus routes on Goodwood Road and Unley Road.
- Single track Tonsley rail line.

- High patronage on both rail and bus services in peak commuter periods.
- Speed restrictions on the Noarlunga rail line. The recent Government announcement of a resleepering program will result in speed restrictions being removed resulting in average travel time savings of three to five minutes on express services between Noarlunga and the city centre and an average of three minutes off other services on that line.
- The outer southern suburbs have less frequent bus services than the inner metropolitan areas of Adelaide.
- Park and ride facilities are well utilised; for example, at Old Reynella, Brighton, Noarlunga, Panalatinga Road.
- Absence of park and ride facilities at a number of locations.
- Public transport travel times from outer south to City Centre can exceed 75 minutes (for example, between City Centre and Noarlunga Regional Centre).
- Rail track capacity constraint at Goodwood Junction, involving interstate passenger and freight rail.
- Limited passenger transport coverage for suburbs south of Noarlunga and especially so for fringe suburbs like Aldinga and Sellicks Beach.

4.6 Road development strategies

The *Strategic Infrastructure Plan for South Australia* identifies the need to upgrade South Road as Priority 1, with the first stage being the construction of an underpass at Anzac Highway and a tunnel under Port and Grange Roads and the Adelaide-Outer Harbor train line, as well as widening South Road between Port Road and Torrens Road. The intention is to ultimately transform South Road into a non-stop route between the Southern Expressway and the Port River Expressway. The plan also identifies the need to continue with the upgrading of Victor Harbor Road.

One of the key outcomes of these proposals is to significantly improve the travel time between the north and south of Adelaide, particularly for freight transport. This reduction in travel time along South Road will attract heavy vehicles off other parallel north-south roads in Adelaide, such as Marion Road.

These proposed road improvements to South Road, and the improvements along Victor Harbor Road have been coded into the passenger demand forecasting model to assess the impacts on road and public transport travel up to 2031.

5 PROPOSAL

5.1 Previous studies

Previous studies focused on the development of the route and station locations, rather than the vehicle technology and details of service levels which would be justified in the corridor. This study has assumed that the existing rail service to Noarlunga Centre would be extended to Seaford with minor modifications to bus feeder services.

The Office of Transport Policy and Planning undertook a transport review in 1990 and prepared a summary report on behalf of the Seaford Transport Review Committee. The primary purpose of the review was to recommend to the Government the most appropriate corridors required for future transport infrastructure expansion and to reserve land for these corridors.

The review considered alternative alignments for road and rail from Noarlunga to Seaford. The review included a public exhibition phase to enable public comment on a number of shortlisted options for road and rail alignments.

A display was exhibited at the Noarlunga library and the then Noarlunga Council Chambers to coincide with the Premier's announcement of the Seaford Development on Thursday 21 June 1990. The exhibition period extended until Friday 27 July 1990.

The recommendations from that report resulted in land being reserved for a public transport corridor through the area now known as Seaford Meadows and initiated further studies into the engineering and economic impacts of a rail extension to Seaford.

Appendix B contains extracts from the summary report that show road and rail alignments that were presented to the public in 1990. One of the alignments used in this evaluation has been developed from studies carried out in the 1980s. The preliminary horizontal and vertical alignment is contained in Appendix C.

5.2 City of Onkaparinga's Westerly Alignment

The Onkaparinga Council invited Professor Peter Newman, of Murdoch University, to inspect the state of public transport in the outer south ahead of a public forum that was held on Tuesday, 10 July 2007.

Following this forum Professor Newman and representatives from the City of Onkaparinga met with officers from DETI to request that a more westerly alignment, which reduces the length of viaduct and bridge over the Onkaparinga Valley, be revisited to assess its performance against the appraisal criteria. DTEI agreed to include in the investigation an appraisal of a Westerly Alignment.

The preliminary horizontal and vertical alignment chosen by the City of Onkaparinga (Westerly Alignment) is shown in Appendix D. A comparison of horizontal alignments is shown in Figure 5 and Appendix E.

5.3 Rail corridor alignment and design parameters

Between July 2005 and October 2005 a technical investigation was undertaken by DTEI with a number of key stakeholders to confirm the design criteria and list the engineering and environmental issues.

The design criteria adopted in this proposal is a grade separated double track alignment except for a section of single track rail over the Onkaparinga Valley. The 1980s horizontal alignment is partly within land designated as under the care and control of the Minister for Transport or Commissioner for Highways. The alignment over the Onkaparinga Valley is on land owned by the Department for Environment and Heritage and SA Water.

The Westerly Alignment north of the Onkaparinga River traverses on land present occupied by private dwellings. The alignment over the Onkaparinga Valley is on land owned by Department for Environment and Heritage.

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Two stations are proposed, one at Seaford Meadows and one at the proposed Seaford rail terminus.

Two rail bridges are proposed, the main one being over the Onkaparinga Valley and River Road, and the other over Old Honeypot Road. Three road bridges are proposed at Goldsmith Drive, Seaford Road and Lynton Avenue.

The proposal uses an extension of the existing dual track rail line at Noarlunga Centre Rail station and traverses under Goldsmith Drive and down to the Onkaparinga Valley estuary crossing over Old Honeypot Road. The rail alignment crosses the Onkaparinga Valley estuary across a 1.2 kilometres single track viaduct and bridge and then runs on a slight upward gradient adjacent to Sauerbiers Road. The crest of the alignment is adjacent to the intersection of Sauerbiers Road and Jarred Road. From Jared Road the rail alignment runs on a downhill gradient to the Seaford Meadows Station. Sauerbriers Road may need to be realigned or closed.

From the Seaford Meadows station the alignment continues on an uphill alignment under Seaford Road and under Lynton Terrace and terminates at the Seaford Interchange. The design criteria for the 1980s alignment and the Westerly Alignment is shown in Table 4.

5

PROPOSAL

Table 3 Design criteria for the 1980s alignment and the Westerly Alignment

DESIGN ASPECT		DESIGN CRITERIA	
Alignment		**1980s alignment**	**Westerly Alignment**
General parameters			
	Gauge	Broad gauge (1,600 mm) but designed for conversion to standard gauge (1,435 mm)	Broad gauge (1,600 mm) but designed for conversion to standard gauge (1,435 mm)
	Clearances including allowances for electrification	8 metre vertical	8 metre vertical
	Design speed	110 km/hr	110 km/hr
	Maximum grade	1:50 (2%) (preferred)	1:35 (2.85%) (absolute maximum acceptable)
	Minimum horizontal curve radii	1000 m within existing 60 m wide rail corridor (preferred)	600 m fully transitioned (absolute minimum without imposing speed restrictions)
	At grade crossings	none	none
	Length of track	5.5 km	5.7 km
	Length of single track	1400 m	1100 m
Onkaparinga Valley crossing			
	Type of structure within valley	Viaduct and bridge	Viaduct and bridge
	Length of structure within valley	1200 m	900 m
Flood immunity			
	Onkaparinga Valley Structure to provide for 100-year ARI flood immunity to top of rail. The minimum acceptable rail level is considered to be AHD 7.0 m[1]	Minimum AHD at top of bridge rail is 10 m	Minimum AHD at top of bridge rail is 7 m (acceptable minimum level)

[1] The predicted 100-year ARI flood level at the bridge site is 3.0m Australian Height Datum (AHD). The minimum acceptable rail level of 7m AHD is derived from the predicted flood level 3m AHD plus two metres for the depth of bridge structure plus two metres clearance between the predicted flood level and the bottom of structure.

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5.4 Feasibility of tunnelling

Professor Newman and the City of Onkaparinga proposed a tunnel to minimise the visual impact of the rail line above the estuary and suggested that a tunnel option would not affect any existing residential properties.

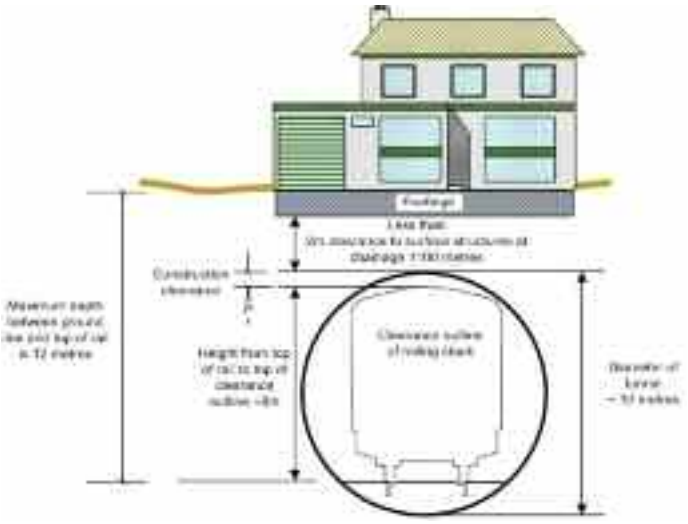
The method of construction for a tunnel would normally be by excavating the ground without removing the surface of the ground above or alternatively by cut and cover techniques.

The configuration of the tunnel would be dependent on the type of rolling stock to be used, the operational requirements for vehicle movements within the tunnel, the means of evacuation to be employed and the engineering properties associated with the ground conditions.

The geometric features for tunnelling within the Westerly Alignment are shown in Figure 4, which assumes a single bore tunnel enclosing the single track with areas for safe refuge and evacuation.

The maximum depth of overburden is three metres and the maximum clearance to house footings is two metres assuming a depth of one metre for a house footing. The tunnel would daylight at construction chainage 1070 and 1140 giving the proposed tunnel an effective length of 70 metres; the alignment north of the tunnel would be an open cut.

There are possibly some engineering techniques that are feasible with shallow overburden but tunnelling along this alignment for a short section would not significantly reduce the number of existing residential properties that would need to be acquired. The number of residential properties adjacent and above the tunnel may in all likelihood still need to be purchased due to the risk of the collapse of the



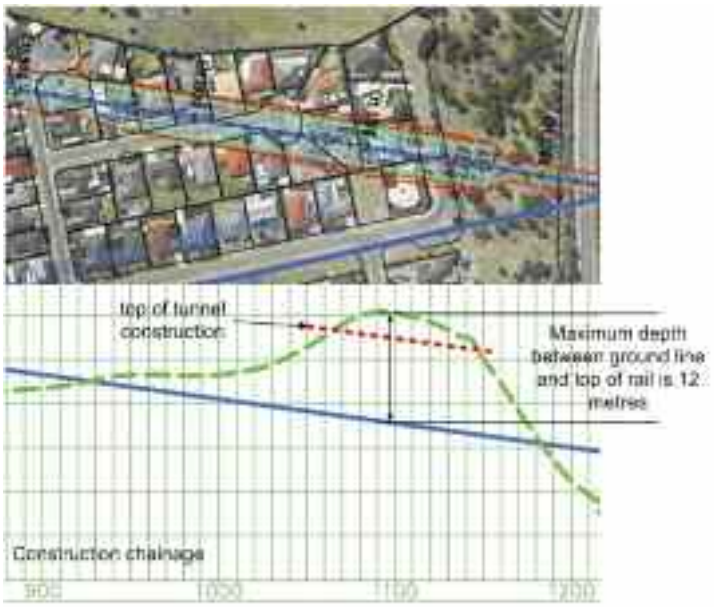


Figure 4 Clearances

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tunnel during construction and the risk associated with ground deformation and the resultant surface settlement. The consequence of this risk is that any surface structure such as a house may be damaged irreparably during and possibly after construction.

As a rule of thumb the cost per metre of a tunnel or a cut and cover is of the order of $250,000 to $500,000, which would significantly increase the cost of infrastructure without reducing the exposure to the risk of repairing or buying properties in the vicinity of construction.

Steep batters have been adopted within the cross section on the approaches to the tunnel to reduce the amount of residential property that would need to be acquired to construct this alignment.

There are no significant benefits in pursuing a tunnel option for this alignment because of its significant cost, its short length and because it does not provide any significant reduction in the amount of residential properties compared to adopting an open cut cross section along the alignment. The costing of the Westerly Alignment option has assumed an open cut cross section with steep batters through the residential development with the need to acquire about 50 per cent of the development (approximately 30 to 40 properties).

5.5 Rail operations

Rail operations for the Adelaide to Seaford line were reviewed in 1991 as part of the Railway Industry Council Urban working group which included the State Transport Authority. Initial cost estimates were prepared for a double and single track option across the Onkaparinga Valley. Due to the significant cost differential between the two options the single track option was progressed due to the low transit time between Noarlunga Centre and Seaford.

A report by TMG in 2005 also concluded that, given the comparatively light existing service densities to Noarlunga, little justification existed for any double track between Seaford Meadows and Noarlunga centre while the line terminates at the Seaford Interchange.

Further analysis and information is required for DTEI and TransAdelaide to determine the maximum service capacity and risks of this single track arrangement.

5.6 Integration with existing bus and rail services

Because the bus network is continually being developed to match changing demand, it is impracticable to define the precise pattern of future bus services at this stage of the proposals development.

The evaluation of the scheme has assumed that bus routes in the outer south would be improved to feed into the rail service to meet demand for public transport in the outer south; these changes are detailed in Appendix F.

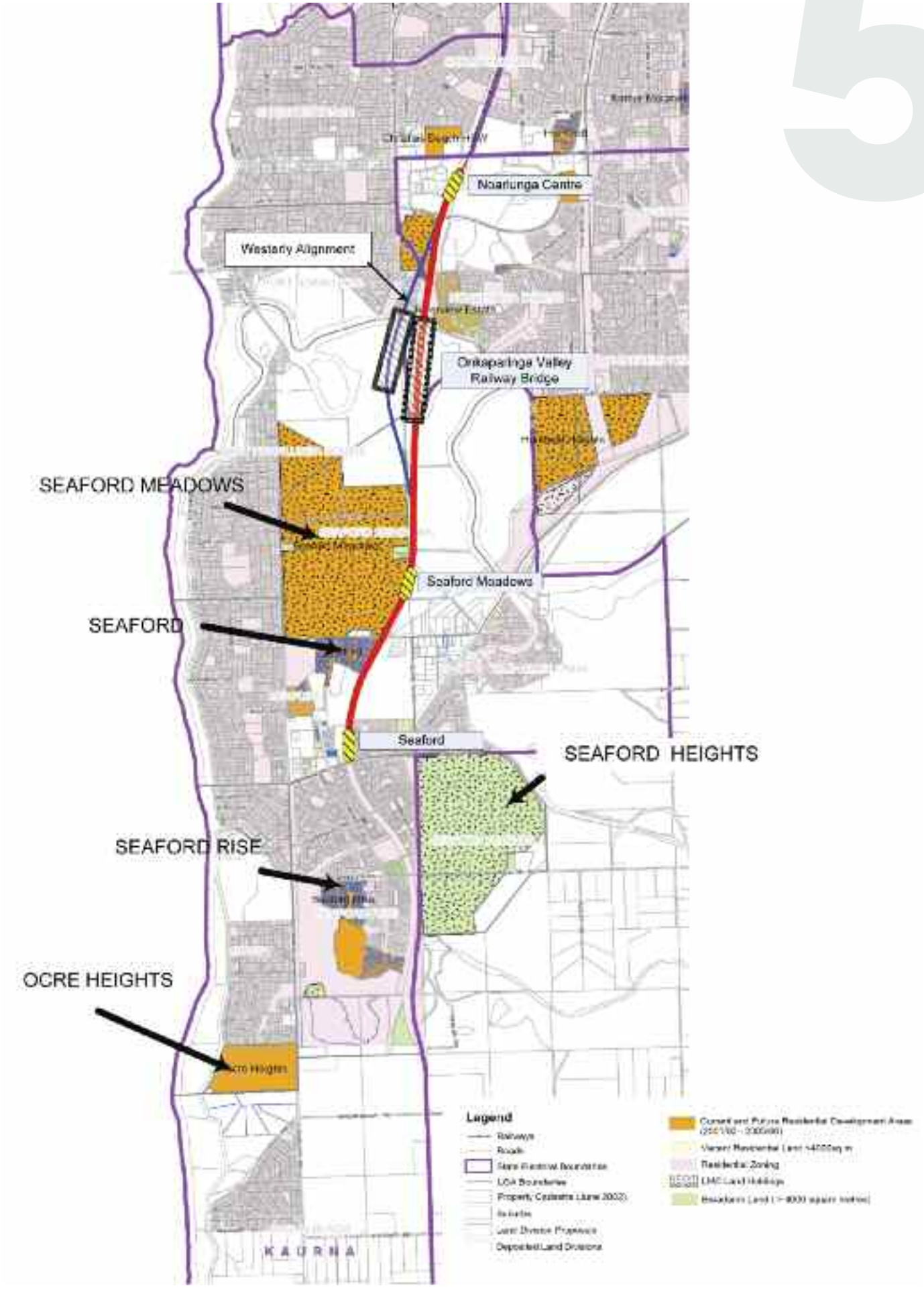
5.7 Stations

The estimate of capital costs assume high quality stations at Seaford Meadows and at Seaford. The stations would be furnished with ticketing machines, CCTV surveillance, real-time and fixed-time information, shelters with seats and a passenger security alarm system. The cost allows for integrating parking and bus access close to the station and incorporating high quality architectural design facilities with high quality surfaces.

5.8 Depot facilities

The evaluation has assumed that there will be no depot facility along the Noarlunga to Seaford extension.

Figure 5 Seaford rail extension alignment (based upon maps produced by Planning SA)



6 ESTIMATION OF PUBLIC TRANSPORT IMPACTS

6.1 Passenger demand forecasting model

Passenger forecast analysis was undertaken using the Metropolitan Adelaide Strategic Transport Evaluation Model (MASTEM). The model predicts demand to 2031.

MASTEM provides estimates of daily aggregate travel patterns within the Adelaide Statistical Division (ASD). The development of the model is predominantly based on the 1999 Metropolitan Adelaide Household Travel Survey (MAHTS99) with information from the Australian Bureau of Statistics (particularly the journey-to-work survey) and population projections derived from Planning SA. At the time of development these were the latest and most comprehensive sources of information available and define some of the assumptions and constraints on the model.

MASTEM has the ability to identify how the transport system in Metropolitan Adelaide is likely to perform at some point in the future following the introduction of rail services to Seaford.

6.2 Limitations of MASTEM and its use

The version of the MASTEM used in this study had the following specific limitations:

- Capacity constraints of vehicles aren't included.
- The model predicts a road network that is running at higher speeds than current observations. Work is continuing to achieve a satisfactory agreement with the 2006 traffic counts and observations of highway speed.
- The model is based on average weekday information and any interventions targeting weekend travel cannot be modelled.
- MASTEM is a zonal-based model using Traffic Analysis Zones (TAZ). Travel behaviour and characteristics of the population are aggregated using these zones, which may be too coarse for analysis in changes to specific population clusters within the outer southern areas of Adelaide which are close to a rail station or bus stop. More detailed level microsimulation models would need to be developed and calibrated to provide high levels of spatial resolution (that is, by service, stop etc.) to achieve this. No microsimulation model has been used in this analysis.
- MASTEM provides estimates of daily aggregate travel patterns within the ASD. The increase or decrease in travel demand for the outer southern area of Adelaide cannot be specifically modelled but must be inferred from results that are averaged over the whole of the ASD.

6.3 Population projections

The population projections used in MASTEM are for the Adelaide Statistical Division (ASD) and correspond to the *South Australia's Strategic Plan* target T1.22 of increasing South Australia's population to two million by 2050. The MASTEM snapshots for the number of households and population for 2006, 2018 and 2031 are shown in the Table 4.

6

Table 4 MASTEM snapshots for the number of households and population for 2006, 2018 and 2031

MASTEM Snapshot	Household		Population	
Year	ASD	Outer South	ASD	Outer South
2006	472,297	14,470	1,132,932	33,834
2018	531,771	18,539	1,221,508	41,445
2031	590,989	22,683	1,322,795	49,407

These population projections are based upon population estimates for 2006. The census data for 2006 will not be available until later in 2007. Once the data are available, Planning SA will be in a position to provide revised projections for the State and for specific areas, such as the southern area of Adelaide. This updated information will then be integrated into the Seaford rail line extension investigation.

ESTIMATION

7 SERVICE OPTIONS CONSIDERED DURING THE EVALUATION

The actual train and bus services that would run on the extended alignment have not yet been defined in detail and it has been necessary to make some assumptions in order to produce passenger demand forecasts for the analysis. The base and project case options for the analysis are described below; the actual timetable and service pattern is likely to be different from what is assumed in this analysis.

These assumed service options form the basis for the derivation of operating costs to compare each option and are dependent upon assumptions made about restructuring of existing bus services in the area following the introduction of the extended train service to Seaford.

Rail services are based upon the existing timetable (March 2006). The changes to the patterns of bus services are shown in Appendix F.

7.1 Existing situation

The existing situation includes the Noarlunga to City train at March 2006 levels of service, which is timetabled at an average frequency of 10 minutes during the am and pm peaks and a 20-minute frequency during the interpeak. The existing bus service throughout the appraisal period is the March 2006 timetable for bus services in Metropolitan Adelaide.

7.2 Specification of future rail services to Seaford

The forecast for demand for public transport in MASTEM uses the population projections for the outer south, which are based upon the *South Australia's Strategic Plan* target of increasing the population of South Australia to two million by 2050.

To meet this demand the supply of public transport services has been evaluated based upon minor changes to bus services in the Seaford area which are listed in Appendix F, and the extension of rail services to Seaford.

Future scenario for the delivery of public transport services in the outer south

The future scenario for a rail service to Seaford is based upon existing rail timetables. Over the appraisal period it is assumed that there is no major change in the supply of rail and bus services with the provision of public transport services remaining unchanged as at March 2006.

Base case: The Noarlunga to Adelaide rail service runs at the existing timetable (as at March 2006) with modifications to the frequency of the existing bus feeder services into Noarlunga Centre as detailed in Appendix F. The assumed capital and recurrent expenditure follows the historic pattern of investment over the past ten years on rail infrastructure. Travel time along the Noarlunga to Adelaide rail line is currently affected by speed restrictions. Without intervention, further speed restrictions would result in increased travel times that may lead to reduced performance of rail services.

The base case will be varied to assess the sensitivity of the results with the completion of concrete re-sleepering on the Noarlunga rail line, which then provides quicker train running speeds between Noarlunga and Adelaide.

Project case: The project case is the extension of the rail service defined in the base case extended to Seaford. The Noarlunga Rail line is extended to Seaford with two additional stops, approximately 1.5 kilometres apart, one located at Seaford Meadows and the terminus located at Seaford. The performance along the Noarlunga to Adelaide rail line is expected to fall as outlined in the base case. The details of bus feeder services within Seaford and Seaford Meadows are shown in Appendix F.

7

The factors varied in MASTEM to test the base and project cases are shown in Table 5.

Table 5 Summary of the factors varied in MASTEM for the base and project case

	Scenario		
Factor	**Existing Situation**	**Base Case**	**Project Case**
Rail services	Existing timetable March 2006	Existing timetable March 2006	Extend rail service to Seaford with March 2006 timetable.
Bus services	Existing timetable March 2006	Minor improvement to bus frequency along existing routes and Seaford rail stations.	Minor improvement to bus frequency and routes to feed into Seaford Meadows.
Population	Actual as at March 2006	2 million by 2050 (SASP T1.7)	2 million by 2050 (SASP T1.7)
Road improvements	As at March 2006	South Road	South Road
MASTEM snapshot	2006	2018 & 2031	2018 & 2031

7.3 Sensitivity testing

A discount rate of four per cent and 10 per cent will used to test the performance of options against changes in the value of costs and benefits over time.

The capital cost will be varied by testing the lower and upper bound of the range estimate and upper bound estimate for an option with a double track viaduct and bridge over the Onkaparinga Valley.

The base case will be varied to assume that concrete re-sleepering of the Noarlunga rail line has been completed, which then provides quicker train running speeds between Noarlunga and Adelaide.

The capital and operating expenditures needed over the appraisal period to provide faster train services between Noarlunga and Adelaide is assumed to have been spent and is not quantified in this analysis because the cost is assumed to exist in the base and project case.

OPTIONS

8 RESULTS OF THE EVALUATION

8.1 Capital costs

Non-commercial transport projects such as road construction and public transport initiatives generally are not able to provide a financial rate of return, as many of the benefits that arise from the initiative are not able to be financed. The South Australian Government would need to pay all capital and operating costs of the project as they emerge.

8.1.1 Cost of infrastructure

The range estimate for the cost of infrastructure has been based upon a cost estimate undertaken by an independent estimator, which provided the costing methodology and unit rates derived from similar work undertaken in Australia.

The 2007 range estimate for the cost of infrastructure associated with the 1980s alignment is between $136 million and $175 million and is presented in Table 6. The range estimate the alignment with a double rail track over the Onkaparinga Valley is between $170 million and $215 million.

The range estimate for the Westerly Alignment with a single rail track over the Onkaparinga Valley is between $156 million and $195 million.

The assessment of 'on costs' has relied on previous estimates and the 'contingency' of 40 per cent applied to the estimated direct cost for the unit rates is considered reasonable at the concept stage.

Table 6 Estimate for the cost of infrastructure

Item	Base case	1980s alignment $ millions (2007 prices)	CofO Westerly Alignment $ millions (2007 prices)
On Costs			
Project management, project planning and design	-	14.8	14.8
Direct Costs			
Services relocation	-	2.5	2.5
Land acquistion and property modification		2.5	27.6
Civil works		19.8	18.0
Viaduct and bridge over Onkaparinga Valley		38.5	29.4
Grade separation bridge works		13.2	13.2
Terracing and crib walling within corridor		2.9	7.2
Landscape		0.9	0.9
Rail track, signalling and communications		26.6	28.4
Stations		14.6	14.6
Electrification		-	-
Contingency			
Contingency 40% (direct/on costs included in the above rates)		-	-
Most Likely Total Project Cost		**136.2**	**156.5**
P90 estimate		**171.9**	**195.0**

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There are a number of uncertainties and there is a low level of confidence in the accuracy of a number of unit rates. These uncertainties exist because either the unit rate is speculative in nature or because design attributes have yet to be fully defined and the estimator cannot fully quantify their impact because of lack of information or because their likelihood of occurring cannot be ruled out.

The P90 value has been derived from the range in cost items within the estimate and represents a 90 per cent probability that the estimate will be within the range estimate. This means that there is a 10 per cent probability that the P90 figure will be exceeded because of these uncertainties.

The P90 value has been used in this appraisal.

Further planning and design work is required to quantify the extent of road works, to fix the horizontal and vertical alignment and to develop preliminary cross sections within the rail corridor.

Preliminary bridge design and geotechnical information is required to remove the uncertainties associated with the type of structure and foundations needed for the viaduct and bridge over the Onkaparinga Valley and their costs.

8.1.2 Track renewal and replacement

Track renewal and replacement costs will not be incurred during the appraisal period. The economic life of rail track infrastructure is estimated to be 60 years and any major renewal or replacement cost is assumed to be in the latter half of its economic life and is outside the appraisal period.

The economic life of the rail viaduct and bridge over the Onkaparinga River is estimated to be 100 years and is expected to have some major specific maintenance during the appraisal period; for example cleaning, sandblasting and painting exposed steel work, replacing deck joints and bearings or repairing corroded reinforcement and spalling concrete. These repairs are expected to be toward the end of the appraisal period. This analysis assumes any specific viaduct and bridge maintenance will be 20 per cent of the initial capital cost of the viaduct and bridge and will occur at year 25 during the appraisal period.

Track and routine viaduct and bridge maintenance costs have been included in the estimate for train operating costs.

8.1.3 Train consist size and refurbishment costs

The train consist size required to meet the expected passenger demand is estimated by consideration of the train consists needed to provide the service schedule and the demand for the services in the morning peak which establishes the train size. The determination of fleet size is based on the following assumptions:

- Train consists required to meet the schedule have been estimated by Plateway using the OpenTrack simulation software.
- MASTEM patronage estimates.
- The current peak loading figure (arrivals at Adelaide Railway Station between 8 am and 9 am) is 12.2 per cent of daily boardings[4].
- Railcars have a planning load capacity of 130. A contingency of 25 per cent is applied to the train size.

The estimate of consist size and total train fleet is shown in Table 7.

[4] Based on 2005 DTEI patronage surveys.

The estimated cost for each new rail car has been taken from recent rail car purchases elsewhere in Australia with the life of a rail car assumed to be 35 years with a refurbishment at year 20.

Extending rail services to Seaford at current timetables will require an incremental increase of 14 rail cars at an estimated total cost of $56 million. The derivation of the cost of the total rolling stock and refurbishment for each option is shown in Table 8, the lead time for delivery of new rolling stock may be up to five years.

8.1.4 New buses and refurbishment costs

The base case has been derived assuming that the bus network will be maintained and developed in the outer south to meet the demand from an increase in the population.

The fleet size is expected to increase by four vehicles from the existing situation as at March 2006 to the base case to meet the additional route kilometres and frequency outlined in Appendix F. Through modifications to frequency and rerouting of services, the project case does not require any additional bus vehicles over the base case.

Table 7 Estimate of consist size and total train fleet

	Train Consists	AM Peak Boardings arriving at Adelaide Railway Station (8am to 9am)	Trains arriving at Adelaide Railway Station (8am to 9am)	Average Train Loading	Average Consist Size	Maintenance Allowance	Railcar Fleet Size
	(a)	(b) = MASTEM *0.122	(c)	(d)=(b)/(c)	(e) = (d)/130*1.25)	(f)	(a)*(e)*(1+(f)
base case							
Rail Service to Noarlunga	47	3,985	24	166	1.6	10%	83
project case							
Extend Rail Service to Seaford	49	4,475	24	186	1.8	10%	97

Table 8 Estimate of costs for new rolling stock and refurbishment

	Incremental change in fleet size	Traction	Unit cost of rail car	Total cost of rolling stock	Unit cost of rail car refurbishment	Total cost of rolling stock	Year of refurbishment
	Number		$ Million	$ Million	$ Million	$ Million	Number
	a	b	c	d=a*c	e	f=a*e	g
Extend rail service to Seaford	14.0	diesel	4.00	56.00	1.00	14.00	20

A bus vehicle cost of $750,000 per unit is assumed with a mid-life refurbishment every seven years estimated to be 30 per cent of the initial capital cost with a new replacement bus vehicle every 15 years.

8.2 Operating costs

8.2.1 Rail operating costs

Operating costs for the extension of rail services to Seaford are net changes in the cost of operating the proposed rail service to Seaford.

Table 9 Operating costs: extension of rail service to Seaford

OPERATING COSTS Item	SEAFORD $ million pa
Frequency (peak / interpeak) minutes	10/20
Incremental increase in railcar kms/yr	1,000,000
Incremental increase in train kms/yr	181,000
Train operations	2.85
Track and station maintenance	0.5
Sub total direct costs	3.35
Incremental increase in overhead	0.00
Incremental increase in train operating costs	**3.35**

The project case assumes that the current timetable for Noarlunga to Adelaide rail services will be extended to Seaford.

The additional rail services required on the extension to Seaford will have implications for TransAdelaide in terms of the number of staff required, energy and infrastructure and vehicle maintenance.

The estimates in this analysis are based upon a simplified operating cost methodology that is used by DTEI and TransAdelaide to estimate the effects of strategic network modifications and are indicative only and do not represent the actual net change in train operating costs but are considered sufficiently accurate to compare the cost of various operating scenarios for a train extension to Seaford.

8.2.2 Incremental change in bus contract payments

As outlined in 8.1.4, through modifications to frequency and rerouting of base case bus services the project case does not require any additional bus vehicles kilometres over the base case.

The reduction in vehicle depreciation, overhead and bus vehicle maintenance has not been quantified and is assumed to be small.

8.3 Residual value

The evaluation period has been selected at 30 years. The residual value represents the anticipated new benefit accruing over the remaining asset life and represents a proxy for its market price at year 30 of the appraisal period.

Table 10: Residual values (1980s alignment): key assets

Asset	Capital Cost $ Million	Economic life	Life at end of appraisal period	Residual value $ Million
Track	108.1	60	27	54.05
Viaduct and bridge	28.1	100	27	19.67
Bus	0	15	0	0
Train	56.0	35	27	11.2

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8.4 Revenue

8.4.1 Net additional revenue

Projections for an increase or decrease in revenue were estimated from the net change in total passenger boardings using MASTEM forecasts of the changes in public transport demand within the metropolitan area as a consequence of the Noarlunga rail extension to Seaford.

The estimated revenue to government is $1.36 (2007 prices) per trip which recognises that a significant proportion of public transport users are concession card holders and do not pay the full fare price of $2.50 (2006 prices). The predicted annual ticket revenue is approximately $2 million and is derived in Table 10.

8.4.2 Incentive payment to contractors

The current contractual arrangements with public transport service providers include an additional incentive payment that is related to the number of boardings. The reduced need to pay an incentive payment to bus contractors has been calculated by using the MASTEM demand forecast which predicts a decrease in bus boardings in the metropolitan area compared to the base case. This incentive payment to bus contractors has been assumed to be an average over the metropolitan area of $0.99 per boarding (2007 prices) which totals $0.94 million per annum. The derivation is shown in Table 11.

Table 11 Predicted revenue

Option	Incremental change in public transport trips derived from MASTEM					Incentive payment to bus contractors				
	Demand / weekday	Expansion factor[1]	Demand	Ticket revenue	Cost	Demand / weekday	Expansion factor	Demand	Unit Cost	Cost
	Trips/weekday	number	trips/yr	$/trip	$/annum	boardings/ weekday	number	Bus Boardings/yr	$ /vkm	$/annum
	a	b	c=a*b	d	e=c*d	a	b	c=a*b	d	e=c*d
Extend rail services to Seaford	5,309	280	1,486,520	1.360	2,021,073	-3,402	280	-952,560	0.990	-943,034

[1] Expansion factors are needed to derive annual benefits from weekday data. The DTEI Triple Bottom Line appraisal process recommends an expansion factor of 280 derived from 251 annual working days factored by 89% of the annual traffic occurs during these working days (251/0.89).

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The incentive payment for the rail system is a transfer benefit between government agencies and has not been included in the cost estimates because it is assumed that it has been used to fund additional rail operating expenditure.

8.5 Disruption costs

The construction period is expected to be 18 months and works will mostly be contained within the existing rail corridor land with minimal impact on road traffic.

8.6 Journey times

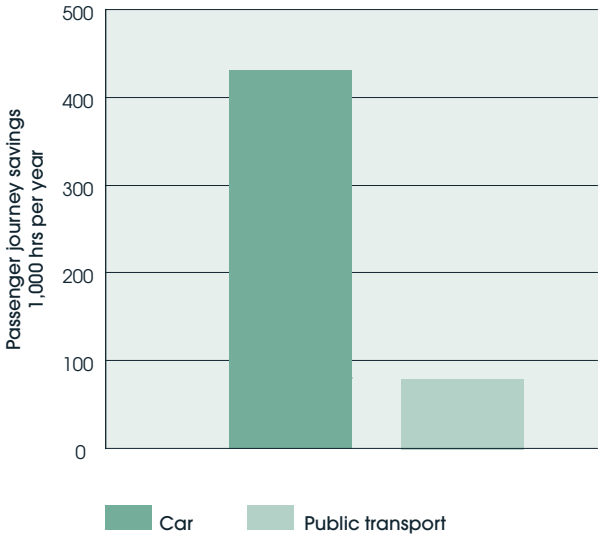
8.6.1 Journey time savings to existing public transport users

Journey time is an important element in the analysis of new transport schemes. From the supply side, the objective of most transport schemes is to improve accessibility and reduce journey times, while from the demand side, the main journey attributes from the traveller's point of view are cost and time.

The plot shown in Figure 6 demonstrates the size of the public transport journey time savings that would be achieved in the outer southern area of Adelaide.

Providing a rail service to Seaford with frequent bus feeder services at Seaford Meadows and at Seaford stations would reduce public transport travel times by up to 80,000 passenger hours and reduce car passenger travel times by up to 400,000 passenger hours because of projected net reductions in highway use that arise from a mode shift away from car use to public transport.

Figure 6 Journey time savings to existing public transport users



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8.6.2 Journey time benefits to diverted and generated public transport users

Although the majority of passengers on the new rail service between Seaford and Adelaide would be existing public transport users, extending the rail services to Seaford and linking it with feeder buses is forecast to generate an additional 1.5 million public transport trips per annum (5,300 additional weekday trips) created largely due to car drivers and passengers switching to public transport. In terms of trips the rail extension will generate up to a 2.3 per cent increase in new public transport trips because of the new Seaford rail service of which 2.2 per cent would transfer from car and 0.1 per cent would be newly generated transport trips. If the base case is varied to assume that concrete re-sleepering of the Noarlunga rail line has been completed, which then provides quicker train running speeds between Noarlunga and Adelaide, then the rail extension would generate up to a three per cent increase in new public transport trips. The majority of these new public transport trips would transfer from car travel.

The calculation of benefits to new users should reflect the fact that they have transferred from other routes or modes, or represent generated demand. Economic theory suggests that their benefits should represent approximately half of the benefit to each existing user (the "rule of a half")[5]. These benefits are detailed in Table 12.

Figure 7 Origin of transport passengers on the new Seaford to Adelaide rail service

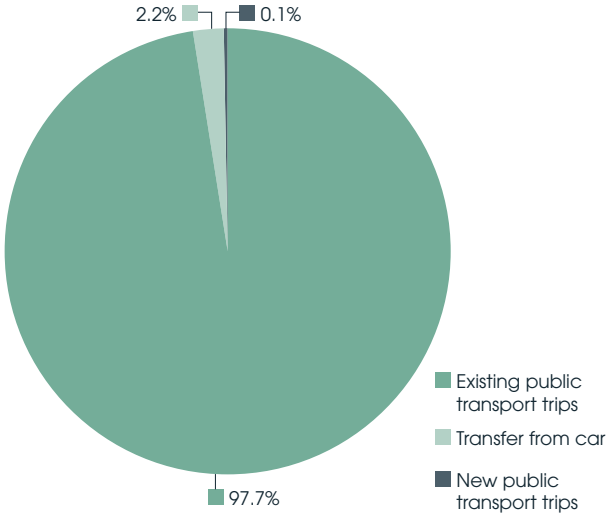
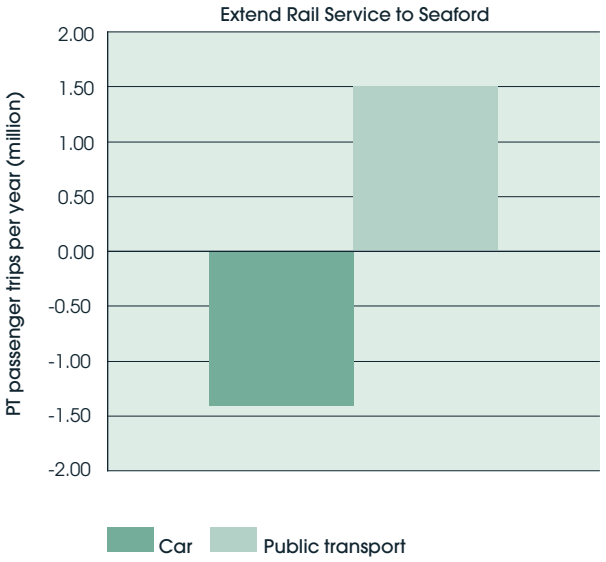


Figure 8 Change in overall demand (trips)



RESULTS

[5] Economic theory suggests that, for small changes, benefits to new users should represent approximately half of the benefit to each existing user (the "rule of a half").

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Table 12 Journey time benefits associated with those people who use public transport

Description	Existing Public Transport Users								
	Number of users before commencement of new rail service[2]	Anticipated growth in existing public transport system per weekday	Total passenger trips per weekday	Expansion factor[4]	Total passenger trips per year	Time saving per trip	Time saved for existing users	Value of Time[1]	Monetary value to existing users
	Pass Trips / weekday	Pass Trips / weekday	Pass Trips weekday	Number	Pass Trips (1,000's)	Minutes	hrs/year 1000's	$/hr 2006	$/annum 2006
	a	b	c=a+b	d	e=d*c/1000	f	g=e*f/60	h	i=g*h
Extend Rail Services to Seaford	224,321	3,656	227,977	280	63,833	0.0755	80.29	11.15	895,319

Description	New Users									
	Former Car drivers and passengers switching to public transport[2]	Number of generated passenger trips per weekday	Total diverted or new passenger trips per weekday	Expansion factor[4]	Total passenger trips per year	Time saving per trip	Time saved for new users	Value of Time[1]	Rule of a Half[3]	Monetary benefit new users
	Pass Trips / weekday	Pass Trips / weekday	Pass Trips weekday	Number	Pass Trips (1,000's)	Minutes	hrs/year 1000's	$/hr		$/annum
	a	b	c=a+b	d	e=d*c/1000	f	g=e*f/60	h	i	j=g*h*i
Extend Rail Services to Seaford	5,038	271.00	5,309	280	1,486	0.0755	1.87	11.15	0.50	10,424.82

Notes

1 The value of time is from DTEI Triple Bottom Line appraisal process where the generalised cost of travel $10/hr, taken from the Australian Transport Council National Guidelines for Transport System Management in Australia (2006), has been weighted for peak hour travel on public transport. The unit value used in this analysis is $10.8/hr 2006 prices and has been inflated to 2007 prices.

2 Car passenger trips derived from MASTEM.

3 The calculation of benefits to new users should reflect the fact that they have transferred from other routes or modes, or represent generated demand. Economic theory suggests that, for small changes, their benefits should represent approximately half of the benefit to each existing user (the "rule of a half ")..The rule of a half has only been applied to former car drivers and former pedestrians. It has not been applied to diverted public transports users.

4 Expansion factors are needed to derive annual benefits from weekday data. The DTEI Triple Bottom Line appraisal process recommends an expansion factor of 280 derived from 251 annual working days factored by 89 per cent of the annual traffic that occurs during these working days (251/0.89).

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8.6.3 Improved quality of station facilities and rolling stock

The investment in new station facilities and new rail rolling stock will benefit passengers by making it easier to access public transport through new park and ride facilities and make it easier to change from bus to train.

Generic values for infrastructure and vehicle features are provided in Australian Transport Council National Guidelines for Transport System Management in Australia (2006). Because of the uncertainty at this time surrounding the use of these values with outputs from MASTEM these benefits have not been monetised.

8.7 Resource corrections

Australian Transport Council National Guidelines for Transport System Management in Australia (2006) provide the following guidance on how to derive resource corrections.

If travellers based their travel decisions on the resource cost of their travel, the user benefits estimated above would also fully record the benefits arising from the shift to public transport. In practice, this will not often be the case because, for example, the presence of taxes and subsidies make it difficult for travellers to correctly perceive the resource cost of their travel. Accordingly, an adjustment is required to take account of the full resource value of the benefit that occurs when people transfer from another mode to public transport. This adjustment, which is known as a resource correction, reflects the difference between the benefit based on the perceived cost of travel (recorded in derivation of journey times above) and the benefit based on the resource cost of travel.

Where the resource cost of travel is greater than the perceived cost, the resource correction will be an additional benefit. Where the perceived cost is greater than the resource cost, the resource correction will be a disbenefit (that is, a negative benefit). Thus, the general formula for the resource correction will be as follows:

Benefit due to under-perception of resource costs = (resource cost of travel – perceived cost of travel) multiplied by the quantity of travel.

The resource corrections used in this analysis are those associated with unperceived vehicle operating cost, road decongestion costs and road maintenance costs.

8.7.1 Benefits to car drivers who shift to public transport

In the case of car drivers who shift to public transport, there are further benefits to be taken into account because of the misperception of resource costs by motorists. These additional resource savings include reduced car vehicle operating costs.

Resource savings in vehicle operating costs that are not perceived include items such as the gap between the financial and resource cost of fuel, and the resource cost of most other items that are a function of vehicle use such as tyres, maintenance and a share of vehicle depreciation. Some of these effects will partially offset one another; for example, motorists over-perceive the cost of fuel because the financial price includes taxes, but under-perceive costs such as tyres that are incurred only occasionally. The resource correction will be a benefit equal to:

Car-kilometres of reduced vehicle use multiplied by (resource cost of car travel per kilometre – perceived cost of car travel per kilometre).

The unperceived car operating costs associated with car drivers who switch to public transport are shown in Table 13.

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Table 13 Unperceived car operating costs

Option	Mode	Incremental change change in number of car vehicle kms derived from MASTEM	Expansion Factor 1	Incremental change in number of car vehicle kms per annum	Change in unperceived car vehicle operating costs	
					Unit Cost	Cost
		Total weekday daily vehicle kms	Number	Total car vehicle kms per annum	$/vkm	$/annum
		a	b	c=b*a	d	e=c*d
Extend Rail Services to Seaford	Car	-107,839	280	-30,194,787	0.05	-1,402,980

Notes

[1] Expansion factors are needed to derive annual benefits from weekday data. The DTEI Triple Bottom Line appraisal process recommends an expansion factor of 280 derived from 251 annual working days factored by 89 per cent of the annual traffic occurs during these working days (251/0.89).

8.7.2 Benefits to motorists who remain on the road system

In this appraisal a shift of a car passenger to public transport is considered significant and would result in less car use for passengers travelling to and from the outer south of Adelaide. Congestion costs are assumed to apply to car and bus travel within peak periods. The methodology used to estimate the `decongestion' benefits for remaining motorists associated with some car users switching to public transport is to derive the quantity of road traffic that will be removed from the road system and the change in value of travel time for car passenger trips from MASTEM.

Conventional economic theory suggests that the benefit from a reduction in road traffic to motorists who continue to use the road network is reduced by a half to take into account that additional traffic will make use of the road space made available by the diversion of trips to public transport. MASTEM predicts some of the effects of induced traffic but to what degree is uncertain at this stage. The analysis has assumed that no adjustment for induced traffic is required.

The journey time benefits associated with those people who continue to travel by private car is given in Table 14.

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Table 14 Journey time benefits associated with those people who continue to travel by private car

Description	Car passenger trips remaining on road network [2]	Expansion factor [4]	Total remaining passenger trips per year	Change in travel for car users: Time saving per trip	Change time for car pass	Value time [1]	Adjustment for induced road traffic [3]	Monetary benefit new users
	Pass Trips 1,000s	Number	Pass Trips (1,000s)	Minutes	1000s hrs/year	$/trip		$/annum 2006
	a	b	c=a+b	d	e=c*d/60	f	g	h=e*f*g
Extend Rail Services to Seaford	3,084,145.00	280	863,560.60	0.0300	431.78	15.49	100%	6,687,500.28

Notes

[1] The value of time is from DTEI Triple Bottom Line appraisal process where the generalised cost of travel $10/hr, taken from the Australian Transport Council National Guidelines for Transport System Management in Australia (2006), has been weighted to account for the greater amount of business travel on roads compared to public transport. The unit value used in this analysis is $15/hr 2006 prices and has been inflated to 2007 prices.

[2] Car passenger trips derived from MASTEM.

[3] Conventional economic theory suggests that the benefit from a reduction in road traffic to motorists who continue to use the road network is reduced by a half to take into account that additional traffic will make use of the road space made available by the diversion of trips to public transport. MASTEM predicts some of the effects of induced traffic but to what degree is uncertain at this stage. The analysis has assumed that no adjustment for induced traffic is required.

[4] Expansion factors are needed to derive annual benefits from weekday data. The DTEI Triple Bottom Line appraisal process recommends an expansion factor of 280 derived from 251 annual working days factored by 89 per cent of the annual traffic that occurs during these working days (251/0.89).

8.7.3 Avoided road damage

The reduction in the number of buses travelling on the roads corresponds to a reduction in the wear and tear of the road asset. The supply of bus services is based upon minor changes to bus services. .Bus kilometres are based upon the specific changes within the outer southern area of Adelaide to bus routes and bus frequencies derived from MASTEM.

The avoided road damage from the reduction of buses on the road network has been estimated from research undertaken by Austroads in estimating the unit cost of road wear for specific vehicles[6]. The reduction in the number of bus vehicle kilometres on the metropolitan network is very small. The base case assumes that bus services will increase route kilometres to cater for demand in the outer south as the population increases. The project case assumes that the base case bus services will be re-routed to feed into Seaford. The net effect is that there is no change in the number of bus vehicle kilometres on the metropolitan network between the base and project case.

8.8 Transit oriented development andland use

8.8.1 Benefits of a TOD

Investment in a rail extension to Seaford provides the opportunity to encourage a more sustainable form of land use. Transit-Oriented Development (TOD) at the proposed new stations at Seaford Meadows and at Seaford have the opportunity to develop synergies between the bus/rail system and the built form and provide the opportunity to develop significant amounts of both affordable and high-needs housing.

The market will generally provide the sort of accommodation for which there is the greatest demand, typically low density residential development. With rail services to Seaford there are opportunities to develop intense and diverse development around the Seaford Meadows and Seaford stations which provide the benefits of higher density transit oriented developments.

[6] *Estimates of Unit Road Wear Costs* Binh Vuong & Chris Mathias ARRB Transport Research, page vi.

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The source of benefits from TOD-style neighbourhoods adjacent to the Seaford Meadows and Seaford Stations are:

1. Increasing density will increase the population within the catchment area for the Seaford Meadows and Seaford Stations. This benefit is valued in terms of journey times savings to people who use the r ail service.
2. Urban consolidation benefits are estimated as the net savings in housing and associated infrastructure cost from higher density TOD-style of development at Seaford Meadows and at Seaford as proposed to development on the fringes of the outer southern areas of Adelaide. This benefit has not been monetised because no market takeup analysis has been undertaken to determine if the changes are real increases and not movements from one area to another, such as an increase in development in Seaford at the expense of Noarlunga.
3. The property price uplift attributable to new rail extensions and TOD developments. There is a body of research that proposes that fixed rail systems provide a scale of investment that may have identifiable impacts on land values over time compared to bus-based systems, which are less likely to have any measurable impact.

   This research proposes that new or improved fixed rail systems increase land values which reflect the pressure for development within the vicinity of fixed rail systems and that these can be considered a value-added benefit additional to the journey time benefits accruing from a new rail system.

   The principal component of transport benefits is travel time savings to the users of the system. These benefits have secondary benefits for employers as their labour market areas can be extended and for employees who now have a wider range of jobs available within a given time constraint. There are also increased catchment areas for all types of services and facilities (such as schools, shops and leisure facilities).

There is a debate about potential double-counting of the benefits of a proposed investment. Conventional transport cost benefit analysis already values the benefit of time savings as a result of transport improvements (especially for road schemes). This benefit influences property market values, and so care is needed not to include benefits from a TOD scheme to be both travel time changes and land value enhancements. This benefit has not been monetised because of the debate about double counting the benefits.

4. Reduced levels of car ownership for people residing in a TOD-style neighbourhood. This item has been monetised.

8.8.2 Potential for TOD-style neighbourhoods

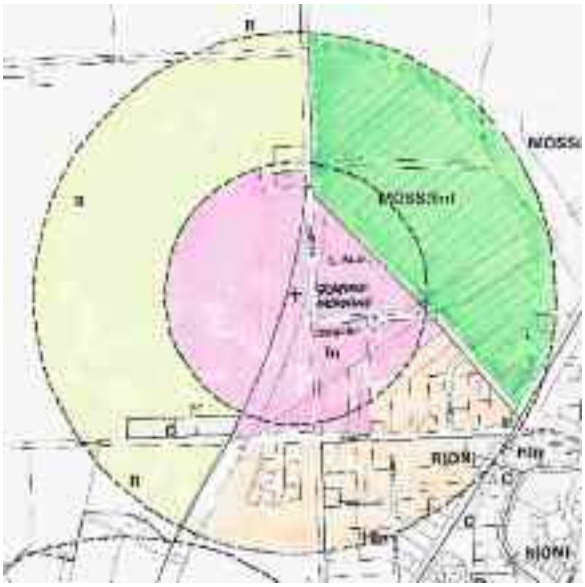
Developers will need to risk investing in mixed-use, higher densities and lower than normal levels of car parking provision to develop transit-oriented developments at Seaford Meadows and Seaford.

The potential for a TOD-style development around each station is outlined below.

Seaford Meadows

Seaford Meadows is a 'greenfield' site, with minimal existing development within 400 metres of the proposed station location. The area of land that would be available for development is estimated to be 22 hectares, or 44 per cent of the catchment. The remaining portion of the catchment is zoned Industry and Metropolitan Open Space System (Environmental). As the land is largely undeveloped there is a possibility that the residential portion of the catchment may be extended both sides of the rail corridor up to the Sauerbiers Road alignment. This would increase the catchment to 50 per cent of the 400metre radius, or 25 hectares.

Figure 9 The 400m and 800m catchment for the Seaford Meadows and Seaford stations



Seaford Meadows – 750 dwellings proposed.

Seaford – 518 dwellings proposed.

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Based on an assumed gross residential density of 30 dwellings per hectare (for a transit-focussed neighbourhood type TOD) this would enable a total of 750 dwellings to be accommodated within the TOD residential zone (30x25). Seventy five (10 per cent) could be affordable dwellings and 37 (five per cent) high-needs dwellings.

Seaford

Seaford District Centre is an established commercial centre about 20 years old. The existing centre incorporates a medium-sized shopping centre, public and private primary and high schools, recreation centre, library, churches, and health centre. Based on a catchment radius of 400 metres, the area of vacant land that would be available for residential development is estimated to be 10.35 hectares. The density of the existing residential zone is 13 dwellings per hectare.

Its higher status as a district centre may be able to promote a gross residential density of up to 50 dwellings per hectare for a TOD at Seaford, giving a total potential of 518 dwellings on the vacant land (50x10.35). Fifty two (10 per cent) would be affordable dwellings and 26 (five per cent) high-needs dwellings.

Whilst this proposed density might seem ambitious, including a larger portion of the LMC land beyond the 400 metre-radius boundary could offset a reduced density on the smaller allotments closer to the existing developer areas. The LMC land is presently zoned Industry, and any residential development on that land would require a rezoning.

8.8.3 Station spacing

The Seaford Meadows station is only 1.5 kilometres from the Seaford terminus. Removing the Seaford Meadows station or investigating other options to space stations so that quicker transit running times can be achieved, may make the service more attractive and attract more passengers.

Spacing between stations is a balancing act. The stations need to be close enough to be easy to reach from many areas in the outer south either by walking or travelling a short distance by bus. However, there is a need to keep the train moving along on the line, since stopping too often will make the trip a slow one and the service will be less attractive for passengers.

Remove Seaford Meadows:

Removing the Seaford Meadows Station, which is located in a hollow, provides shorter and a more reliable transit time between Noarlunga and Seaford by not requiring trains to both brake and accelerate out of the station against the grade in both directions. There is possibly some advantage, from a public transport perspective, that higher transit speed on the Seaford to Adelaide rail service would attract additional patronage. Buses would service the Seaford Meadows development and feed passengers into the Seaford Terminus.

Removing the Seaford Meadows Station would reduce walking access to the rail service and reduce the opportunity to develop TOD-style neighbourhoods. The Seaford terminus becomes the main train loading point for the outer south and there may not be sufficient car parking to cater for a growing public transport demand and the terminus may become congested with feeder buses.

A Seaford Meadows station may be preferred by developers who have the opportunity to develop TOD-style neighbourhoods that provide high density and premium developments close to and within easy walking distance of the Seaford Meadows station.

Relocate Seaford terminus to Seaford Heights:

There is possibly some benefit in retaining the Seaford Meadows station and relocating the Seaford terminus to Seaford Heights. The stations would then be 2.75 kilometres apart allowing shorter transit time

between stations. The Seaford Heights terminus would be located adjacent to the large greenfield residential site of Seaford Heights.

This proposal has the advantage of stations being located adjacent to two large residential catchments of Seaford Rise and Seaford Heights which are within easy walking distance to rail services. There is potential to develop TOD-style neighbourhoods at Seaford Heights, which is a greenfield site, close to the rail terminus, further increasing the potential catchment for rail services.

Relocating the terminus to Seaford Heights would require an additional 1.75 kilometres of rail track in a rail corridor that is under the ownership of the Minister for Transport. This increases the scope and cost of the proposal and wouldl reduce the economic result unless rail and bus services can attract more patronage through higher frequency services and quicker train running times along the Seaford to Adelaide rail corridor and /or the population catchment exceeds estimates.

These benefits remain speculative in that no analysis or modelling has been undertaken to quantify the effects of removing the Seaford Meadows Station or relocating the Seaford Terminus to Seaford Heights.

Seaford Meadows Master Plan

Land SA, the developer for Seaford Meadows, will prepare a Master Plan for its proposed development, which in turn will inform a review of the Structure Plan with the City of Onkaparinga. DTEI understands that Land SA has developed two master plans for Seaford Meadows: one that assumes that a railway station is built with development allowing for bus access to the station and a TOD-style neighbourhood with higher residential densities near the station, the other Plan assumes that there is no station and no TOD-style neighbourhood and is developed with standard street arrangements. Developers may require a decision from the Government on the determination of station at Seaford Meadows within the next four years.

8.8.4 Avoided car ownership

Avoided car trips are determined from MASTEM and are assumed to be mostly from people moving into newly developed areas around Seaford Meadows and Seaford who choose not to rely on car travel or choose not to buy a second car because of the close proximity to rail services and connecting bus services. It is more likely that these people would go without either the purchase of a new car or a second vehicle. The second vehicle will most likely be older than the average age of the total vehicle fleet. ATC 2006[7] states that about half of vehicle depreciation is linked to the distance travelled by a vehicle, and is recorded in the resource cost of car use – the other half of vehicle depreciation is related to time, that is, the age of the vehicle. Hence, the additional resource benefit from the reduced need for car ownership, mostly based upon the older second vehicle, is about $1,550 per vehicle saved and this benefit is a once only benefit included in the year in which the new rail service to Seaford commences.

The unit saving due to a reduced need for car ownership is usually equal to half the benefit accruing to a former car driver who is able to avoid ownership of a car when they shift to public transport. The evaluation is shown in Table 15.

8.8.5 Integration with land use plans

The proposed changes in the Onkaparinga City Development Plan are supportive of a proposal to extend the Noarlunga rail line to Seaford and enable an opportunity to integrate land use and transport planning. The potential extension of the rail line to Seaford from Noarlunga Centre provides an opportunity to incorporate a transit-focused development as part of the overall development of Seaford Meadows. The proposed structure plan identifies such an area and policies should support increased densities, a greater variety and flexibility in dwelling forms and mixture of land use.

[7] Australian Transport Council (ATC) 2006, *Transport System Management in Australia*, Volume 4 Urban Transport.

Table 15 Evaluation of avoided car ownership

Option	Mode	Total car vehicle trips per weekday	Expansion factor[2]	Total car vehicle trips per annum	Incremental change in number of car vehicle trips derived from MASTEM	Expansion factor	Total change car vehicle trips per annum	Per cent reduction on number of trips	Number of cars owned in Adelaide Metropolitan Area[1]	Potential reduction in car ownership	Unit cost per vehicle saved	Per cent of potential reduction in car ownership that cannot be avoided	Total cost of avoided car ownership after year of commencement
		Total vehicle trips per weekday		Total vehicle trips per weekday 1000s	Total vehicle trips per annum		Total vehicle trips per weekday 1000s	Per cent	Number	Number	$/ESA vkm	Per cent	
		a	b	c=a*b/1000	d	e	f=d*e/1000	g=f/c	h	i=g*h	j	k	l=i+j+k
Extend Rail Services to Seaford	Car	3,089,183	280	864,971	-5,038	280	-1,411	-0.16%	689,043	-1,124	1550	50%	-870,888

Notes

[1] Number of car vehicles on the register as at 30 June 2006: refer to DTEI (2006) *Annual Report 2005-2006 Department for Energy and Infrastructure*, Government of South Australia.

[2] Expansion factors are needed to derive annual benefits from weekday data. The DTEI Triple Bottom Line appraisal process recommends an expansion factor of 280 derived from 251 annual working days factored by 89 per cent of the annual traffic occurs during these working days (251/0.89).

Table 16 Evaluation of road crashes

					Fatalities				Casualti				
Option	Mode	Incremental change in number of vehicle kilometres travelled derived from MASTEM	Expansion factor[5]	Change in number of vehicle kilometre per year	Casualty rates[1]	Change in number of accidents per annum	Value/ accident[2]	Value/ annum	Casualty rates[2]	Changes in number of accidents per annum	Value/ accident[2]	Value/ annum	Monetary value road crashes
		Total vehicle kilometres per annum		Total vehicle kilometres per annum	per 100 million vkms[1]	Number	$/accident 2006 prices	$/t[2] 2006	per 100 million vkms	Number	$/accident 2006 prices	$/t[2] 2006	$/annum
		a	b	c+a+b	d	e=c/d* 100 mill	f	g=e*f	$/h	i=c/h* 100 mill	j	k=i*j	l=k+g
Extend rail services to Seaford		-107,838.5	280	-30,194,787	1.04	-0.31	1,871,841.4	-587,806.4	60	-18.12	115,927.4	-2,100,242.0	-2,688,048.5

Notes

[1] Refer to Table 7 *Road Fatalities Australia* 2002 Statistical Summary.

[2] Refer to Austroads (2004) Table 12 updated to August 2004 using ABS average weekly earnings index.

[3] Figure derived from CASR 2004, "Trends in traffic casualties in South Australia 19981-2003", The University of Adelaide.–South Australia.

[4] Estimated casualty crash cost derived from from Austroads (2005).

[5] Expansion factors are needed to derive annual benefits from weekday data. The DTEI Triple Bottom Line appraisal process recommends an expansion factor of 280 derived from 251 annual working days factored by 89 per cent of the annual traffic occurs during these working days (251/0.89).

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8.9 Road crashes

8.9.1 Fatality and casualty crashes

The contribution of the extension of the Noarlunga Rail line to Seaford to reducing accidents has been calculated by deriving unit crash cost information for fatal crashes and casualty crashes and then combining them with estimates of crash numbers, themselves generated by combining traffic and crash rate information, to estimate aggregate annual crash costs for base case and project options.

Changes in estimated levels of fatalities and casualties for private transport have been calculated and the results are shown in Table 16.

The results of the evaluation show that the modal transfer from private to public transport and the corresponding reduction in the number of car journeys arising from improved public transport would result in an overall reduction in the number of road accidents. It is estimated that up to 18 casualty road crashes per year and one fatal accident would be avoided every three years as a result of improving public transport in the outer southern area of Adelaide.

8.9.2 Personal security

Investment in new public transport infrastructure presents the opportunity to provide public transport passengers with improved secure journeys so that passengers feel safe and crime on public transport is reduced.

This requires ongoing funding for adequate security measures, including monitoring of CCTV cameras and alarms as well as adequate lighting, help phones and communication facilities.

These may be combined with other measures to improve security such as good urban design and locating stations to ensure that they have regular activity overlooking the facilities to provide passive surveillance that deters antisocial behaviour. Providing secure car parks to prevent damage to vehicles and prevent stealing of vehicles improves security for public transport passengers.

Personal assaults

The assumption at the concept phase is that the station facilities will be simple open structures made of transparent materials. The facilities will be monitored by CCTV systems. The station facilities will be located near the high activity precincts of Seaford and Seaford Meadows. It is assumed that these locations have regular activity overlooking the facilities. This type of passive surveillance will deter antisocial behaviour.

Act of terrorism

The new rail infrastructure is just one component of the transport system. Any control to mitigate the risk of terrorism needs to be assessed using a systems approach looking not only at causal factors on the rail infrastructure, but also at causal factors jointly from the urban form, transit operation and from current security measures undertaken by SAPOL and TransAdelaide. As the definition of the project further develops a risk management assessment in accordance with AS/NZS 4360 would be undertaken to inform the detail design process to ensure that adequate security measures commensurate with Alert Level - Medium are built into the infrastructure. Following this assessment implementing the infrastructure to required standards is considered a reasonable mitigating measure at this time against the threat of terrorism on the Seaford rail line extension.

8.10 Healthy weight

8.10.1 Increase walking

Extending the rail services to Seaford and linking them with feeder buses is forecast to generate an additional 1.5 million public transport trips per annum created largely due to car drivers and passengers switching to public transport. Each trip has a walking component to and from their destination to access and egress public transport vehicles. Public transport stops are located on average every 500 metres and it is estimated that people transferring from car travel to public transport would walk up to an additional 1.5 million kilometres per year. This active travel will help lessen the health problems caused by obesity.

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8.11 Emissions

Transport generates air pollution emissions, either directly or through electricity generation, which give rise to discomfort and adverse health effects and affect ecosystems, buildings and general amenity. Pollution studies have shown that high levels of ambient air pollution are associated with strong increases in adverse health effects, including premature death, respiratory and cardio-vascular problems. The evidence for these effects is strongest for particulates and ozone and the relationships are widely accepted as causal. Recent studies reveal such effects occur at the levels of ambient air pollution present in urban areas today and are sufficient to trigger these health effects.

Atmospheric pollutants can lead to discolouration and material erosion on buildings. For example, surface erosion, especially for stone, is associated with sulphur dioxide and acidic deposition. Ozone is also known to damage polymeric materials such as plastics and rubbers. Air pollution also can impact on natural and semi natural ecosystems. For example, evidence suggests that ozone is commonly found in concentrations that can reduce crop yields. Impacts on ecosystems ranging from forests to freshwater are also well documented, with acidity, nitrogen deposition and ozone playing a role. Air pollution also has effects on visibility and amenity.

Greenhouse gases trap this heat in the atmosphere and warm the earth's surface. Carbon dioxide ($C0_2$) produced mainly by burning fossil fuels (coal, oil and gas) is the most important greenhouse gas made by human beings. There is a growing body of evidence that links man-made greenhouse gases with global warming.

Reducing local air pollutants within the outer south of Adelaide will have a direct positive effect on those people working, living in and visiting the outer southern areas of Adelaide. Reducing global emissions will have a direct positive effect on everyone.

The environmental impacts are mainly associated with the marginal changes in road traffic (cars and buses) and rail frequency on atmospheric pollution and noise nuisance. The impacts are generalised over metropolitan Adelaide and therefore no information is available on the specific location of the emissions.

Emission quantities were calculated for the changes in traffic (bus and cars) and rail (train and tram) for the rail extension from Noarlunga to Seaford. These quantities were derived using the monetary valuations and rates in gram/passenger kilometre for specific vehicles contained in DTEI's analysis of greenhouse emissions and exhaust pollution for different public transport modes[8] and using the incremental change in passenger kilometres for each mode of travel produced by option trials in MASTEM.

RESULTS

[8] Department for Transport Energy and Infrastructure (2006) *Greenhouse Gas Emissions & Exhaust Pollution – Comparison of Passenger Transport Modes* Internal Report, March.

8.11.1 Local air pollution

The main local pollutants included in this evaluation are particulate matter (PM), nitrous oxides (NOx), non volatile hydrocarbons (HC) and carbon monoxide (CO).

A DTEI study of emissions for greenhouse gas and exhaust emissions produced representative vehicle performance data derived from both the point-of-use (exhaust pipe) and production (power station) stages of the fuel cycle. From this study changes in emission levels have been calculated for the extension of the rail line from the Noarlunga to Seaford. See Figures 10 and 11.

The traction system for the existing rail service is diesel powered and a mix of diesel and CNG powered engines has been assumed for the bus fleet.

The modelling shows that an extension of the rail line to Seaford would reduce local pollution levels within the metropolitan area due to a modal shift away from car transport to public transport. The results are shown in Appendix G.

Figure 10 Change in local emissions

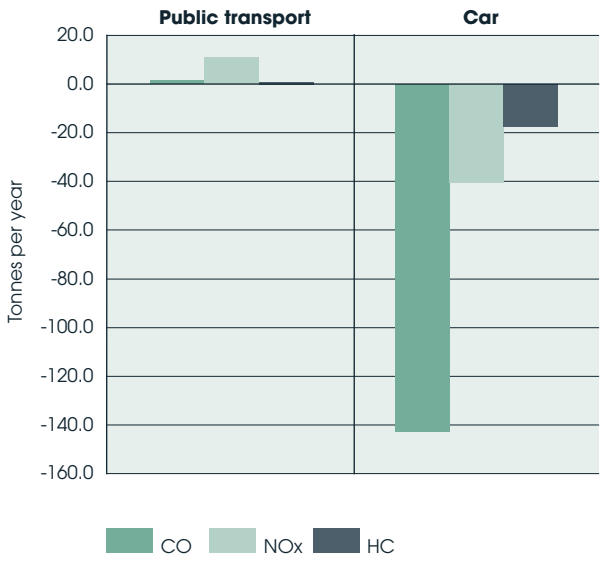

Figure 11 Change in local emissions (particulates)

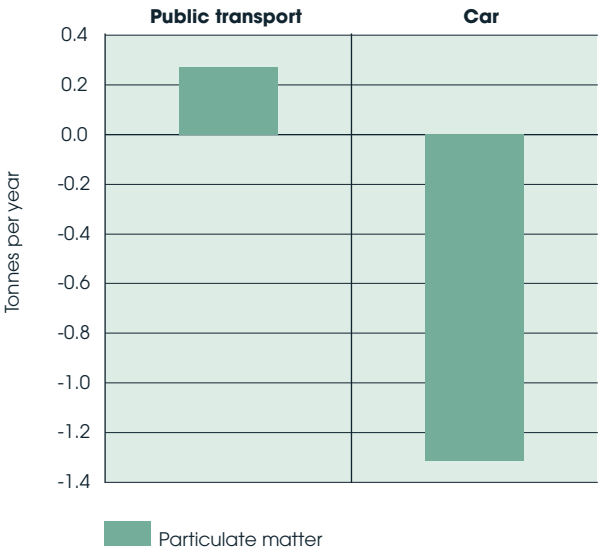

Figure 12 Greenhouse gases

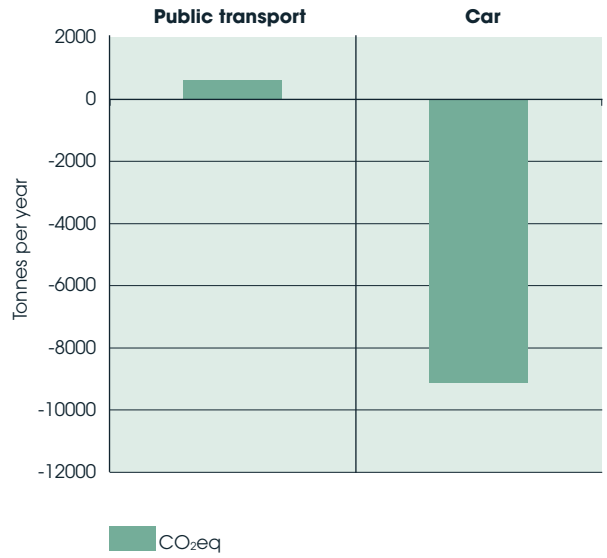

Figure 13 Change in passenger kilometres travelled per year

8.11.2 Greenhouse gases

Greenhouse pollutants produced by road transport are reported in terms of carbon dioxide (CO_2) equivalent emissions. The figures in Appendix G indicate that the extension of rail line to Seaford would decrease the amount of global air pollution emissions from a shift from private car to public transport. The increase in public transport emissions is attributed to the net effect of additional diesel rail and bus operations.

Extending rail services to Seaford represents a significant benefit with a reduction in global air emissions of up to 9,500 tonnes of carbon dioxide per year. This is derived from the sum of the increase in public transport emissions and the decrease in private car emissions. See Figure 12.

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8.12 Transport demand

Reduction in use of the transport network through a modal shift of private car travel to public transport will eventually lead to the reallocation of urban space from the use of cars on a road network to more community space for attractive pedestrian areas and access to local areas through the use of walking and cycling.

8.12.1 Transport use and meeting the target

Transport use is measured in terms of passenger-kilometres travelled on both public and private transport within metropolitan Adelaide. As such, it is a very useful measure of the effectiveness of policies to encourage a shift from private to public transport.

The results from MASTEM indicate that a 5.5 kilometre extension of the Noarlunga rail line to Seaford would result in an increase in public transport use of around 10 million passenger kilometres per year. Private transport use would reduce by up to 30 million passenger kilometres per year.

In sustainability terms an extension of rail services to Seaford would provide an overall reduction in use of the metropolitan transport network by up to 20 million passenger kilometres per year. See Figure 13.

During the peak hours parts of the road network become congested with reduced travel speeds. A high speed rail mode becomes an effective congestion relief mechanism improving the capacity of the road network.

Extending rail services to Seaford shows a reduction in car passenger kilometres resulting from car drivers and passengers shifting to public transport because of higher road traffic congestion and less distance travelled on the road network. The extension of rail services to Seaford is expected to increase the use of public transport by up to 0.17% of metropolitan weekday passenger vehicle kilometres.

Table 17 Incremental change in use (passenger kilometres) on the metropolitan road

Mode	Base case	Expansion factor	Passenger kilometres per year	Base per cent mode split	Project case (2018 snapshot)	Expansion factor	Passenger kilometres per year	Project case mode split	Incremental change
	Passenger kilometres / weekday	Number	Pass kilometres (1,000s)	Per cent	Passenger kilometres / weekday	Number	Pass kilometres (1,000s)	Per cent	Per cent
	a	b	c=a*b	d	e	f	g=f*e	h	i=h-d
Extend rail services to Seaford									
Car	24,901,035.00	280.00	6,972,289.80	92.99%	24,790,129.00	280.00	6,941,236.12	92.81%	-0.17%
Rail	432,712.00	280.00	121,159.36	1.62%	522,260.00	280.00	146,232.80	1.96%	0.34%
Bus	1,445,595.00	280.00	404,766.60	5.40%	1,397,815.00	280.00	391,388.20	5.23%	-0.16%
PT Total	1,878,307.00	280.00	525,925.96	7.01%	1,920,075.00	280.00	537,621.00	7.19%	0.17%

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8.12.2 Land-take

The implementation of the rail extension to Seaford along the 1980s alignment can be contained within the existing rail corridor partly on land designated as under the care and control of the Minister for Transport or Commissioner for Highways. The alignment over the Onkaparinga Valley and adjacent to Sauerbriers Road is on land under the care, control and management of DEH and on land owned by SA Water. In total nine hectares of land over the effluent ponds would be transferred from SA Water and 9.5 hectares of natural land would need to be resumed from the Onkaparinga River recreation park, adjacent to Sauerbriers Road, to enable the construction of a railway along this alignment. The cost estimate has assumed that no land acquisition is required and that a rail corridor over the Onkaparinga estuary can be secured at no cost to the project.

The Westerly Alignment proposed by the City of Onkaparinga would involve a significant degree of landtake and property acquisition. In total between 30 to 40 properties north of the Onkaparinga Valley may need to be demolished, in total six hectares of land would need to be acquired from private property, the City of Onakparinga and the South Australian Housing Trust, and 30 hectares of natural land would need to be resumed from the Onkaparinga River recreation park to enable the construction of a railway along this alignment. This alignment would also require the closure of a section of Sauerbriers Road.

Further information and analysis is required on the type and foundation structure for the viaduct and bridge in order to determine the optimum viaduct and bridge structure. The location of the bridge foundations may affect the preliminary horizontal and vertical alignment for the rail line.

8.13 Access to everyday facilities

8.13.1 Urban separation

The evaluation shows that extending rail services to Seaford improves access to everyday facilities for those without a car and reduces community severance.

Community severance is measured in terms of pedestrian delay. Pedestrian delay when crossing a road is mostly the result of the waiting time for a suitable gap in the traffic or for a signal phase which allows pedestrians to cross safely. The community severance impacts of a rail extension to Seaford are based upon forecast changes in traffic flows on the main roads predicted with MASTEM.

The assessment shows that extending rail services to Seaford with connecting bus services is forecast to bring about a significant overall reduction in cars using the road network because of the modal shift from private to public transport.

8.14 Natural environment

8.14.1 Noise

Traffic is one of the principal sources of urban noise and the train extension to Seaford would provide considerable benefits in terms of reductions in the amount of cars on the network as people shift to using public transport. The reduction in car traffic would lead to a reduction in general traffic noise. The results are shown in Appendix D.

The rail corridor is 60 metres wide and is mostly below the natural ground surface alongside residential areas and is therefore unlikely to generate significant

noise nuisance adjacent to the rail corridor.

The cost estimate does not include provision for extensive noise attenuation measures; further work is required to quantify the impact of noise from the rail corridor on adjacent residential developments.

8.14.2 Heritage and natural environment

The Onkaparinga estuary comprises a number of habitats, including the tidal channel, saltmarshes and artificial wetlands. These habitats are significant to many birds, fish and crustaceans, and for some species they serve as feeding, breeding and/or nursery areas.

The Onkaparinga estuary is also a popular recreational area, with thousands of people visiting each year to engage in a diverse range of activities, from kayaking to birdwatching. The local community values the estuary as a significant resource for recreation as well as for education and tourism.

A number of management agencies in partnership with community groups have undertaken a suite of programs to improve the condition of the estuary and its surrounding habitats.

Initial evaluation of the alignment has determined the preference for a viaduct and bridge over the tidal estuary to minimise the impact on the tidal flats and impact on peak tidal flows and flooding. An earth embankment at this stage is not considered feasible because of the negative environmental impact on tidal flows and poor foundation within the soft alluvial deposits.

There is an opportunity to restore the flora and fauna within the floodplain compared to what exists currently if the SA Water effluent evaporation ponds are rehabilitated and the 66kV power lines are relocated to facilitate the building of a rail viaduct and bridge over the tidal flats.

There has been no detailed Aboriginal Heritage Survey along the alignment and no specific consultation on the rail extension proposal with the Kaurna people. The estuary has been an important site for them for at least several thousand years.

8.14.3 Impacts on the Onkaparinga Valley recreation park

Following completion of the upgrade to the Christies Beach wastewater treatment plant, SA Water intends to close the Noarlunga Downs sludge lagoons and will rehabilitate the site. SA Water is currently investigating the use of this site for wetlands. The 1980s alignment proposes a viaduct and bridge across these lagoons.

DTEI will ensure that the configuration of the alignment within any future wetland scheme, the construction method, and the environmental management during construction and operation of a railway, will minimise the construction footprint left in the wetland area. The footprint of the permanent works for a viaduct and bridge would be small and would allow for land beneath the structure to be incorporated into any future wetland scheme.

The Westerly Alignment is considered to have more of an adverse impact on the recreation park than the 1980s alignment because of the amount of landtake and because the alignment will further divide the park and reduce access within the park.

8.15 Reduction of barriers

8.15.1 Mobility impaired access to public transport

The new stations will be compliant with the Federal Disability Discrimination Act, which provides for easier accessibility for everyone, particularly for those in wheelchairs, parents with prams and mobility impaired passengers. Connecting bus services will be within quick and easy walking distances to rail services.

9

SENSITIVITY TESTING

The results of the sensitivity analysis are summarised in Table 18 and show a variation of results for the economic return of the project that are dependent upon the assumptions made for the estimate of infrastructure costs and journey time savings.

Table 18 Results of sensitivity tests

		Benefit Cost Ratio	Net Present Value $ millions
1	1980s Alignment P90 infrastructure cost estimate, 6% discount, 100% road decongestion benefit	0.7	-71.4
2	Item 1 using a different base case that provides faster train running time between Noarlunga and Adelaide	1.0	-25.6
3	Item 1 using a discount rate of 4%	0.8	-46.8
4	Item 1 using a discount rate of 10%	0.5	-89.4
5	Item 1 using most likely estimate Infrastructure cost estimate	0.8	-41.0
6	Item 1 using 50% road decongestion benefit	0.5	-103.0
7	1980s Alignment P90 infrastructure cost estimate, 6% discount, 100% road decongestion benefit, double track over Onkaparinga Valley.	0.6	-100.6
8.	Westerly Alignment P90 infrastructure cost estimate, 6% discount, 100% road decongestion benefit, single track over Onkaparinga Valley.	0.6	-84.4

No sensitivity testing was undertaken on a range of population projections for the outer south. The preliminary benefit cost ratio (BCR) range is between 0.5 and 1.0.

There is a significant improvement in the economic result if rail services are extended to Seaford after concrete re-sleepering of the Noarlunga to Adelaide rail corridor. This would provide faster train services and increase the BCR from 0.7 to 1.0.

10

STAKEHOLDER CONSULTATION

Following completion of the MASTEM modelling and preliminary evaluation of the outputs of the various studies a strategic review was undertaken in March 2007 with Planning SA, TransAdelaide and the Passenger Transport Division of DTEI to present the investigation's findings and confirm some assumptions made in the analysis before finalisation of a draft report.

In 1991 the Railway Industry Council Urban Working Group, within which the State Transport Authority, now TransAdelaide, was a member, commissioned a number of studies on the engineering feasibility, cost and operational implications of extending the Noarlunga Rail line to Seaford.

Between July 2005 and October 2005 the engineering and environmental issues were again reviewed with the following stakeholders who would be affected by the project and may affect the scope and cost of the project:

- The City of Onkaparinga: to assess the impacts on local roads, Onkaparinga reserve and stormwater management.
- SA Water: to assess the timing of the proposed remediation of the effluent ponds located in the Onkaparinga tidal estuary and the extent of works to integrate the site into the Onkaparinga Valley reserve.
- The Department for Aboriginal Affairs and Reconciliation: to discuss an appropriate way of consulting with the Kaurna people and assess the extent of the consultation.
- The Department for Environment and Heritage: to assess the impacts of a proposal for conversion of DEH land from recreation park to conservation park status and the status of the Onkaparinga estuary as a listed area on the National Heritage Register.
- Land Management Corporation (LMC): to assess the impact of the rail alignment on land held by LMC.
- Preliminary discussion with telecom utilities and other utilities: to assess the location and impact of other services on the project.

Consultation with a number of government agency working groups:

- Planning SA facilitated several workshops with government agencies and the non-government sector as a vital input to the development of a master plan for the Seaford Meadows land. The possible extension of a rail line to Seaford has been incorporated into this Master Plan.
- In July 2005 a Transit-Oriented Development Steering Group, comprising representatives from the Land Management Corporation (LMC), Department for Transport, Energy and Infrastructure (DTEI), Department for Families and Communities, Department for Education and Children's Services, Planning SA and TransAdelaide was convened to promote transit-oriented development in Adelaide, building on commitments articulated in *South Australia's Strategic Plan*. The Steering Group has identified Seaford Meadows and Seaford as an area that can be developed along Transit Oriented Development Principles in Adelaide.

A number of officers within TransAdelaide and the Public Transport Division of DTEI have been consulted on specific issues associated with the investigation to formulate the benefits and costs associated with the proposal.

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SENSITIVITY

The consultation focused on the following topics:

- A simplified operating cost methodology has been developed by DTEI and TransAdelaide to estimate the effects of strategic network modifications. This has been used to provide indicative operating costs for the Seaford Rail extension.
- A working group has been established between Policy and Planning Division and the Public Transport Division of DTEI to develop the Public Transport assignments in MASTEM and the specification of the MASTEM model for use in analysing the Seaford Rail extension.

11 ISSUES

Key issues raised by this investigation are outlined below:

- **Further development of the proposal is needed to remove uncertainties in the costs.** There are a number of uncertainties and a number of unit rates about which here is a low level of confidence in their accuracy. Further planning and design work is required to quantify the extent of road works, to fix the horizontal and vertical alignment and to develop preliminary cross sections within the rail corridor. Preliminary bridge design and geotechnical information is required to remove the uncertainties associated with the type of structure and foundations needed for the viaduct and bridge over the Onkaparinga Valley and their costs.
- **Single track vs double track bridge over the Onkaparinga Valley.** TransAdelaide has expressed the view that the single track layout over the Onkaparinga Valley will affect the reliability of the Seaford to Adelaide rail service. The risk is that this arrangement may affect TransAdelaide's ability to keep to a specific timetable and also affect the effectiveness of connecting bus services.

  Independent studies propose that it is possible to operate the current train timetable with a 5.5 kilometres extension to Seaford incorporating a 1.4 kilometre single track over the Onkaparinga Valley.

  Operational flexibility and reliability of the public transport system is a critical issue in retaining passengers and encouraging new passengers. Understanding whether a single track bridge will compromise this ability is a critical issue for resolution during the project definition phase.

  Further studies are required to investigate the effect of a single track over the Onkaparinga Valley on the reliability of the operation of the Seaford to Adelaide rail corridor. This information can then be used to decide whether a single track arrangement can be implemented over the Onkaparinga Valley with duplication occurring at some time in the future if passenger demand increases.
- **The Seaford and Seaford Meadows Station are too close.** The Seaford Meadows station is only 1.5 kilometres from the Seaford terminus. Removing the Seaford Meadows Station or investigating other options to space stations so that shorter transit running times can be achieved, may attract more passengers.

  Spacing between stations is a balancing act. The stations need to be close enough to be easy to reach from many areas in the outer south either by walking or travelling a short distance by bus. However, there is a need to keep the train moving on the line, since stopping too often will make the trip a slow one and the service will be less attractive for passengers.

  Remove Seaford Meadows:

  Removing the Seaford Meadows station, which is located in a hollow, provides quicker and a more reliable transit time between Noarlunga and Seaford by not requiring trains to both brake and accelerate out of the station against the grade in both directions. There is possibly some advantage, from a public transport perspective, that faster train services on the Seaford to Adelaide rail service will attract additional patronage. Buses would service the Seaford Meadows development and feed passengers into the Seaford terminus.

11

Removing the Seaford Meadows Station would reduce walking access to the rail service and reduce the opportunity to develop TOD-style neighbourhoods. The Seaford terminus becomes the main train loading point for the Outer South and there may not be sufficient car parking to cater for a growing public transport demand and the terminus may become congested with feeder buses.

A Seaford Meadows Station may be preferred by developers who have the opportunity to develop TOD-style neighbourhoods that provide high density and premium developments close to and within easy walking distance of the Seaford Meadows Station.

Relocate Seaford terminus to Seaford Heights:

There is possibly some benefit in retaining the Seaford Meadows station and relocating the Seaford terminus to Seaford Heights. The stations would then be 2.75 kilometres apart allowing shorter transit time between stations. The Seaford Heights terminus would be located adjacent to the large greenfield residential site of Seaford Heights.

This proposal has the advantage of stations being located adjacent to two large residential catchments of Seaford Rise and Seaford Heights which are within easy walking distance to rail services. There is potential to develop TOD-style neighbourhoods at Seaford Heights, which is a greenfield site, close to the rail terminus, further increasing the potential catchment for rail services.

Relocating the terminus to Seaford Heights would require an additional 1.75 kilometres of rail track in a rail corridor that is under the ownership of the Minister for Transport. This increases the scope and cost of the proposal and would reduce the economic result unless rail and bus services can attract more patronage through higher frequency services and quicker train running times along the Seaford to Adelaide rail corridor and/or the population catchment exceeds estimates.

These benefits remain speculative in that no analysis or modelling has been undertaken to quantify the effects of removing the Seaford Meadows station or relocating the Seaford terminus to Seaford Heights.

- **Seaford Meadows Master Plan needs to be developed.** The developer for Seaford Meadows is required, under the development deed, to prepare a master plan for its proposed development, which in turn will inform a review of the Structure Plan with the City of Onkaparinga. DTEI understands that the developer has developed two master plans for Seaford Meadows, one that assumes that a railway station is built with development allowing for bus access to the station and a TOD-style neighbourhood with higher residential densities near the station. The other plan assumes that there is no station and no TOD-style neighbourhood and is developed with standard street arrangements.

  Developers may require a decision from the Government on the determination of a station at Seaford Meadows within the next four years.

- **Links between MASTEM predicted additional trips and population increase are unclear.** MASTEM has not been sufficiently developed to produce automatic outputs that can show the relationship between population increase and public transport demand and origin and destination of specific trips.

  Further work should be done to confirm the benefits of the proposal using updated versions of MASTEM with a number of population scenarios for the outer south and with spatial diagrams to show the origin and destination of trips.

- **Corridor land is State Government owned but titled under different Ministers**. The 1980s alignment over the Onkaparinga Valley is on land owned by the Department for Environment and Heritage and SA Water. The remainder of the alignment is on land owned by the Minister for Transport or Commissioner for Highways. No land costs have been included in the estimate to provide for cross-departmental funding transfers to account for the change in ownership of the land.

ISSUES

12

CONCLUSIONS

The main conclusion reached by the study is that the proposal does not yet justify the major initial expenditure. However, extending rail services to Seaford after concrete resleepering of the Noarlunga rail line provides an improved benefit cost ratio and offers the best value for money.

A rail extension to Seaford would provide a range of benefits.

Despite the main conclusion, the results of the multi-criteria assessment show that the majority of the criteria set to evaluate the rail extension to Seaford would be met. Significant benefits would be realised in terms of improving accessibility to and from the outer southern areas of Adelaide as well as improving the environment.

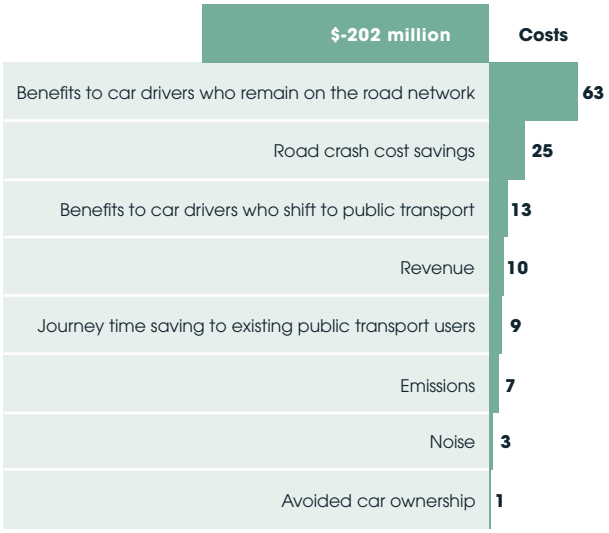
The provision of a rail service to Seaford would encourage a large number of people to use the system. The improved accessibility, especially between the outer south and inner south, would help the people from the outer south areas to have better access to job opportunities located north of Seaford. The rail line would also encourage Transport Oriented Development-style of neighbourhoods and encourage development within Seaford and Seaford Meadows. The predicted modal shift in journeys of up to 2.3 per cent from private transport is extremely encouraging, given the reliance on private car travel in the outer southern areas of Adelaide.

The results of the preliminary appraisal and benefit cost ratio are detailed in Appendix A and summarised in Figure 14.

Analysis of the benefits of a rail extension show an attraction to quicker, more comfortable and more reliable service compared to travel on a road network that becomes more congested over time.

The main beneficiaries are car drivers who remain on the highway system. These benefits are achieved by the extension of rail services to Seaford providing a significant shift of transport travel from the road network to the public transport system.

Figure 14 Costs and benefits present value $ millions



The preliminary benefit cost ratio range is between 0.5 and 1.0.

There is a significant improvement in the economic result if rail services are extended to Seaford after concrete re-sleepering of the Noarlunga to Adelaide rail line. This would provide faster train services and increase the BCR from 0.7 to 1.0.

The 1980s alignment, the most direct route from Noarlunga to Seaford, performs better than the Westerly Alignment when compared to the appraisal criteria.

The Westerly Alignment underperforms when compared to the 1980s alignment in a number of key areas because it:

- Is more costly.
- Requires more land from the Onkaparinga River recreation park.
- Requires the demolition of a number of private properties.

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CONCLUSIONS

A rail extension would offer an attractive alternative to the private car.

Improving the quality of public transport, particularly by reducing journey times through the introduction of extended rail services along a dedicated corridor to Seaford would provide an attractive alternative for people who currently use cars or would otherwise consider using private cars in the area in the future.

Extending rail services to Seaford shows a net reduction in car passenger kilometres resulting from car drivers and passengers shifting to public transport because of higher road traffic congestion and less distance travelled on the road network. The extension of rail services to Seaford is expected to increase the use of public transport by up to 0.17% of metropolitan weekday passenger vehicle kilometres.

Improvement in rail services between Noarlunga and Adelaide would provide an improvement in the economic result.

Travel time along the Noarlunga to Adelaide rail line is currently affected by speed restrictions. Without intervention, further speed restrictions would result in increased travel times that may lead to reduced performance of rail services. Improving this situation through concrete re-sleepering of the rail line will provide faster and smoother train services and extending the rail line to Seaford with these improved train services produces significantly higher benefits. These benefits are generated from the increased attraction to this service, being quicker, more comfortable and more reliable compared to travel on a road network that becomes more congested over time.

Extending rail services to Seaford after concrete re-sleepering of the Noarlunga rail line provides an improved benefit cost ratio and offers the best value for money.

The proposal is technically feasible.

The proposal is feasible within the defined scope of works described in this report. There are a number of uncertainties and a number of unit rates about which there is a low level of confidence in their accuracy. These uncertainties exist because either the unit rate is speculative in nature or because design attributes have yet to be fully defined and the estimator cannot fully quantify their impact because of lack of information or because their likelihood of occurring cannot be ruled out.

Further planning and design work is required to quantify the extent of road and rail works, to fix the horizontal and vertical alignment and to develop preliminary cross sections within the rail corridor.

Preliminary bridge design and geotechnical information is required to remove the uncertainties associated with the type of structure and foundations needed for the viaduct and bridge over the Onkaparinga Valley and their costs.

Consultation with a number of key external stakeholders is also required to secure the rail corridor across the Onkaparinga estuary.

The estimates of capital costs are predictable within certain ranges.

The 2007 range estimate for the cost of infrastructure is between $136 million and $175 million. If the proposal includes a double rail track viaduct and bridge over the Onkaparinga Valley the range estimate is between $170 million and $215 million.

An estimated additional 14 railcars would be required, depending on the service levels adopted to meet passenger demand, at a cost of $56 million.

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RECOMMENDATIONS

This investigation shows that extending rail services to Seaford provides a benefit cost ratio (BCR) between 0.5 and 1.0. With other benefits assessed by the evaluation criteria the investigation demonstrates that the scheme is worthy of implementation at a future time if rail services are improved and if population estimates for the southern areas of Adelaide remain the same or are higher than current predictions.

It is therefore recommended that:

- The Seaford Rail extension be retained as a potential public transport project.
- The 1980s alignment, the most direct route from Noarlunga to Seaford, be the adopted route for a future rail extension to Seaford.
- The costs and benefits of providing a station at Seaford Meadows or the relocation of the Seaford terminus to Seaford Heights be reviewed.
- The feasibility and priority for funding of the proposal be reviewed:
  - After concrete re-sleepering of the Noarlunga to Adelaide rail corridor is complete.
  - If high frequency and high speed rail services and other public transport priorities are approved.
  - Once population increases in the southern areas of Adelaide.
- The rail corridor over the Onkaparinga Valley be secured in the name of the Minister for Transport.
- A rail corridor to Aldinga be identified.

PRELIMINARY BENEFIT COST RATIO – APPENDIX

A

Table 19 Preliminary benefit cost ratio

	Extend rail services to Seaford NPV $Million 2007 prices	Extend rail services to Seaford: Concrete resleepering
COSTS		
Capital costs (Infrastructure)	135.9	135.9
Operating costs	31.6	31.6
New Buses or Refurbishment of existing buses	0.0	0.0
New trains & refurbishment of existing trains	49.3	49.3
Renewal Infrastructure	1.4	1.4
Residual Value	-15.9	-15.9
Present value costs	**202**	**202**
BENEFITS		
Revenue		
Net additional revenue on public transport	19.1	25.0
Incentive payment to bus contractors	-8.9	-3.3
Journey times		
Journey time savings to existing public transport passengers	8.5	25.3
Time savings for diverted and generated public transport trips	0.1	0.4
Quality of station facilities and rolling stock	High +ve	High +ve
Resource corrections		
Benefits to car drivers who shift to public transport	13.3	14.3
Benefits to motorists who remain on the road system	63.2	76.3
Avoided road damage	0.0	0.0
Transit Oriented Development and integration with land use plans		
Integration with Metropolitan Land use plan and City of Onkaparinga development plan	High +ve	High +ve
Transit influence on uplift of property value	Low +ve	Medium +ve
Avoided car ownership	0.6	0.9
Crash savings		
Avoided fatality crashes	5.6	6.0
Avoided casualty crashes	19.8	21.4
Public Transport accidents	0.0	0.0
Personal security		
Personal assaults	High +ve	High +ve
Acts of terrorism	High +ve	High +ve

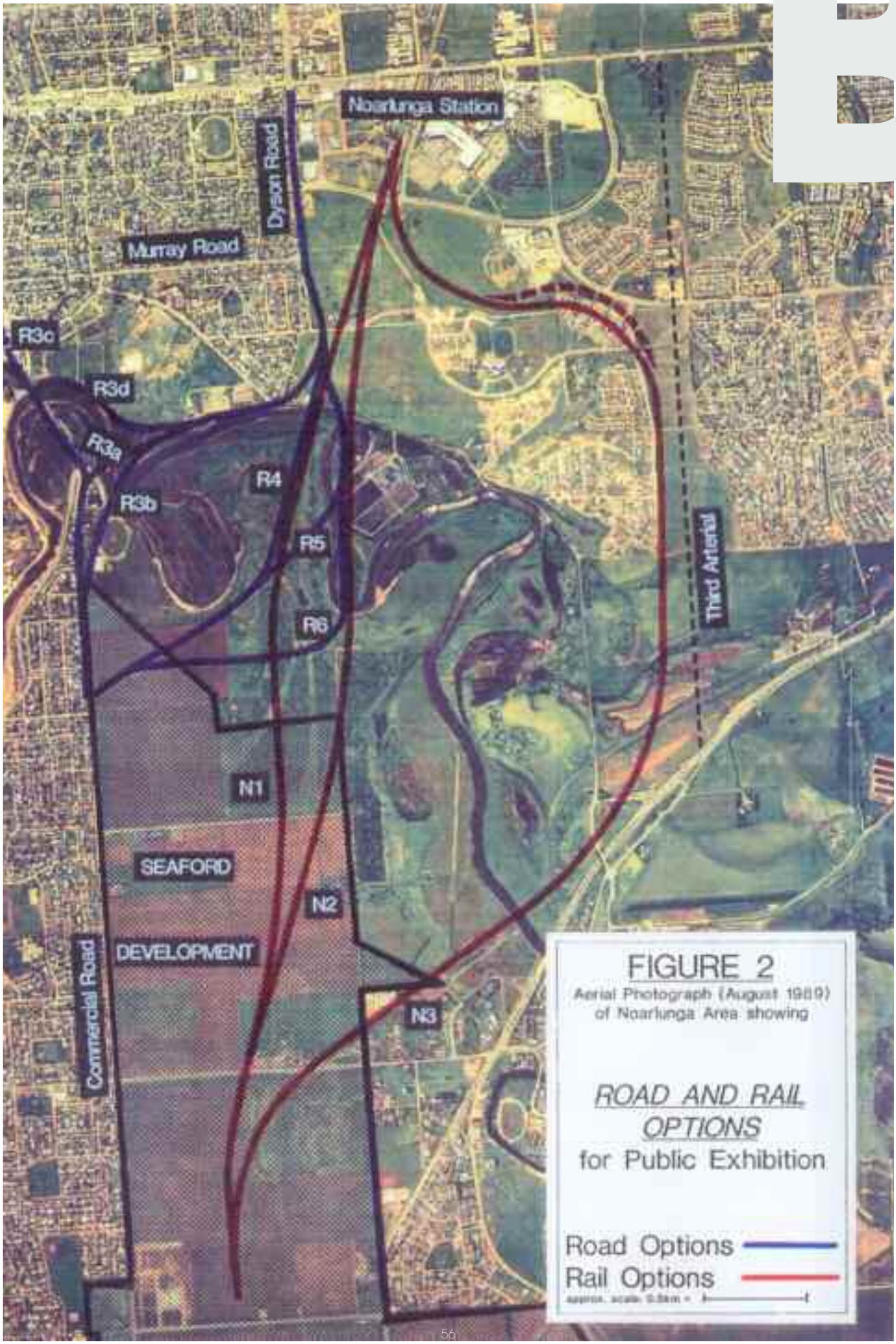
	Extend rail services to Seaford NPV $Million 2007 prices	Extend rail services to Seaford: Concrete resleepering
Healthy weight		
Increase walking	Medium +ve	High +ve
Emissions		
Local air pollution	5.5	5.9
Greenhouse	1.7	1.8
Transport demand		
Transport use and meeting the PT target	Medium +ve	High +ve
Land-take	Low +ve	Low +ve
Access to everyday facilities		
Urban separation	Medium +ve	High +ve
Natural environments		
Noise	2.6	2.8
Heritage and landscape	Medium -ve	Medium -ve
OTHER FUNDING		
Developer	0	0
Other agencies	0	0
Present value benefits	**130.9**	**176.8**
NPV net benefits	**-71.4**	**-25.6**
Benefit Cost Ratio (BCR)	**0.7**	**1.0**
Government funding		
Capital Costs (Infrastructure)	89.0	89.0
Additional Train Opex	31.6	31.6
Additional Bus Opex	25.5	25.5
Total (K)	120.6	120.6
NPV/K	**-0.59**	**-0.21**

Notes
High +ve qualitative assessment of non-monetised benefit

ROAD AND RAIL ALIGNMENT PRESENTED TO THE PUBLIC IN 1990

APPENDIX B

APPENDIX B

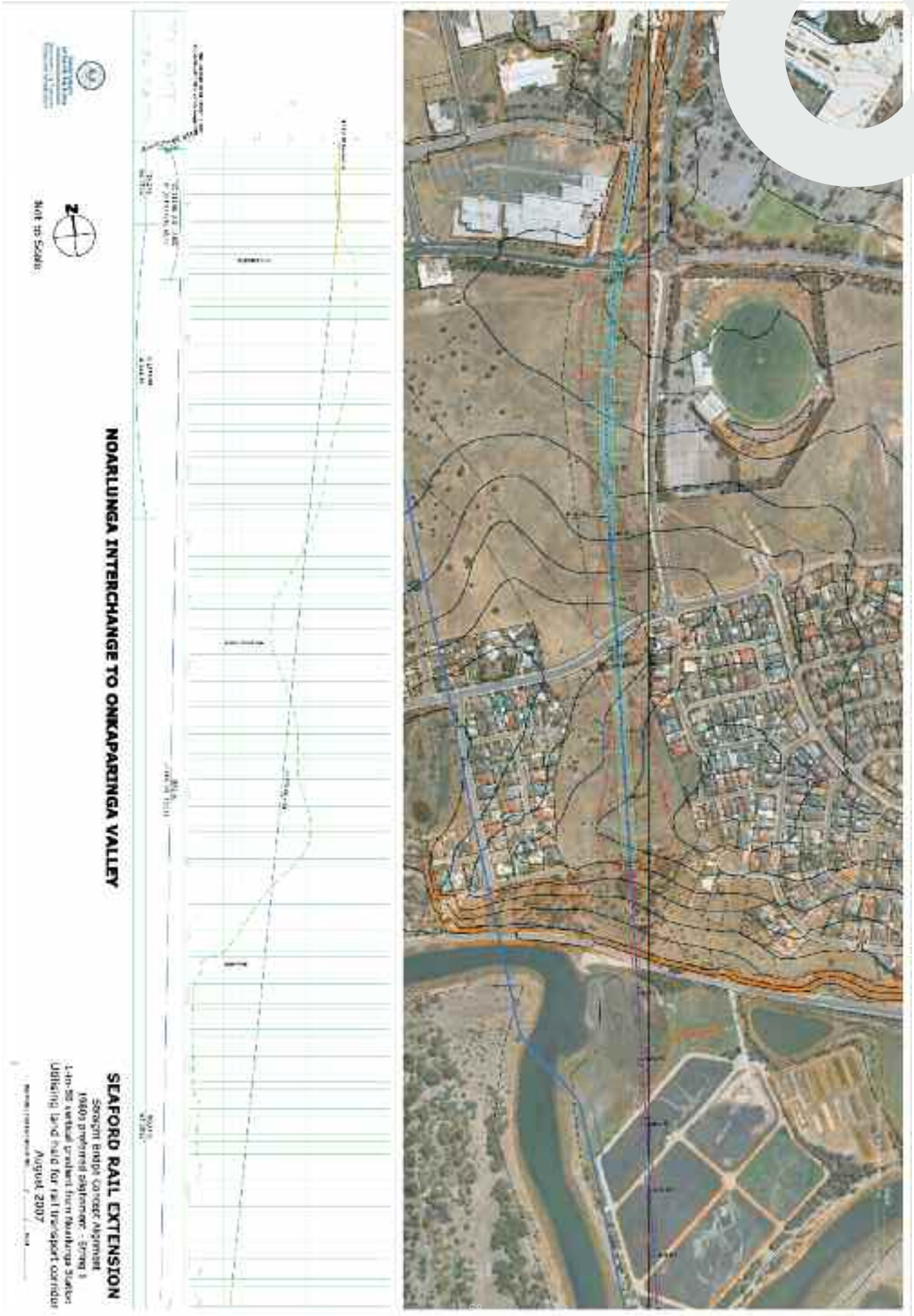

Noarlunga Station
Dyson Road
Murray Road
R3c
R3d
R3a
R3b
R4
R5
R6
Third Arterial
N1
SEAFORD
N2
DEVELOPMENT
Commercial Road
N3
FIGURE 2
Aerial Photograph (August 1989)
of Noarlunga Area showing
ROAD AND RAIL
OPTIONS
for Public Exhibition
Road Options
Rail Options

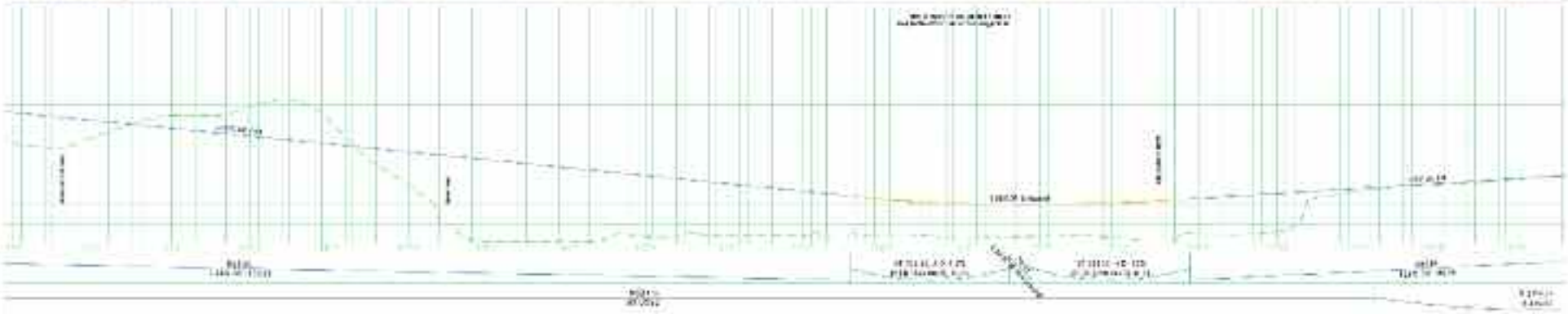
B


Noarlunga Station
Dyson Road
Murray Road
Third Arterial
ROAD ROUTE
RAIL ROUTE
SEAFORD
DEVELOPMENT
Commercial Road
FIGURE 5
Aerial Photograph (August 1989)
of Noarlunga Area showing
RECOMMENDED
ROAD AND RAIL
ROUTES
Road Route
Rail Route

PRELIMINARY HORIZONTAL AND VERTICAL ALIGNMENT (1980s alignment)

APPENDIX C



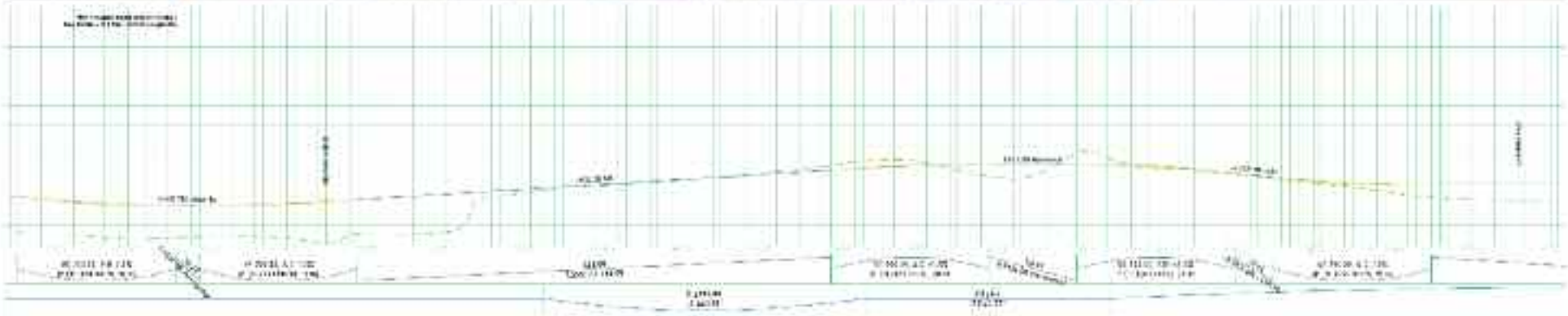


ONKAPARINGA RIVER VALLEY

Not to Scale

SEAFORD RAIL EXTENSION

Seaford Bridge Concept Alignment
1980s preferred alignment - String 1
1-in-50 vertical gradient from Noarlunga Station
Utilising land held for rail transport corridor
August 2007

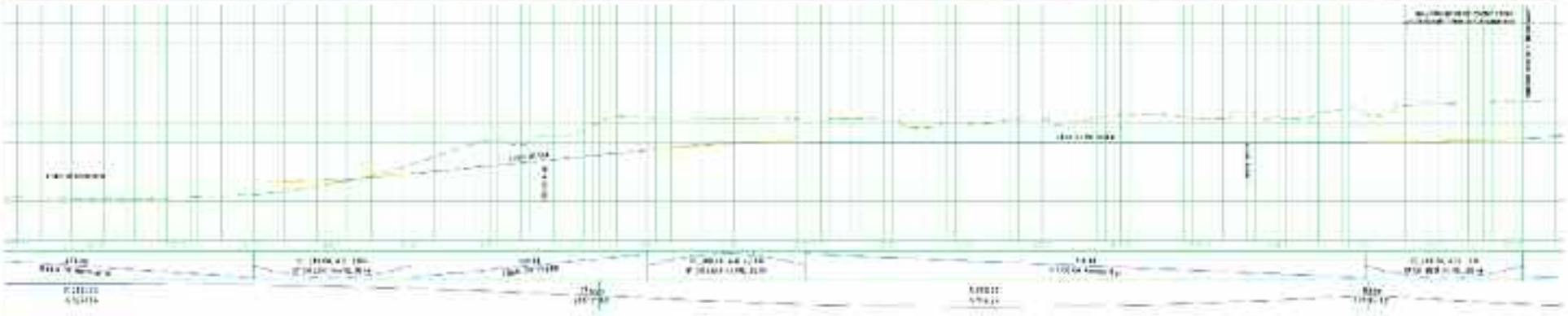


SEAFORD MEADOWS AND RIVER ESCARPMENT

Not to Scale

SEAFORD RAIL EXTENSION

Seaford Bridge Concept Alignment
1980s preferred alignment - String 1
1-in-50 vertical gradient from Noarlunga Station
Utilising land held for rail transport corridor
August 2007

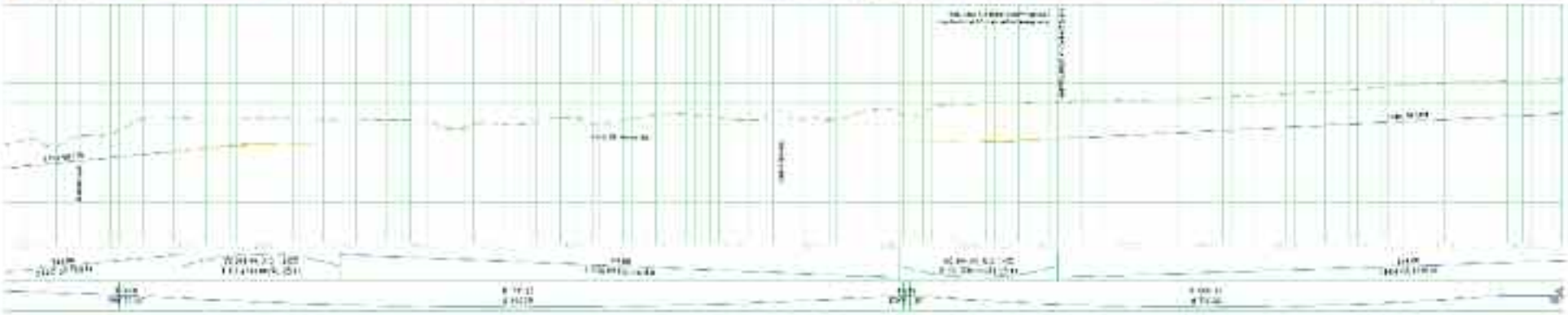


SEAFORD MEADOWS & SEAFORD

Not to Scale

SEAFORD RAIL EXTENSION

Straight Bridge Concept Alignment
1980s preferred alignment - String 1
1-in-50 vertical gradient from Noarlunga Station
Utilising land held for rail transport corridor
August 2007



SEAFORD AND SEAFORD RISE

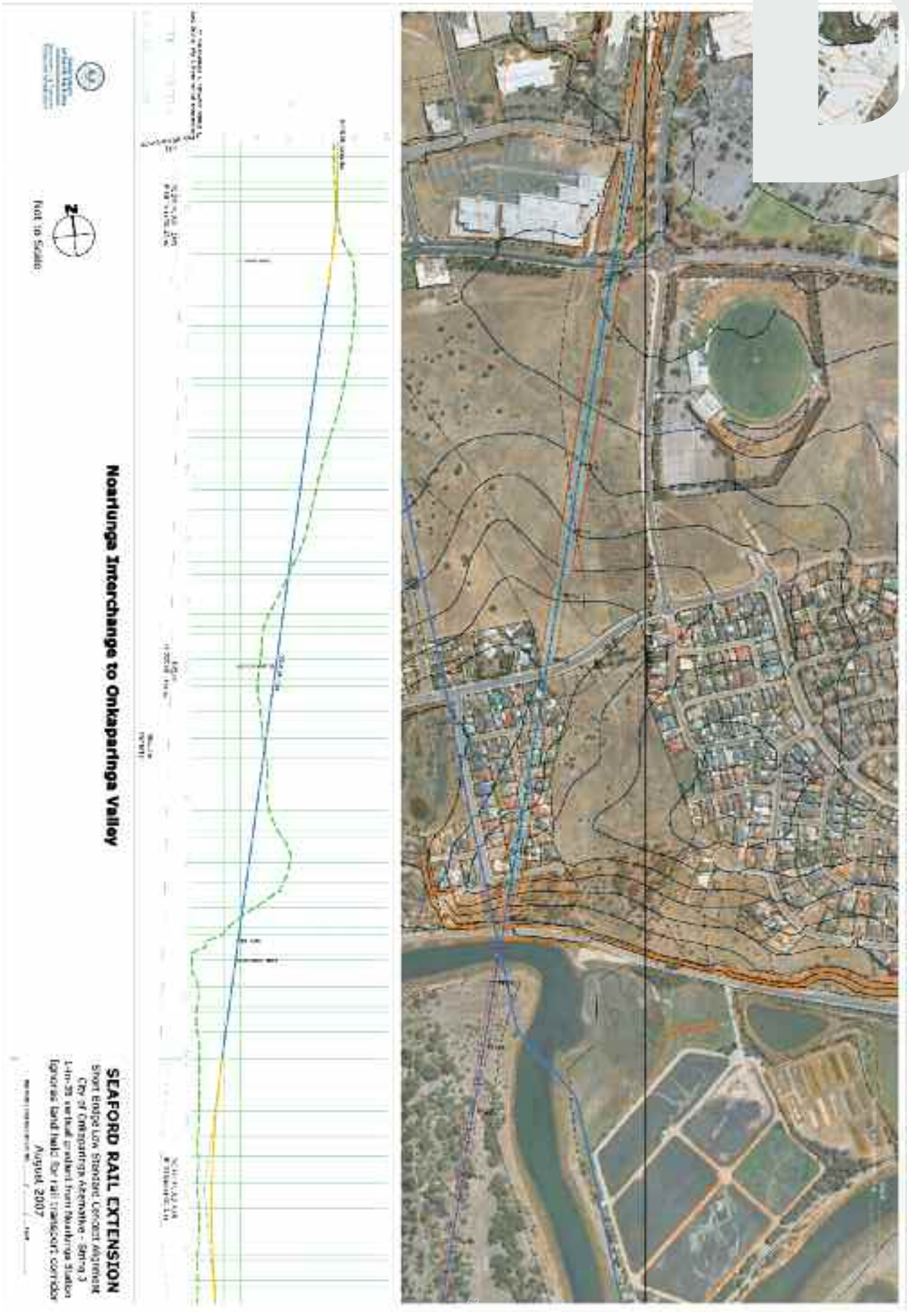
Not to Scale

SEAFORD RAIL EXTENSION

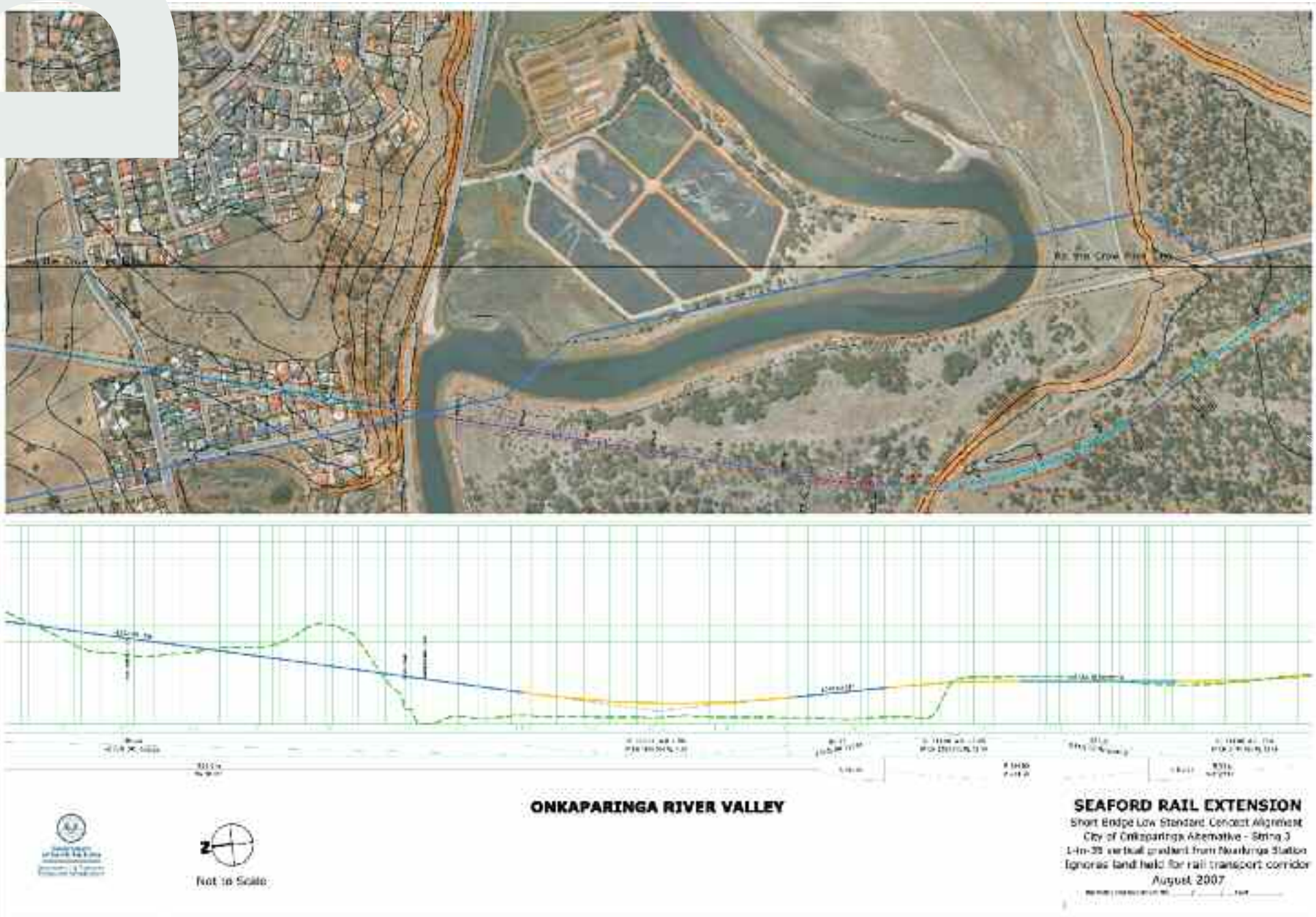
Straight Bridge Concept Alignment
1980s preferred alignment - Spring 1
Seaford Interchange Site
Rail transport corridor continues south
August 2007

CITY OF ONKAPARINGA WESTERLY ALIGNMENT

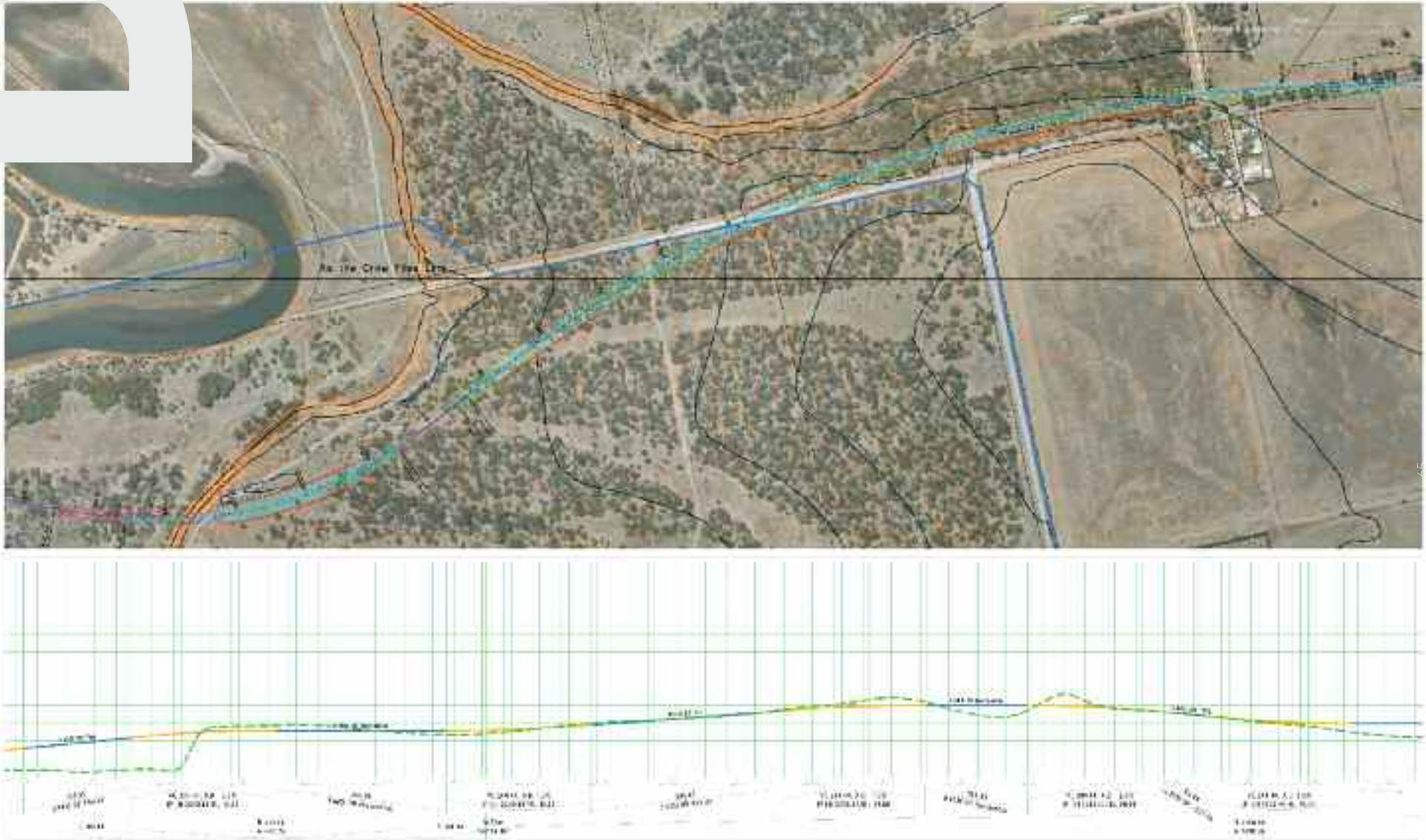
APPENDIX D



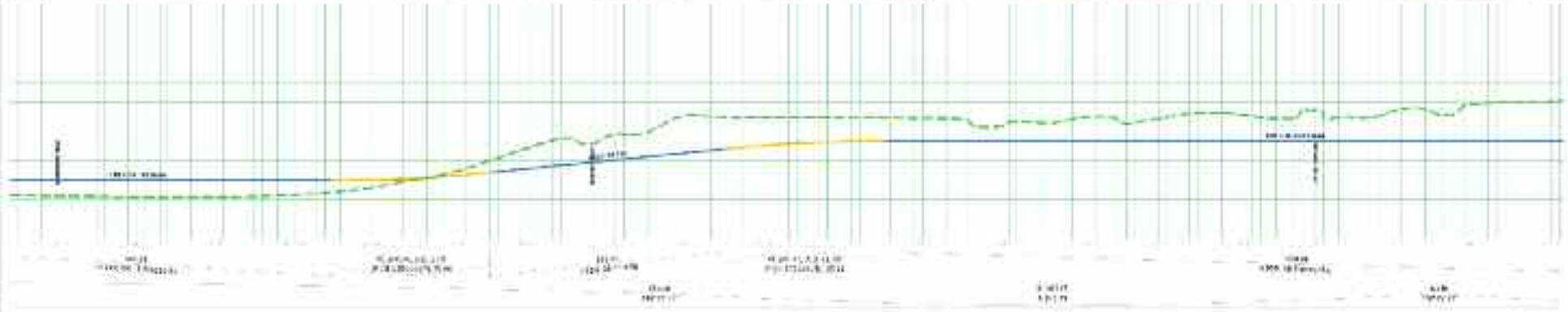
APPENDIX


ONKAPARINGA RIVER VALLEY
Not to Scale
SEAFORD RAIL EXTENSION
Short Bridge Low Standard Concept Alignment
City of Onkaparinga Alternative - String 3
1-in-35 vertical gradient from Noarlunga Station
Ignores land held for rail transport corridor
August 2007

APPENDIX D


SEAFORD MEADOWS
Not to Scale
SEAFORD RAIL EXTENSION
Short Bridge Low Standard Concept Alignment
City of Onkaparinga Alternative - Stage 3
Onkaparinga Valley to Saunders Road Section
Connects to Rail Transport Corridor at chainage 3600
August 2007

APPENDIX D



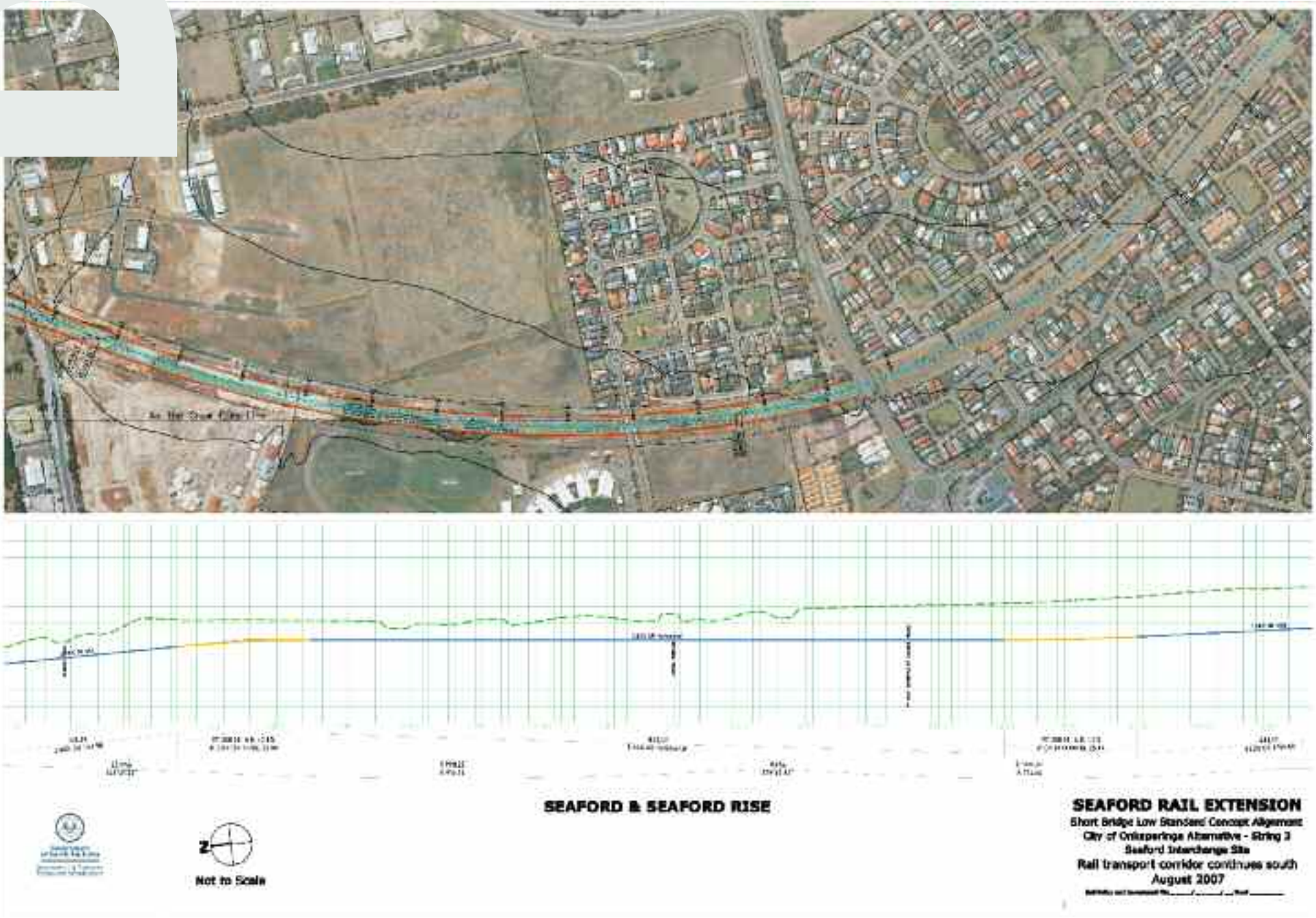
SEAFORD MEADOWS & SEAFORD

Not to Scale

SEAFORD RAIL EXTENSION

Short Bridge Low Standard Concept Alignment
City of Onkaparinga Alternative - String 3
Seaviews Road to Griffiths Drive Section
Within Rail Transport Corridor
August 2007

APPENDIX D


SEAFORD & SEAFORD RISE
Not to Scale
SEAFORD RAIL EXTENSION
Short Bridge Low Standard Concept Alignment
City of Onkaparinga Alternative - String 3
Seaford Interchange Site
Rail transport corridor continues south
August 2007

COMPARISON OF HORIZONTAL ALIGNMENTS – APPENDIX E

ASSUMED BUS SCHEDULE – APPENDIX

March 2006 existing pattern of bus services		Existing 2006			*Base Case 2018 & 2031 patterns of services* Adelaide to Noarlunga Rail service				*Project Case 2018 & 2031 patterns of services* Adelaide to Seaford Rail Service				
Service Number	Description	AM	PM	Daily	AM	PM	Daily	Service Length	AM	PM	Daily	Service Length	Total Distance
		Headways (mins)			Headways (mins)			Km				Km	Km
					Bus service 745A and 747C increased in frequency to and from Seaford and Seaford Meadows				Bus service routes and frequency remain approximately the same as the base case with a number of minor modification to reroute existing bus services into Seaford and Seaford Meadows.				
741N	Maslin Beach - Colonnades	30	30	41.03	30	30	41.03	13.26	30	30	41.03	13.89	345.27
741S	Colonnades - Maslin Beach	30	26	39.57	30	26	39.57	13.26	30	26	39.57	13.89	358.09
742N	Maslin Beach - Colonnades	0	0	170.00	0	0	170.00	13.01	0	0	170.00	13.64	81.84
742S	Colonnades - Maslin Beach	0	0	170.00	0	0	170.00	13.01	0	0	170.00	13.64	81.84
745A	Seaford Circuit	60	24	52.51	15	15	23.18	23.61	15	15	23.18	23.61	1,038.84
745CD	Colonnades - Seaford Shopping Centre	0	0	510.00	0	0	510.00	13.46	0	0	510.00	13.46	26.92
745CU	Feeder Service	40	0	340.00	40	0	340.00	11.42	40	0	340.00	11.42	34.26
747C	Seaford Circuit	30	23	48.75	15	15	23.18	23.38	15	15	23.18	23.38	1,028.72
747CD	Colonnades - Seaford Shopping Centre	0	0	510.00	0	0	510.00	10.39	0	0	510.00	10.39	20.78
747CU	Feeder Service	120	0	1020.00	120	0	1,020.00	11.96	120	0	1020.00	13.23	13.23
750N	Sellicks Beach - Noarlunga Centre	60	90	85.00	60	90	85.00	35.55	60	90	85.00	33.83	405.96
750S	Noarlunga Centre - Sellicks Beach	60	45	85.00	60	45	85.00	35.55	60	45	85.00	33.83	405.96
751N	Aldinga Shopping Centre - Noarlunga Centre	60	90	113.33	60	90	113.33	31.99	60	90	113.33	31.99	287.91
751S	Noarlunga Centre - Aldinga Shopping Centre	60	45	113.33	60	45	113.33	31.99	60	45	113.33	31.99	287.91
743N	Seaford Circuit includes Seaford Meadows											*	
743S	Seaford Circuit includes Seaford Meadows											*	
Totals								281.84				282.19	4,418.00
Change in bus fleet from March 2006					Increase bus fleet size by 4 units				Increase bus fleet size by 4 units				

* = service has been replaced

EMISSIONS EVALUATION – APPENDIX

Table 20 Emissions evaluation, March 2006: Local air pollution

Option	Mode	Incremental change in number of weekday vehicle kms (Tram, Train Bus) derived from MASTEM	Expansion factor	Change in number of vehicles kms per year	Vehicle Type	Fleet %	Carbon Monoxide Emissions CO				Oxides of Nitrogen Emissions NOx		
		Total vehicle kms per weekday a	b	Total vehicle kms per annum c=a*b		d	g/km[1] e	tonnes f=c*d*e/1000*1000	$/t[2] 2006 g	$ h	g/km[1] i	Tonnes j=c*d*i/1000*1000	$/t[2] 2006 k
Extended rail service to Seaford	Rail	568	280	159,040	electric	0%	1.1	0.00	3.49	0.00	7.2	0.00	1,011.06
	Rail	568	280	159,040	diesel	100%	9.2	1.46	3.49	5.10	68	10.81	1,011.06
	Bus	-1	280	-280	diesel	62.0%	2.1	0.00	3.49	0.00	19	0.00	1,011.06
	Bus	-1	280	-280	cng	38.0%	2.1	0.00	3.49	0.00	11.9	0.00	1,011.06
	Total Public Transport (PT)							**1.5**				**10.80**	
	Car	-107,839	280	-30,194,787	conventional	80%	5.7	-137.69	3.49	-480.04	1.3	-31.40	1,011.06
	Car	-107,839	280	-30,194,787	diesel	5%	0.8	-1.21	3.49	-4.21	1.5	-2.26	1,011.06
	Car	-107,839	280	-30,194,787	lpg	15%	0.8	-3.62	3.49	-12.63	1.5	-6.79	1,011.06
	Total Car							-142.52		-496.88		-40.46	
	Total (PT +CAR)							**-141.1**				**-29.7**	

Notes

[1] Refer to g per km data Emissions Diesel Scania Bus, typical passenger car and diesel rail car (g/km) in DTEI (2006) "Greenhouse Gas Emissions & Exhaust Pollution- Comparison of Passenger Transport Modes" Internal Report, March.

[2] Department for Transport Energy and Infrastructure (2006) "Greenhouse Gas Emissions & Exhaust Pollution – Comparison of Passenger Transport Modes Internal Report, March (Best estimates for "Valuation of pollutants emitted by road transport into the Australian atmosphere Dr Tom Beer, CSIRO, August 2002).

[3] Estimates of average occupancy rates on public transport from MASTEM.

Table 21 Emissions evaluation, March 2006: Greenhouse emissions and noise

Option	Mode	Incremental change in number of vehicle kms (Tram, Train Bus) derived from MASTEM	Vehicle Type	Fleet %	Greenhouse Emissions CO^2 Equivalent			
		Total vehicle kms per annum a		b	g/km[1] c	Tonnes d=a*b*c/1000*1000	$/t[2] 2006 e	$ f=e*d
Extended rail service to Seaford	Rail	159,040	electric	0%	3379	0.00	18.59	-
	Rail	159,040	diesel	100%	3964	630.43	18.59	11,722.38
	Bus	-280	diesel	62.0%	1948	-0.34	18.59	- 6.29
	Bus	-280	cng	38.0%	1839	-0.20	18.59	- 3.64
	Total Public Transport (PT)							
	Car	-30,194,787	conventional	80%	330	-7,971.42	18.59	- 148,221.69
	Car	-30,194,787	diesel	5%	545	-822.81	18.59	- 15,299.40
	Car	-30,194,787	lpg	15%	306	-1,385.94	18.59	- 25,770.36
	Total (PT +CAR)							

Notes

[1] Refer to g per km data Emissions Diesel Scania Bus, typical passenger car and diesel rail car (g/km) in DTEI (2006) "Greenhouse Gas Emissions & Exhaust Pollution – Comparison of Passenger Transport Modes" Internal Report, March.

[2] Department for Transport Energy and Infrastructure (2006) "Greenhouse Gas Emissions & Exhaust Pollution – Comparison of Passenger Transport Modes Internal Report, March (Best estimates for "Valuation of pollutants emitted by road transport into the Australian atmosphere" Dr Tom Beer, CSIRO, August 2002).

[3] Estimates of average occupancy rates on public transport from MASTEM.

	Particulates Emissions Pm					Hydrocarbon Emissions HC				Total Tonnes	Value Local Air Pollution
$	g/km[1]	Tonnes	$/t[2] 2006	$	g/km[1]	Tonnes	$/t[2] 2006	$/t[2] 2006		Tonnes	$ /annum
l=k*j	m	n=c*d*m/ 1000*1000	o	p=o*n	q	r=c*d*q/ 1000*1000	s	t=s*r		u=(f+j+n+r	v=(h+l+p+t)
-	0.3	0.00	171,298.43	-	0.7	0.00	22,429.17	-		0.0	0.0
10,934.29	1.7	0.27	171,298.43	46,313.61	6.2	0.99	22,429.17	22,116.24		13.5	79,369.2
- 3.33	1.2	0.00	171,298.43	- 35.68	3.2	0.00	22,429.17	- 12.46		0.0	-51.5
- 1.28	0.012	0.00	171,298.43	- 0.22	0.7	0.00	22,429.17	- 1.67		0.0	-3.2
		0.3				1.0				13.5	79,314.6
- 31,749.76	0.03	-0.72	171,298.43	- 124,135.67	0.6	-14.49	22,429.17	- 325,077.12		-184.3	-481,442.6
- 2,289.65	0.3	-0.45	171,298.43	- 77,584.79	0.5	-0.75	22,429.17	- 16,931.10		-4.7	-96,809.8
- 6,868.94	0.03	-0.14	171,298.43	- 23,275.44	0.5	-2.26	22,429.17	- 50,793.30		-12.8	-80,950.3
-40,908.35		-1.31		-224,995.90		-17.51		-392,801.52		-201.81	-659,202.65
		-1.0				-16.5				-188.3	-579,888.1

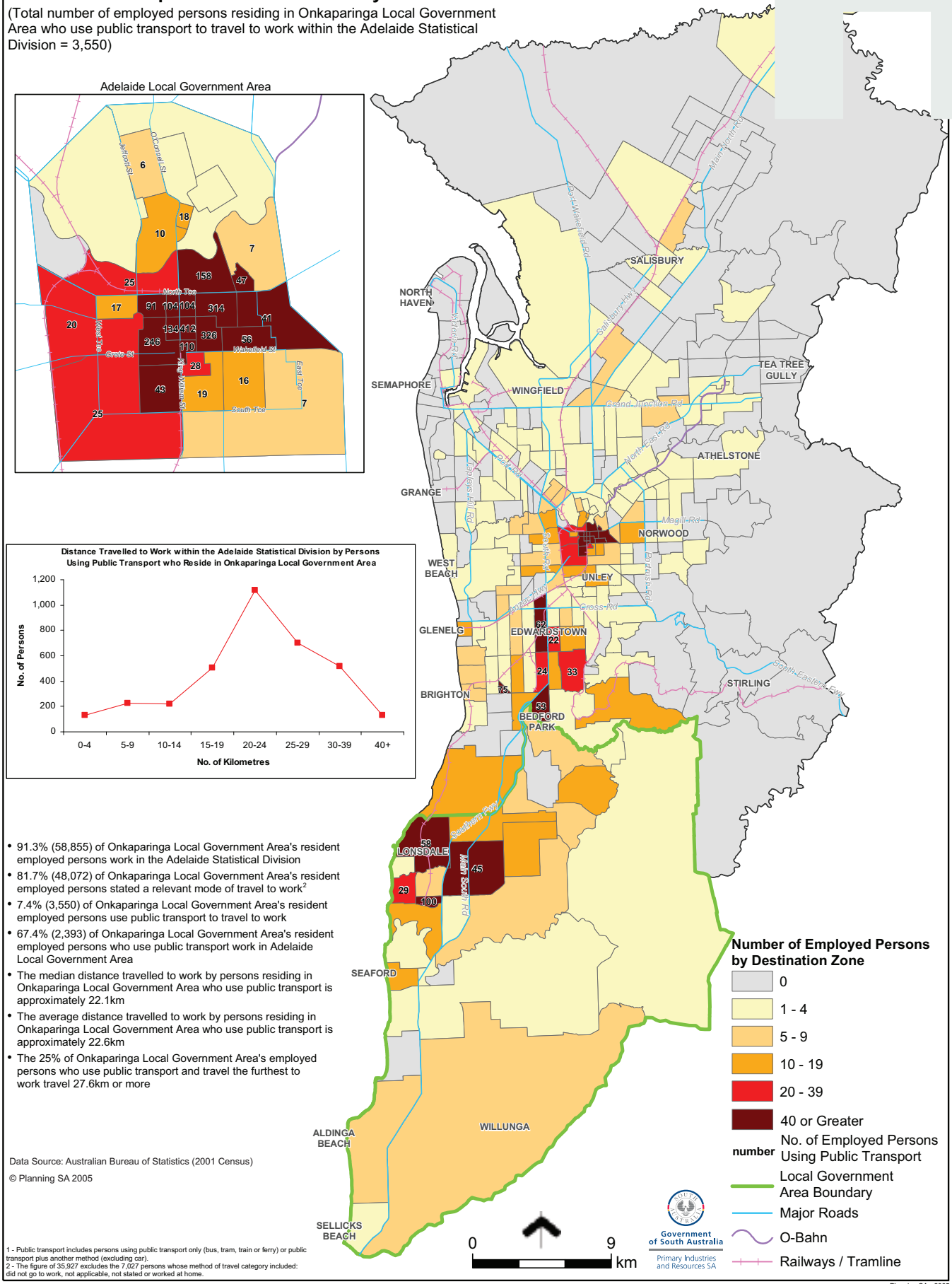
Total tonnes Greenhouse		Noise	
Tonnes	$/annum	$/vkm	$/annum
g=sum(d)	h=f*e	i	j=a*i
		0.000046	0.00
630.4	11,722.4	0.001627	258.76
		0.002673	-0.46
-0.5	-9.9	0.002673	-0.28
629.9	11,712.5		258.0
		0.009065	-218,963.87
		0.009065	-13,685.24
-10,180.2	-189,291.5	0.009065	-41,055.72
-9,550.3	-177,579.0		- 273,446.82

JOURNEY TO WORK DATA FROM THE ABS 2001 CENSUS APPENDIX

ONKAPARINGA

Number of Employed Residents of Onkaparinga Local Government Area who Use Public Transport[1] to Travel to Work by Destination Zone - 2001

(Total number of employed persons residing in Onkaparinga Local Government Area who use public transport to travel to work within the Adelaide Statistical Division = 3,550)



- 91.3% (58,855) of Onkaparinga Local Government Area's resident employed persons work in the Adelaide Statistical Division
- 81.7% (48,072) of Onkaparinga Local Government Area's resident employed persons stated a relevant mode of travel to work[2]
- 7.4% (3,550) of Onkaparinga Local Government Area's resident employed persons use public transport to travel to work
- 67.4% (2,393) of Onkaparinga Local Government Area's resident employed persons who use public transport work in Adelaide Local Government Area
- The median distance travelled to work by persons residing in Onkaparinga Local Government Area who use public transport is approximately 22.1km
- The average distance travelled to work by persons residing in Onkaparinga Local Government Area who use public transport is approximately 22.6km
- The 25% of Onkaparinga Local Government Area's employed persons who use public transport and travel the furthest to work travel 27.6km or more

Data Source: Australian Bureau of Statistics (2001 Census)

1 - Public transport includes persons using public transport only (bus, tram, train or ferry) or public transport plus another method (excluding car).
2 - The figure of 35,927 excludes the 7,027 persons whose method of travel category included: did not go to work, not applicable, not stated or worked at home.

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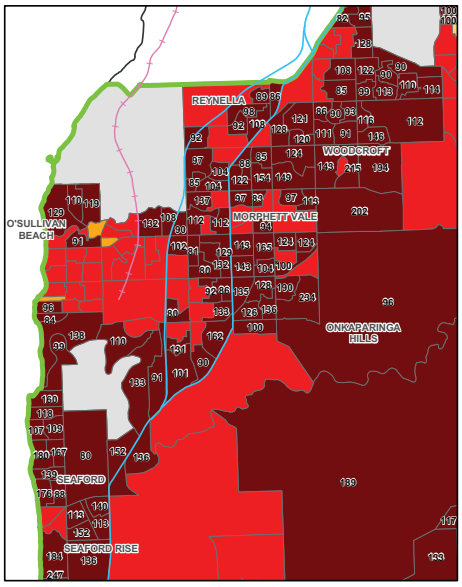
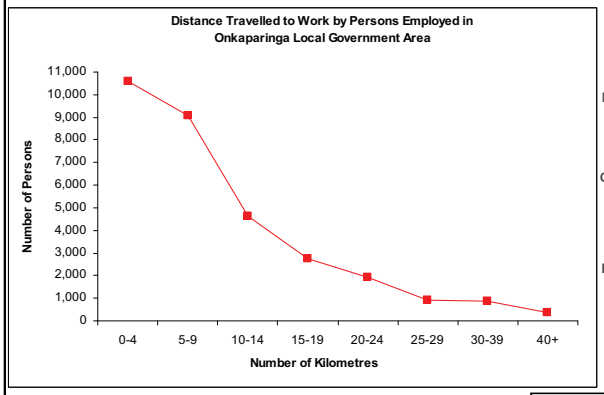
JOURNEY TO WORK DATA FROM THE ABS 2001 CENSUS APPENDIX

ONKAPARINGA

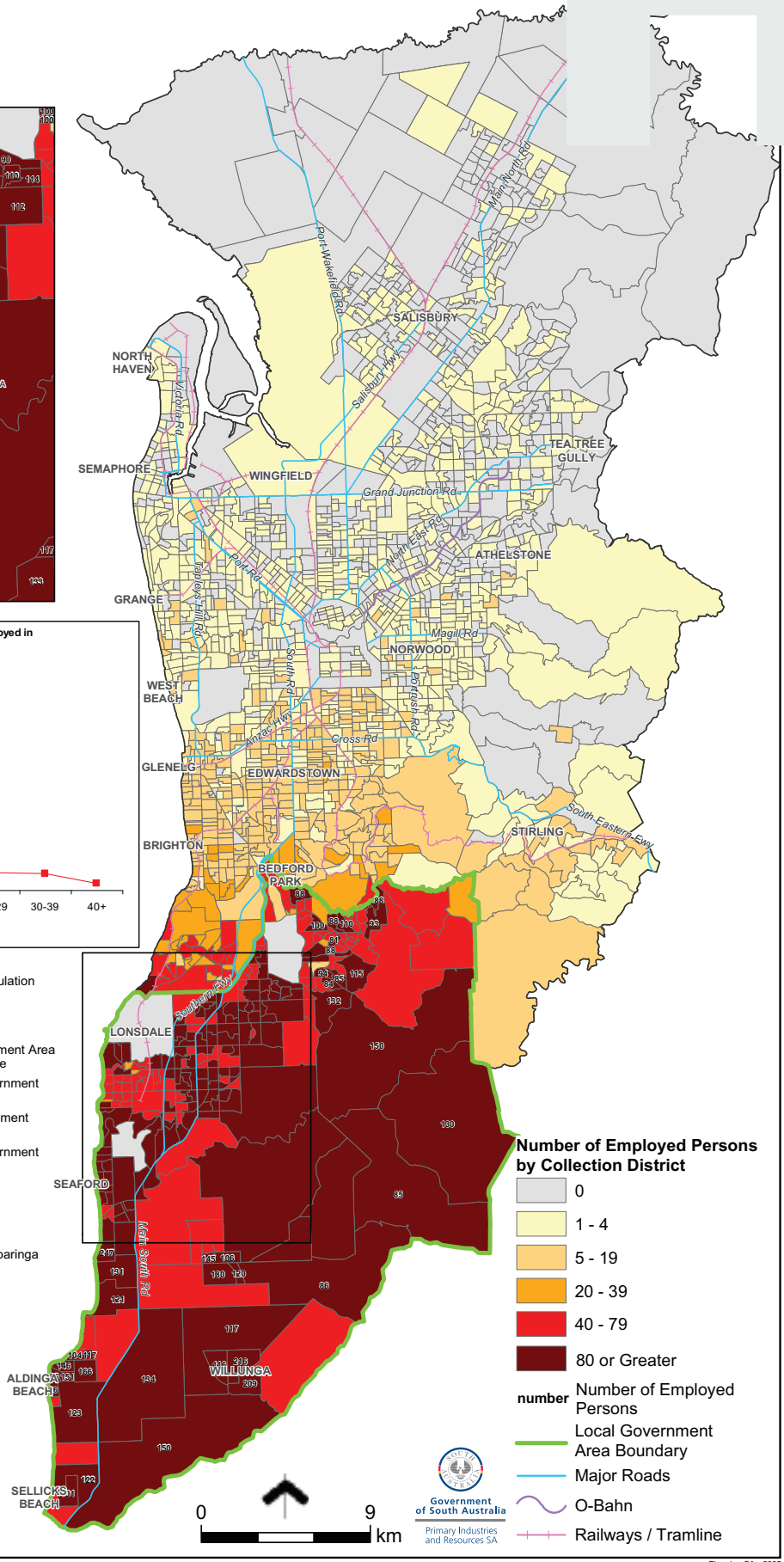
Origin of Persons Employed in Onkaparinga Local Government Area by Collection District - All Modes of Travel, 2001

(Total number of employed persons working in Onkaparinga Local Government Area = 32,217)





- 7.2% of the Adelaide Statistical Division's resident working population are employed in Onkaparinga Local Government Area
- 96.7% (31,169) of persons working in Onkaparinga Local Government Area reside in the Adelaide Statistical Division
- 3.3% (1,048) of persons working in Onkaparinga Local Government Area reside in the Outer Adelaide Statistical Division or Murray Bridge
- 76.6% (24,675) of persons working in Onkaparinga Local Government Area also reside in Onkaparinga Local Government Area
- 34% (10,594) of persons working in Onkaparinga Local Government Area travel less than 4km from their collection district of origin
- 77.9% (24,273) of persons working in Onkaparinga Local Government Area travel less than 14km from their collection district of origin
- The median distance travelled to work by persons employed in Onkaparinga Local Government Area, is approximately 6.2km
- The average distance travelled to work by persons employed in Onkaparinga Local Government Area is approximately 9.7km
- The 25% of persons who travelled the furthest to work in Onkaparinga Local Government Area, travelled 12.7km or more



Data Source: Australian Bureau of Statistics (2001 Census)

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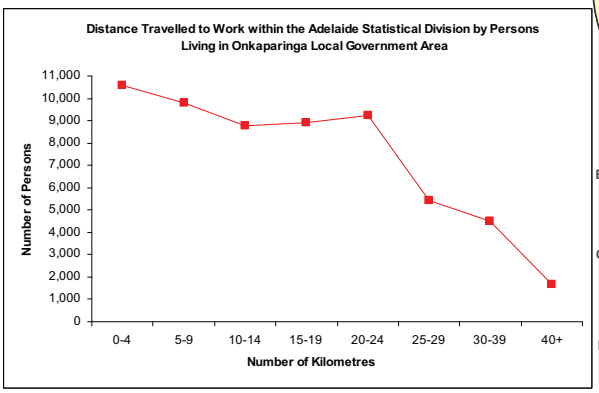
JOURNEY TO WORK DATA FROM THE ABS 2001 CENSUS APPENDIX

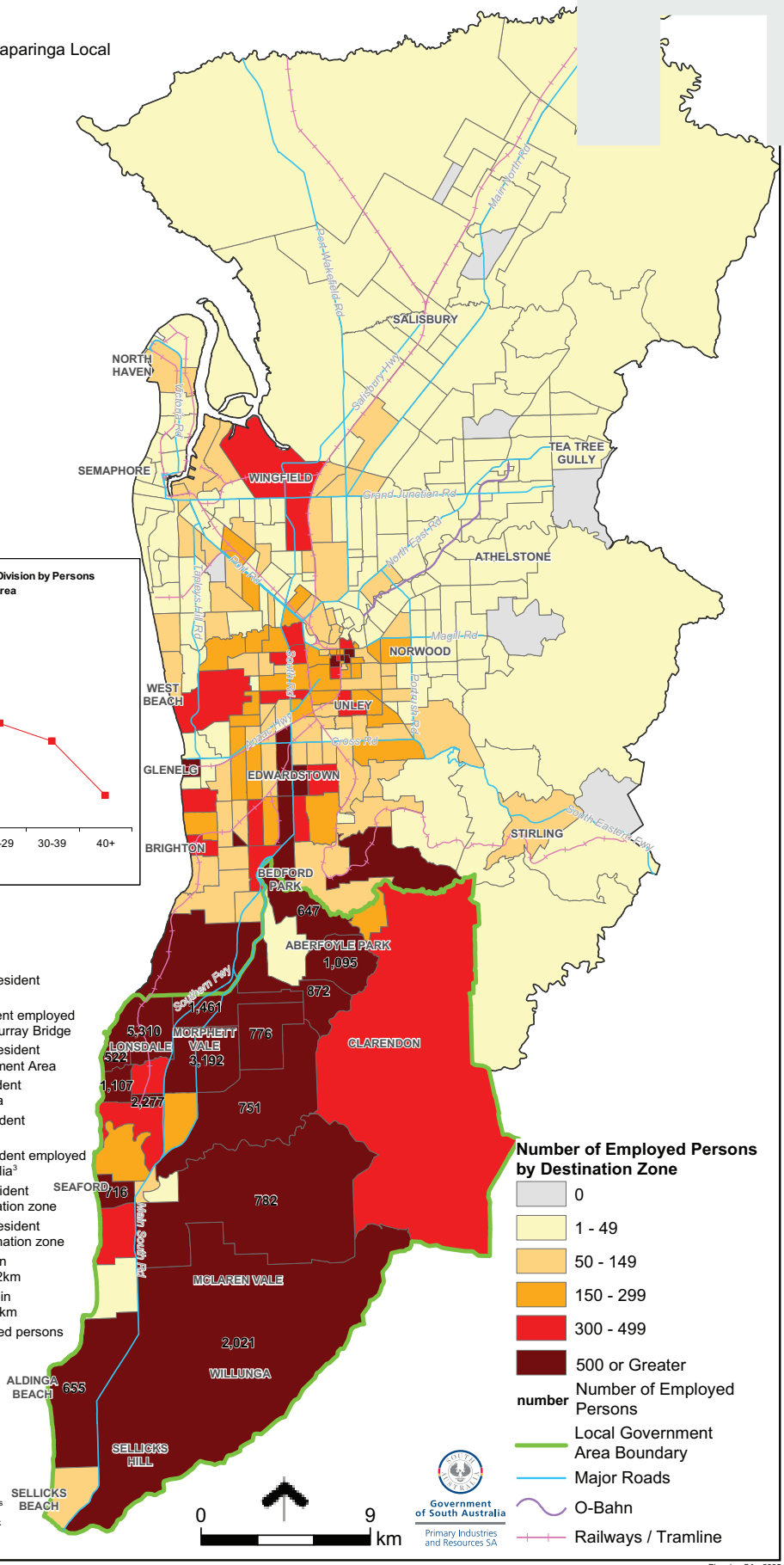
ONKAPARINGA

Work Destination of Persons Living in Onkaparinga Local Government Area by Work Destination Zone - All Modes of Travel, 2001

(Total number of employed persons living in Onkaparinga Local Government Area = 64,489)



- 91.3% (58,855) of Onkaparinga Local Government Area's resident employed persons work in the Adelaide Statistical Division
- 1.1% (714) of Onkaparinga Local Government Area's resident employed persons work in the Outer Adelaide Statistical Division or Murray Bridge
- 38.3% (24,675) of Onkaparinga Local Government Area's resident employed persons also work in Onkaparinga Local Government Area
- 12% (7,733) of Onkaparinga Local Government Area's resident employed persons work in Adelaide Local Government Area
- 5.2% (3,324) of Onkaparinga Local Government Area's resident employed persons have no fixed work address[1]
- 2.5% (1,596) of Onkaparinga Local Government Area's resident employed persons work in the remainder of South Australia[2] or Australia[3]
- 18% (10,579) of Onkaparinga Local Government Area's resident employed persons travel less than 4km to their work destination zone
- 49.5% (29,131) of Onkaparinga Local Government Area's resident employed persons travel less than 14km to their work destination zone
- The median distance travelled to work by persons residing in Onkaparinga Local Government Area, is approximately 14.2km
- The average distance travelled to work by persons residing in Onkaparinga Local Government Area is approximately 15.7km
- The 25% of Onkaparinga Local Government Area's employed persons who travelled the furthest to work, travelled 22km or more



Data Source: Australian Bureau of Statistics (2001 Census)

1 - Persons with no fixed work address are likely to be have been employed in professions such as taxi driving etc.
2 - Persons who may have either been visitors to the study area or residents who travelled to work outside of the study area to somewhere within the rest of South Australia.
3 - It is likely that the majority of persons employed in the remainder of Australia were temporarily residing in the ASD on census night, for work or travel purposes etc.

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