Transcript of speech by Edwin Michell to the Transport Australia Society of Engineers Australia on 4 October 2018, edited and with introduction incorporated by Cooma and Monaro Progress Association. The presentation included a power point display. A similar display was used by the author in presenting the railway plan to the Snowy Region Construction and Development Conference in Cooma on 15 November 2018. Slides from the second display have been posted on the website, complementing the earlier speech.

The Canberra to Eden Railway

Cooma and Monaro Progress Association is interested in the establishing of a railway between Canberra and the Port of Eden, a distance of 312 kilometres. This would be achieved by re-establishing and improving the disused railway between Queanbeyan and Bombala, and building a new railway descending the South Coast Range from Bombala to Eden, a distance of 105 kilometres. A short new link, to Canberra Airport, would complete the railway. Surveyor Charles Scrivener in 1905 surveyed an approximate route for a new section of railway from Bombala to Eden, following Wog Wog Creek and the Towamba River. Engineer and economist Edwin Michell in 2018 designed more closely a conceptual line following Scrivener's corridor. This design looked for the most favourable way across the topography and nominated the design speed for passenger trains as an outcome of that search. Freight trains would be slower. This approach resonates with experience of design of local roads in mountainous terrain. The aim was to find a favourable way, not at a pre-determined speed. Edwin Michell completed the Concept Plan of Canberra to Eden Railway in June 2018. In August he completed a preliminary estimate of the cost. By November 2018, he had completed a financial cost/benefit analysis and a socio-economic cost/benefit analysis of the concept plan.

The idea of a railway to Eden has been around for longer than Canberra itself. It was when Dalgety was a candidate site for the national capital, that Scrivener proposed the railway corridor from Bombala to Eden, as part of a Dalgety to Eden railway.

The quote on screen is from Henry Parkes, in his final weeks as premier of New South Wales. He argued then, as Edwin Michell argues now, that the natural advantages of Eden as a harbour would ensure its strategic importance, once suitable transportation infrastructure was in place. This talk will explain Edwin Michell's vision of why the time has now come to realise this century-old prospect.

Project Rationale

The Canberra to Eden railway has been conceived primarily as a freight railway, connecting the port of Eden to the national railway network. Twofold Bay, where Eden is located, has been recognised as one of the finest deep-water harbours in Australia. Eden port at present does not handle a great freight volume – about one million tons per year – but it has perhaps the greatest potential of any port in Australia, for expansion. The need for realising this potential is to link the port to the wider freight network, most importantly, to Inland Rail, which will link Melbourne with Brisbane.

Inland rail comprises 1,100 kilometres of existing railway to be enhanced, and 600 kilometres of new sections. Construction began in 2018 and the project is expected to be operational in 2025. It will follow the existing way from Melbourne through Albury and Junee, and then diverge northwards from the way to Sydney. The total estimated cost is 11 billion dollars. The Australian Government has committed nine billion dollars to the project.

The NSW government has in 2018 identified east-west links off the Inland Rail, to connect this major freight route to additional ports, as a priority for the next decade. Unfortunately, to reach those existing ports, the rail routes pass through metropolitan areas, and most of these ways are serving at or near capacity. Development of the port of Eden would make an alternative freight gateway that bypasses the bottlenecks.

The plan also proposes a rebirth of passenger trains in the Canberra region. A fast, frequent passenger service would improve access to affordable housing, reduce the pressure to expand Canberra, and improve connectivity to the ACT public transport network.

Finally, re-opening the Canberra-Bombala railway could eventually result in integrating with an improved fast railway to Sydney, and possibly also an extension to link up with the Victorian regional rail system, or even the Snowy Mountains skifields.

Why now?

The Queanbeyan-Bombala railway was closed 30 years ago owing to low freight and passenger volumes. What has changed so much in that time, that we should take another look at this railway?

The first thing to consider is that this is going to be more than a re-opening of the Bombala line. The Bombala line was a provincial branch line with limited volumes of freight flowing from the small farming community north to Sydney. A main line extension to Eden however, will attract large volumes of freight from far beyond the immediate region, flowing both to and from the port; and faster speeds for passenger trains will mean that the train can once again be a genuine competitor for road transport.

Australia's freight industry is presently hampered by a lack of competition, capacity constraints, and high costs. Rail's share of the freight task is presently low, but increasing energy costs are making road transport relatively more expensive, and the existing metropolitan ports are relatively high-cost and congested operations. Also, environmental and community concerns make it difficult or impossible to establish new ports.

Thirty years ago, Barangaroo was Sydney's container terminal, and now it's all high rise. Also some of the recent attempts to create new ports at James Price Point and Abbot Point show the difficulties of making an entirely new port. It is far easier to connect an existing port to the freight network than to build an entirely new port, especially in the relatively densely populated and environmentally sensitive south-east of the country.

Housing affordability is also something that has changed a lot in 30 years. Thirty years ago, Australia's population was 16 million. Now it has recently passed 25 million. Sydney's median house price back then was less than $100,000. Now, it is about one million. This expense is pushing people further from CBDs and extending commute times.

Finally, improved construction techniques compared to a century ago, particularly, large scale earth moving equipment and low cost segmental concrete bridge construction mean it is now far easier to construct railways through mountainous terrain such as the South Coast Range of New South Wales.

Major Works

The first major work is rebuilding the existing line to modern standards. The condition of the line is no longer suitable for returning to regular use. The plan proposes full replacement of all the existing track there – rails, sleepers, and the layer of coarse stone, named ballast, used as a bed for the sleepers; and replacing timber bridges and culverts with concrete.

This will be a single track railway with passing loops at intervals of roughly 50 kilometres.

Where the curvature of the existing alignment is too tight for higher speeds, there will need to be deviations to increase the radius, allowing higher speeds.

For passengers, improving accessibility of the Canberra terminus is essential. Canberra Airport has been quite vocal for some time about locating a fast rail station there, but it is also important to have adequate links to the ACT public transport network in order to reduce the proportion of park and ride travel.

The most significant engineering challenge is the descent of the escarpment of the South Coast Range from the Monaro to sea level. The challenge, however, is not unprecedented in modern Australian experience. It is similar to sections of the Inland Rail in Queensland between Toowoomba and Brisbane.

A preferred corridor for descent of the South Coast Range has been identified, with elevation mostly not far from the existing ground level, with relatively few tunnels, bridges and viaducts, broadly similar to the route proposed by Scrivener in 1905.

Railway Specifications

The concept plan has adopted railway specifications of Australian Rail Track Corporation, as the governing standard to ensure full interoperability with the wider Australian network. Significantly, that entailed a full replacement of timber sleepers with concrete, and the 45 kilogramme per metre rails with 65 kilogrammes per metre, as well as full replacement of ballast to a depth of 300 millimetres below the sleepers.

In order to achieve higher speeds for passenger and freight rail, the plan uses the same typical minimum radius as for Inland Rail, 800 metres, which allows 115 kilometres per hour running of freight trains. In a departure from Inland Rail freight standard, 650 metres has been adopted as the absolute minimum radius, higher than Inland Rail's 400 metres, as 650 metres is the minimum radius at which tilting passenger trains can achieve 160 kilometres per hour. This reflects the greater importance of passenger rail to the Canberra-Eden business case, compared with Inland Rail.

Maximum gradients are informed by the existing maximum gradients on the Queanbeyan to Bombala line, namely 2 to 2½ per cent. While this is steeper than the ideal for a freight railway, these are the same maximum values that have been adopted on Inland Rail.

Route Overview

The proposed route is shown on the map. We are going to look at the estimated construction quantities and costs in three sections: firstly, Canberra to Cooma, a 114 kilometre section, and mostly following the existing line; Cooma to Bombala, 93 kilometres, still following the existing line, but with extensive deviations to improve the curvature; and Bombala to Eden, 106 kilometres of all new alignment via Nungatta and Towamba. Three preliminary routes were identified, shown in pink, blue, and orange on the map, but we will be discussing the orange route via Towamba, which was by far the most suitable of the three.

ESTIMATED DIRECT CONSTRUCTION COSTS PLUS LAND, EXCLUDING CONTRACTOR'S OVERHEADS AND CLIENT'S COSTS

Canberra to Cooma: $386 million, comprising:

Track (ballast, sleepers and rail)	28%
Replace 5 bridges and 2 new bridges, 2,510 linear metres	19%
Earthworks easing curves, several locations, 2.2 m cu m	13%
Colinton tunnel, floor lowering	1%

Signalling	11%
Civil works incl. 5 separated road Xings, level Xings, drainage, fencing	15%
Stations	11%
Land	2%

The slide shows a plan view of the railway with north on the left, above; and an elevation profile, below. This section is the better of the two existing sections. It was built to the mainline standards of the day. There are only five locations where any deviaton from the existing corridor is required. Mostly minor in scale, only a couple of kilometres long, and typically moving the line less than a hundred metres. The major exception is a 1,400 metre long viaduct at Tuggeranong to bypass a long tortuous sub-section. The maximum gradient (named the ruling gradient) of the section is 1 in 40, that is 2½ per cent, on the initial climb out of Canberra. While this is steeper than ideal for a freight railway, it is the same as on Inland Rail.

Cooma to Bombala: $261 million, comprising:

Track	31%
Bridges and culverts, 1,600 linear metres	10%
Earthworks	24%
Signalling	9%
Civil works	17%
Stations	4%
Land	5%

This section was not built to as high a standard as the Canberra to Cooma section, and so to improve it to modern standards there is a greater proportion to be deviated from the existing corridor. However, despite these deviations being quite long, they are generally minor, mostly lying within 200 metres of the existing line and in no case further than one kilometre, so compensation for land acquisition should be much lower than for an unrelated railway. The earthworks in this section, although greater than in the previous section, about three million cubic metres, are quite manageable, with most of the cuttings or embankments less than five metres in height, and only a handful up to 15 metres. There are fewer bridges on this section. The total cost is lower, at about $2.8 million per kilometre.

A feature of the profile is the long climb at a gradient of 1 in 70 up to Nimmitabel, at an elevation of almost 1100 metres. The deviations are required particularly after Nimmitabel. The most significant is at the MacLaughlin River. Another notably long deviation is between Jincumbilly and Bombala where the existing winding alignment needs to be straightened. The ruling gradient throughout Cooma to Bombala is 1 in 40.

Bombala to Eden: $1.06 billion, comprising:

Track	10%
Bridges and culverts	26%
Earthworks	33%
Tunnels	12%
Signalling	3%
Civil works	3%
Stations	9%
Land	4%

There is no existing railway between Bombala and Eden, so this section is all new. It is approximately the same length as each of the two previous sections but about three times as expensive, which reflects the mountainous terrain of the South Coast Range. Almost three quarters of the cost is in tunnels, bridges, and earthworks. The route would include three tunnels, 13 viaducts, 7 bridges including a 740-metre-long cable-stayed bridge over the last crossing of the Towamba River, and over 16 million cubic metres of earthworks, with cuttings and embankments up to 25 metres in height. Although the eventual volume would possibly reduce, the actual volume would still place this project among the largest for earthmoving in Australia. It is not in the same league as Badgery's Creek Airport which is reportedly going to involve 50 to 100 million cubic metres of earthmoving. Land acquisition is estimated at only 4 per cent of the total cost, reflecting the large proportion of the alignment which is within State forest and bushland.

The plan view, with north at the top, shows the alignment starting in farmland, mostly flat, south of Bombala, and generally following the Monaro Highway corridor. The railway crosses the top of the escarpment near Bondi Forest at an elevation of about 740 metres. The railway follows a double reverse curve over Bondi Creek and White Rock River. It turns towards the planned Nungatta station near Imlay Road, and after a number of viaducts and a 950-metre-long tunnel, the line emerges into the Towamba valley near Burragate. It then follows the Towamba River, crossing the river twice and eventually emerging from the river valley near Boydtown on the southern shore of Twofold Bay.

The cost estimate includes a major redevelopment of the Port of Eden with the construction of a large intermodal and bulk freight handling facility.

The curvature of the double reverse curves has a minimum radius of 650 metres, allowing speeds for freight trains of 100 kilometres an hour, and for tilting trains, 160 kilometres an hour.

The elevation profile shows a near monotonic descent from the top of the escarpment down to Towamba, with a flat section about one quarter of the way down at Nungatta, where a passing loop and a forestry freight handling facility are proposed. The flat section is long enough for an uphill train to reach its maximum speed again, which significantly improves average speed. The ruling gradient of this section will be 1 in 60, possibly even 1 in 70 with further optimisation of the route, which is quite acceptable for a freight railway.

CONCEPTUAL PROJECT COSTS AND SCHEDULE

In total, the direct construction costs excluding preliminaries and general costs in contracts come to $1.71 billion spread over five years. To these costs are added the preliminaries and general costs, client costs, and contingency. Contingency is not an expected construction cost, but is intended to inform budgeting at the early stages of a project. It is to account for unforeseen cost increases and the possibility of increases in project scope. The estimate has followed a best practice approach at concept planning stage and includes a relatively large contingency. This contingency would typically be expected to reduce, ideally to zero as the planning process continues. The contingency which has a 50 per cent probability of not being exceeded, P50, was assessed as $272 million. The contingency which has a 90 per cent probability of not being exceeded, P90, was assessed as $679 million.

Accordingly:

Direct construction costs		$1.71 b			
Preliminaries and general costs		$0.305 b			
Client costs		$0.256 b			
	Subtotal	$2.27 b			$2.27 b
Contingency	P50	$0.27 b		P90	$0.68 b
Totals	incl. P50 contingency	$2.54 b;		incl. P90 contingency	$2.95 b.

The assessed construction period was five years, from 2022 to 2026; with the sections to Cooma and Bombala taking three years, from 2022 to 2024.

Freight train performance

Freight trains are specified to run at a maximum speed of 115 kilometres per hour, with some lengths of the railway limited to 100 kilometres per hour. This would allow a travel time from Canberra to Eden of approximately 4 hours; the northbound time would be 4½ hours, the longer time owing to the climb between Eden and Bombala.

At the gradient for the main climb up from Eden to Canberra, about 1 in 60 to 1 in 70, the uphill speed at full throttle of the locomotive with the assumed freight load is about 40 kilometres per hour.

Freight demand

The estimated freight demand for the railway is about 5.3 million tons per year in 2025-26. This includes potential demands including grains, cotton, fresh fruit and vegetables from the Riverina, Central West, and North West Slopes of New South Wales, possibly with imported fertiliser as a back load; timber from the southern forest, to the interior mills, and to Eden for export; quarry products from the Monaro; and intermodal containers to and from logistics hubs in major cities.

Providing a major freight link to the Port of Eden enables consigners to take advantage of the lower costs at Eden compared with other major ports. Wharfage across Eden is approximately $66 less per 20-foot container than at Port Botany: it is less than half the total cost. For bulk freight, wharfage at Eden is almost as low as half the cost at Port Botany. Pilotage, navigation, and mooring costs are also significantly lower at Eden than at competitive ports. Additionally, in providing a direct-to-port link, not dependent on passing through any congested metropolitan areas, or on switching mode to truck for the final few kilometres, Eden has a significant advantage over other ports and freight railways. With the right infrastructure, both in the railway link and the port itself, Eden could become the port of choice for the Riverina, most of the Central West, and virtually the whole of the South East of New South Wales.

Railway Lines in New South Wales

The map of railway lines in New South Wales shows how Canberra to Eden fits into the wider network. It shows main lines in red, branch lines in orange, and closed lines in grey. The route of Inland Rail, that is, from Melbourne to Brisbane, is shown in blue.

The route in yellow is the way which freight using the Canberra to Eden railway would take from Inland Rail to the coast. Cootamundra is near to the junction between the two railways. It is important as being the point at which the distance to Melbourne and Eden is equal, 500 kilometres to both. North of Cootamundra is the natural market for an upgraded port of Eden, perhaps even a short distance on the Melbourne side of Cootamundra, owing to the higher efficiencies of the freight railway and the port at Eden. At the other end of the natural market zone is Dubbo, from where it is 800 kilometres to both Brisbane and Eden. Accordingly, the likely market catchment is shown, encompassing a considerable proportion of the State, and that is how the volumes of agricultural and containerised freight that are likely to use the railway, have been estimated.

Passenger train performance

Tilting passenger trainsets have been specified for the Canberra to Eden railway, having a maximum speed of 160 kilometres per hour for the railway as specified. There are no speed restrictions except at the approaches to major stations, where the trains will be slowing down anyway.

Eight passenger stations have been identified on the route, all of which have potential for high quality residential development nearby at relatively low cost.

The travel time savings by rail compared with car would average about 30 per cent. Canberra to Cooma would be 52 minutes, putting Cooma well within Canberra's commuter belt. Bombala would be 1 hour and 33 minutes, and Eden, 2 hours and 19 minutes. This would facilitate a timetable of perhaps one service every six hours in each direction, per trainset.

Passenger demand

The eventual passenger demand was assessed as approximately 3,500 passengers per day, or 1.3 million passengers per year. This would comprise about 10 per cent of existing car traffic, all coach and Cooma air traffic, significant tourism demand from cruise ships at Eden, and beach travel by Canberrans, but most of all, induced demand from residential development on the Monaro townships. The induced demand will build up over time from the opening of the railway. The ACT's population growth rate in 2017 was equal highest in the nation, an increase of about 9,000 people per year. If five per cent of these new Canberrans were to decide not to settle in the city but in townships from where they could commute to work by fast train, within three years there would be 1,500 return trips per day: 3,000 individual trips, and that is just commuter demand. Incidental demand, tourism, airport transfer, and travellers continuing on to Sydney, or possibly in the future to Victoria or the skifields, would generate more demand which could be expected to grow for the foreseeable future. There would be a significant population increase for the Monaro townships, which would only be made possible by appropriate high quality residential development in cooperation with State and Local governments.

The next graph breaks down passengers by their main destination. While a two-thirds majority are between Canberra and Cooma, which reflects commuter demand in the northern Monaro townships, the demand beyond Cooma is significant, owing to the holiday demand for Eden as a seaside resort, as well as residential demand in the southern Monaro and far south coast. The demand could be met by three trainsets, each of four cars and 200 passengers capacity, running nine services per day between Canberra and Cooma, and four services per day between Canberra and Eden. Frequency could be concentrated in the morning and evening peak times, with additional services for Eden on the weekend, when commuter demand is lower and holiday demand is higher.

Financial Appraisal

Financially, the freight railway is expected to be competitive with Inland Rail, and with the existing Australian Rail Track Corporation freight charge of $24 per thousand net-ton-kilometres. In 2025-26, this would yield a yearly revenue of $32 million, exceeding the operating and maintenance cost of $8 million. Passenger service is not expected to make an operational profit in its own right. However, passengers are still critical to the overall financial viability of the project, owing to the ability to facilitate value capturing development. With a railway proponent authorised to release land at a rate of up to perhaps one thousand dwellings per year for ten to twenty years, this could offset initial capital costs to the extent of approximately one billion dollars over the course of the project. So the railway is unlikely to be viable without some level of public subsidy, which is justifiable by social benefits of reduced road congestion, improved access to affordable housing, transport mode choice for freight customers and passengers, and the achievement of wider regional development goals.

The appraisal assumed a 50 per cent public contribution to construction costs and a subsidy to passenger operations averaging $12 per passenger trip. Both of these subsidies are well within the typical range of major transport and infrastructure subsidies in Australia. For example, the typical operational subsidy for regional Victorian rail services averages $20 per passenger trip. Given

the assumptions, the private payback period is estimated as 19 years with an internal rate of return of 4.4 per cent per annum. This could be improved by a greater level of value capture development, higher than expected freight volumes, or higher public subsidy.

Cash Flow to 2057

The final graph shows projected cash flows from construction start, assumed to be in 2022, with transfer of ownership to the government after thirty years of operation in 2057.

The columns show the various expenditures and incomes; the most important feature is the red line which shows the net cash position by year. The project becomes cash-flow-positive as soon as the railway is fully operational in 2025-26, and recovers the construction and interest expense in the nineteenth year of operation. The upfront construction expenditure is quickly reduced by the large value capture income in the first three decades of the project.

The two dashed lines below show the net cash position under different value capture scenarios. The green dashed line shows the result if only half the projected value capture income is received. And the blue dashed line shows no value capture at all. The three scenarios make the difference between a strongly profitable enterprise and one that is either barely profitable, taking almost forever to recover its cost, or a project that never achieves profitability at all.

Passengers *and* freight are essential in this economic assessment of success of Canberra to Eden rail or, it can be argued, of most railway projects. The freight operation is profitable in its own right, but it is not profitable enough ever to pay for the upfront capital costs. The passenger operation enables value capture income to offset the construction expense. But the number of sites available for development is finite, and once they are fully developed, the value capture income will drop off dramatically. Passenger fares alone are not likely to be profitable in the long term.

Freight and passengers are both essential: passengers to pay for construction, and freight to ensure the long term viability of the railway.