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APPENDICES

APPENDIX 1

The Physical Determinants of NSW Rail Passenger Services

THE PHYSICAL DETERMINANTS OF NSW RAIL PASSENGER SERVICES

The suburban and non-urban rail network in NSW is inherently radial (Maps 1 and 2, inserted after page 259). This pattern is a function of NSW's and Sydney's geography, geology and topography as well as their history of land settlement and use.

New South Wales covers an area of some 800,000 square kilometres, most of which was once within reasonable access to a railway line. Four main physiographic zones divide the State: the coast, the tablelands (containing the Great Dividing Range), the western slopes of the Great Dividing Range, and the western plains. The tablelands comprise a succession of plateaus, from 60 to 160 kilometres wide. The plateaus range from an average 750 metres in the north to the Kosciusko Plateau in the south, containing Mount Kosciusko (2,228 metres) (Australian Bureau of Statistics 1983). It was the physiography of the State which presented the railway engineers in the 19th Century with challenges rarely experienced in European railway building. Given the level of railway construction technology of the late 19th Century, the major barriers of the Dividing Range were conquered, the deep and unpredictable coastal rivers bridged and a railway line laid along the dangerously unstable shale cliffs of the Illawarra escarpment. By the time Australia developed into a world leader in open cut mining and freeway construction technology (the "mountain moving" business) in the 1960s and beyond, little money was available to improve railway line curves and gradients, and re-build bridges. Like a dinosaur's bones, the State's non-metropolitan permanent way lay in its geological cradle as mute testimony to an Heroic age which technological change had long since passed by. But, it continues to impose its constraints upon cost efficiency, rail safety and service quality to the present day.

Climate is a factor which affects all rail systems and NSW is no exception. The State's climate is generally mild, and free from extremes of heat and cold. But, very high temperatures occur in the north-west and very cold temperatures in the Southern tablelands. Rainfall is associated mainly with tropical and southern depressions, and varies considerably across the State. The largest amount of rain falls in the coastal areas. Annual rainfall varies between 20 per cent and 35 per cent from the mean. Long periods of dry weather in parts of the State occur regularly, but State-wide droughts are rare (Australian Bureau of Statistics 1983). Heavy rainfall and floods have, at times, had a major impact on the operations of the railways, as noted in Chapter 6.

The physiography of Sydney has also had a major influence on the development of the suburban and interurban passenger railway systems. Sydney is located in a well watered and fertile coastal basin. The suburban railway catchment area is bounded in the West and North by the Hawkesbury-Nepean River system, and in the South by the Georges and Port Hacking Rivers. The Parramatta River and Port Jackson provide a natural divide between the northern and southern areas of Sydney. Other topographical features have also determined the development of land use and transport. For example, there is the sub-montane ridge extending from North Sydney to Hornsby which became the preferred site for the North Shore Railway, and led to the suburban development surrounding it. To the North, West and South, the area is bordered by extensive montane regions, which give Sydney its characteristic basin like topography. The montane and sub-montane ridges carry substantial lengths of railway line where gradients of 1:40 are needed. This terrain has also had an influence on the designed capacity of the rollingstock which is higher than normal. This increases capital costs. The terrain also adds to rollingstock maintenance costs, and electric power consumption. Topography, and the proliferation of watercourses, has resulted in the need for many bridgeworks, cuttings and embankments.

Average annual rainfall of Sydney is relatively high at 1214 millimetres. However, recorded variability has been considerable, ranging from a maximum of 2193 millimetres to a minimum of 584 millimetres. Heavy rains have caused major disruption and damage to the network from time to time.

APPENDIX 2

RAILDATA

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A2.1 INTRODUCTION

The essential problem was to develop a robust and consistent database for the thesis which would produce useful results for the empirical analysis. It is strongly believed that this has been done in the work described here in Appendix 2.

The work has also had two unforeseen but happy outcomes. First, it has demonstrated that NSW Railway Accounts (and, for that matter, any Railway Accounts) until very recent years, can yield most of their secrets to standard spreadsheet methodology, if enough care is used in interpreting results over a long enough period of time. There is indeed a "golden thread" of veracity in the Accounts.

Some further points, however, need to be noted:

1. What appears in RAILDATA here is only the tip of a database iceberg. The tables are essentially summaries of a greater volume of data. Sorting, cataloguing and publishing the data could, perhaps, be the subject of an independent research project. For the purpose of the thesis, it was felt that it was more important to explain the methodology of the database which has been done at some length.
2. A further reason for not including all the numbers in RAILDATA is that they are copious and would add too many more pages to the thesis.

A2.2 THE PRIMARY SOURCE DOCUMENT: THE ANNUAL REPORT

A2.2.1 Introduction

The Annual Reports are required to and have always presented a "true and fair view" of the financial position of the NSW Railways (the terms of the NSW Auditor General's certification of the annual accounts). Whilst accounting conventions accepted in the past have distorted some elements of the financial position, and whilst key data has sometimes been deliberately omitted in a particular year, a "golden thread" of robust and consistent records of financial transactions runs through the Annual Accounts year after year. The art in making sense of the financial data is to identify the "golden thread", in the obfuscation of notes and qualifications to accounts. This requires some background knowledge of the workings of the railways.

In accepting the usefulness of the Annual Accounts, the author has also accepted their limitations as they represent a financial accounting approach to the compilation of railway costs. However, by a careful re-formatting of the accounts, it is possible to arrive at a compilation which is in the NFG 2 format. This is based on a set of costing conventions generally adopted by all railways in Australia. One useful convention is that of a "long run avoidable cost" of operating a railway service. NFG 2 also enables costs to be derived from unit cost data. One further, unexpected, bonus was that it identified Business and Corporate Overheads, and its rapid growth from the 1970s.

Having presented the data and pronounced its usefulness in calculating Total Factor Productivity, the thesis comes out in support of an alternative and somewhat iconoclastic viewpoint which asserts that there are severe limitations to the NFG 2 model of railway costs as a tool for assessing future strategic options for railway systems. This alternative view is termed the Beesley/Kettle model (Beesley and Kettle 1985). In its Australian context, it was developed in 1980 to put forward strategies which would have helped the Victorian Railways to achieve pricing efficiency. But the concepts have equal validity in determining production efficiency.

Beesley and Kettle have a number of difficulties with NFG 2 and other unit cost conventions. First is the inbuilt assumption that the model produces one unique and "true" cost for a railway activity. Beesley and Kettle show clearly that there is no such thing as a single "true" cost, when we are considering various strategic options in an ex ante, strategic decision-making sense. Also, that future costs are only measurable with respect to future, specified output changes. Nevertheless, the Beesley/Kettle model acknowledges that an analysis of historical costs is useful if it can provide insights to the behaviour of future costs. Because we use the techniques of econometric analysis to develop Total Factor Productivity measures, we are required to identify any cause and effect relationships which may exist with respect to costs.

The second difficulty experienced by Beesley and Kettle is the assumption that cost avoidability is instantaneous. They argue that there are time lags (sometimes substantial) before costs, labelled as avoidable, can be truly avoided. When one considers the non-flexibility of labour resources in particular, this notion becomes self-evident.

Thirdly, Beesley and Kettle prescribe three basic requirements which must be met, when costs are measured: costs must be relevant, they must be correctly valued and their structure must be known. With these injunctions in mind, the thesis identifies a number of areas where there are specific shortcomings in the NFG 2 methodology when applied to New South Wales Railways' accounts or in the accounts themselves. These are as follows—the railway accounts do not adequately provide for the depreciation of railway fixed assets, the 25 percent value of NFG 2 on variable track maintenance is inappropriate, technological changes in the areas of railway signalling, safe working, shunting and terminal operations need special case studies because of likely impacts on future productivity in practice there has been a blurring in the allocation of costs of track and structures, to maintenance and capital, there appear to be very significant gaps between the valuations of non-renewable capital at historical cost and at market value and the labour theory of human capital points to new ways to decide the optimum size of the future railway work-force.

The thesis proceeds from two logical and practical premises:

1. Because econometric methods are used to develop measures of productivity, all a priori information which is a matter of public record (through Annual Accounts) is used.
2. Whilst the analysis of cost outlays in any given year is an ex post one, these cost outlays refer to given outputs for that year and represent the outcomes of railway management on political decisions made during that year or in the previous year.

A2.2.2 The NFG 2 Conventions

A Working Party on (Railway) Inter-system Freight Costing was set up in October 1984 under the chairmanship of the National Freight Group (NFG) to develop a common set of costing conventions.

The format in Table A2.1 and cost categories is used for reporting the cost of railway traffics, services or business segments to NFG and external bodies.

The above includes capital as defined in NFG 2.

Thus the approach of econometrics is not inconsistent with Beesley and Kettle, if it is accepted that the method of econometrics is a priori and ex post, and for the specific purpose of providing insights which may be used in any ex ante analysis.

There are other practical limitations to NFG 2, in the context of doing business in the freight area, but these limitations are not pertinent to our TFP analysis.

Following a series of meetings, a costing convention was developed which subsequently became known as NFG 1. This convention was used by all railways for the costing of inter-system traffics and also became the de facto standard for reporting costs to Governmental Inquiries and Commissions.

In November 1989 and June 1990, the Working Party met under the chairmanship of the NFG to review experience with NFG 1 and to consider a number of changes in view of its growing use beyond its original purpose. Those attending included the principal officers responsible for traffic costing in each of the five ROA systems.

The meetings met their major objectives of revising NFG 1, for a wider role in railway costing including passenger services and application to business segments as well as individual traffics. The Working Party recommended the adoption of the conventions described below, which collectively became known as the NFG Costing Convention, or NFG 2, summarised in Table A2.1.

Table A2.1 External reporting format (NFG 2)

Item	Explanatory Notes
TRAFFIC	
Net tonnes/passengers	
Net tonne-kilometres/passenger-km	
REVENUE	
Traffic	
Other	
COSTS	
Train-running	
Train crew	See B
On-train crew	See C
Rolling-stock maintenance	
Locomotives	See D/E
Self-propelled/Carriages/Wagons	See D/E
Rolling-stock renewals	See K
Road Services	
Sub-total	
Corridor Variable	
Variable track maintenance	See H
Terminal	
Freight handling	See G
Passenger duties	See G
Shunting	See F
Train examiners	See E
Bogie exchange/transfer	See F
Sub-total	
Total Long-Run Avoidable	
Corridor Fixed	
Track and structure maintenance	See H
Signal and communications maintenance	See J
Signalling, train-working and train control	See K
Non renewable capital	See M
Sub-total	
Business Management	See N
Corporate Overheads	See O
TOTAL	

Note:

For an explanation of each item, see A2.2.2.

The National Freight Group Costing Convention (NFG 2) was developed to provide a basis for traffic costing for railway business planning purposes. The convention provides a consistent methodology for the estimation of costs and common format for their presentation across systems. It is, therefore, suitable for presentation of costings to the National Freight Group and external bodies in such a way as to give assurance that costs have been developed on a common basis. It also provided a standard for business segmentation.

The convention was based around long run costs (nominally five years). For application to other than long run business planning, some adjustments to the costs may be necessary. In particular, the costings may not be appropriate for the formal presentation of annual accounts, nor may they be directly comparable with competitors' costs where these are not developed on an equivalent long run basis.

The Working Party also agreed on the appropriateness of NFG 2 as guidelines for:

- Long run business planning purposes.
- Point to point costing.
- Segregation of major business areas (e.g. passenger/freight split), thus coming up with a practical resolution to the joint cost problem.
- Reporting commodity group/business sector results.

The following general points of application are therefore emphasised:

1. Cost structures of current and previous years are often an appropriate guide to future costs when no better information is available. However, more efficient unit costs may be used to cost future situations where there are realistic plans. For example, where industrial limitations reduce terminal productivity, the achievable cost may be substituted for the historical cost if there are realistic plans to remove such limitations.
2. Care must be taken in the use of historical track, locomotive and wagon maintenance cost data to avoid costs for particular lines or units which, in any one year, are abnormally high or low due to the periodicity of major maintenance and overhauls. Annual averages taken over longer periods should then be used to derive unit cost rates. At the same time, it is recognised that, in particular, locomotive maintenance will increase with age and this factor may be included where relevant information is available.
3. Where the costs of departmental traffic have not been specifically charged to the appropriate operating branch, they should be taken as related to track maintenance and allocated to traffics on a gross tonne-kilometre basis.
4. NFG 2 will attribute about two-thirds of cost to specific traffics as train running and terminal costs. These costs represent the long-run avoidable costs of a traffic. When an overview is being taken of a total corridor or business segment, the remaining costs which are not attributable to specific traffics (such as signalling and communications, the fixed component of track costs, other infrastructure maintenance, other corridor costs not allocated to traffics and an allowance for business and corporate overheads), should be allocated as described earlier. The sum of these unattributed costs and the long run costs attributable to individual traffics as

measured by NFG 2, broadly represent the break-even level of revenues for the corridor as a whole.

5. On some occasions, there may be "opportunity" traffics offering for a shorter term than that underlying NFG 2. The Working Party recognises that on occasion, a shorter-term view of cost increments may be appropriate, but explicit justification should be given in such cases.
6. All traffic costings which are supplied to NFG and external bodies, based on the NFG 2 Costing Convention, should be identified as adhering to NFG 2 and be itemised in the above NFG 2 cost components. Where the method used differs significantly from NFG 2, this should be identified and reasons noted.
7. The legal, organisational and financial environment in which rail systems exist vary from system to system and, of necessity, reporting formats will vary. The convention is not intended to be used as an account reporting standard for annual report purposes. However, the methodology of NFG 2 should still apply as a guideline to segregating passenger and freight costs etc.
8. The NFG 2 principles need not be applied where specific information is available on resources for particular traffics and the attribution of costs will be more relevant and accurate than application of general NFG 2 principles. For example where crew, examiners and locomotive services costs can be identified at depots which handle one traffic only such as coal.

The recommended convention for NFG 2 was:

A. General principles with respect to:

- Allocation of labour overheads.
- Allocation of materials overheads.
- Treatment of unproductive time within the overall utilisation of railway resources.
- Valuation of capital resources.

Together with the methods of valuing:

B. Crew Costs.

C. Fuel Costs.

D. Locomotive Maintenance and Repairs.

E. Carriage and Wagon Maintenance and Repairs.

F. Shunting Costs.

G. Passenger and Goods Handling and Clerical Costs.

H. Track Maintenance.

I. Electric Overhead Facilities Maintenance.

J. Signalling and Communications Maintenance Costs.

K. Signalling, Safe-working and Train Control Costs.

L. Costs of renewable capital assets.

M. Costs on non-renewable capital assets.

N. Business Overheads.

O. Corporate Overheads.

The following sections describe the recommended NFG 2 costing conventions.

A. General Principles

Treatment of labour overheads

The labour cost component of any direct cost item should include the labour overhead costs associated with the direct cost item. These are costs which in the long run are likely to vary with the quantum of the direct labour component employed. Labour overheads to be allocated (where this is not already done automatically within the General Ledger) should include:

- Direct pay-roll overheads:
  - pay-roll tax
  - workers compensation
  - leave and long service leave provisions
  - superannuation
- other labour overheads associated with the specific groups of employees involved (e.g. uniforms, taxi fares and other incidentals).
- "first-level" supervision and the associated clerical costs of the direct labour groups (e.g. yard-masters, loco foremen, roster clerks, workshop foremen, etc.).
- those parts of the Branch level overhead costs which in the long run will vary with the number of staff in the branch. These will exclude certain groups such as management but will generally include clerical staff involved in day to day administration including regional office staff and some staff in central offices.

Treatment of materials overheads

Consistent with the inclusion of labour overheads in labour items, the costs of using materials should include the overheads which are likely in the long term to vary with the quantum of materials used. These should include:

- handling and transport costs of fuel to site of use, whether paid to outside contractors or incurred through departmental haulage.
- transport costs of civil and mechanical branch materials to site of use whether paid to outside contractors or incurred through departmental haulage.
- operating costs of stores branches in systems where these are not directly charged to user branches, and where better data on stores activities is not available, they may be allocated in proportion to the value of stores used, exclusive of locomotive and diesel fuel issues.

Treatment of unproductive time

When estimating the cost of using labour or capital assets the cost rate applied to the period of time for which the resource is productively used should include an allowance for the proportion of time during which the resource is expected to be unproductive.

This expected proportion may be assessed by reference to historically achieved rates of utilisation. However, higher rates of utilisation may be used for costing future situations when these are based on realistic plans for future improvements.

In some situations, unproductive time is caused not by technical factors but instead by staff surplus to requirements which cannot be redeployed because of policy constraints. Where these staff can be positively identified, they may be excluded from the calculations and instead treated as a corporate overhead.

Valuation of capital

The valuation of capital assets should reflect two principles:

1. renewable investment assets should be valued at opportunity cost using a real interest rate. These are generally assets which are required to operate the system in perpetuity at a given level of capacity;
2. non-renewable assets should be valued at historical cost using the relevant nominal interest rate. These are generally assets or investments made to create a particular level of capacity.

Renewable assets should cover, as a minimum, such items as:

- rollingstock (locomotives, self-propelled vehicles, wagons and carriages),
- track (rail, sleepers, fastenings) and
- plant and vehicles used by support services.

Opportunity cost will normally be best measured by the replacement cost of an equivalent unit of capacity. In some cases, a lower or higher cost may be justified, for example where technological change would mean that a replacement asset would have significantly reduced lifetime operating costs. When an alternative approach has been taken, this should be included in any costing carried out under NFG 2.

When valued at replacement cost, capital is effectively valued at a "real" cost which has adjusted the historical cost for the effects of inflation. It should, therefore, also be annualised at the real long term cost of capital (that is, excluding the effects of inflation). The Working Party recommends that the real long term cost of capital used for NFG 2 costings should follow State or Commonwealth guidelines. Where no such guidelines exist, a real rate of 4% pa should be used. Non-renewable assets generally represent investment to provide system capacity. Where depreciation is charged, they should be valued at written-down historical cost. Where depreciation is not charged, the full historical cost may be used. Where available, the relevant nominal interest rate should be used. Where this is not available, the average interest rate paid in the previous financial year should be used. Note that the thesis does not follow this convention, for strong theoretical reasons, set out below.

The above principles apply for all rail business planning purposes. However, when costs are being assessed for comparison with other industries, valuation of capital should more appropriately be consistent with the capital assessment methodology used in assessing the other industry's costs.

In the list of procedures which follow, the costs included under any item should be consistent with the general principle enunciated under A.

B. Crew Costs

Crew costs should be expressed as a rate paid per crew hour. Where paid crew hours are not known, costs may be expressed as a rate per train hour, where train hours include an allowance for positioning and train preparation. This principle will apply for both locomotive crew and on-train crew (e.g. conductors and technicians).

C. Fuel Costs

In cases where a direct fuel use estimate is not available from fuel trials or train performance simulation models, fuel costs should be expressed as a cost per gross tonne kilometre (GTK) where GTK is the total weight of the train including the locomotive. This cost should, where possible, include an allowance for the average grade of the journey corridor.

D. Locomotive Maintenance and Repairs

These costs should include both depot/running shed and workshops maintenance. The cost of routine running shed servicing should be expressed as a cost per hour in traffic. The cost of workshops overhauls and unscheduled maintenance of a major nature should be identified by broad locomotive type and divided into two components:

1. The cost of "above-frame" maintenance (including body and traction motors) should be expressed as a cost per hour in traffic,
2. The cost of "below-frame" maintenance (including frame, wheels, brake-gear and axles), should be expressed as a cost per kilometre.

Where direct estimates of these two components are not available, an assumption of 50% of total locomotive maintenance and repair costs variable with each of loco hours and kilometres may be used. In most cases, it will be convenient to group locos by horsepower: 3,000 HP, 2,000 HP ("main-line") and 1,000 HP ("branch-line") and shunters. Electric locos should be separately identified where it is practical to do so. Engine maintenance costs for self-propelled vehicles (which generally travel at a uniform speed) may, for convenience, be expressed as a cost per vehicle kilometre.

E. Carriage and Wagon Maintenance and Repairs

The same principles which are recommended for locomotives are extended to carriage and wagon (including brake van) maintenance and repairs. This includes all non-engine maintenance of self-propelled vehicles.

Train examination and minor repairs of a routine nature should be expressed as a cost per vehicle kilometre.

Workshops maintenance and repairs which are related to the vehicle body should be expressed as a cost per vehicle day.

Maintenance and repairs which are related to "below-frame" items (bogies, wheels, axles, draw gear, etc.) should be expressed as a cost per vehicle kilometre.

Where such a breakdown of workshops maintenance and repair items is not available, an equal attribution of costs to days and kilometres of vehicle use may be made.

Carriage cleaning costs should be expressed as a cost per vehicle/day.

Costs should be calculated by vehicle type where possible. Where this is not so, costs may be synthesised using equivalence factors within an overall control for total vehicle maintenance.

F. Shunting Costs–Terminal Costs

Shunting costs should include the capital costs of shunting locomotives, locomotive maintenance, locomotive crew, fuel, and yard crew. They should distinguish between yard shunting and train marshalling activities.

Averaging shunting costs across all tonnes and/or wagons is often misleading. The costs should ideally be expressed per rake of wagons shunted. It is recognised that direct data will often not be available for such a procedure, and that an assumed estimate of average rake lengths for different traffics would, therefore, need to be used. Alternatively costs may be expressed per shunting hour, for a specific traffic, so long as the hours include any expected or unavoidable unproductive hours associated with the productive working time for that specific traffic.

Bogie exchange costs should be expressed as a cost per wagon. Transfer costs should be expressed as a cost per tonne and should be commodity-specific where practicable.

G. Passenger and Goods Handling and Freight Accounting Costs

Handling costs should be attributed directly to the traffics to which they relate (e.g. the costs of container gantry staff), or in cases of mixed handling functions, in proportion to the time spent on different tasks. The costs of sales/marketing sections should be treated as a business overhead. Freight accounting costs should be expressed as a cost per consignment (or per tonne, when average consignment size is allowed for). To avoid excessive computation, a sum of $13 (in 1988/89 dollars) consignment note is a reasonable current estimate and can be used for these costs. Freight accounting costs should also include those components of system insurance expenditures which are related to traffic damage or losses. Passenger accounting/ticketing should be expressed as a cost per passenger.

H. Track and Structure Maintenance Costs

Track maintenance costs are defined as that required to maintain track to its current standard. Under this definition routine re-railing to the same weight of rail is to be considered maintenance, but any incremental expenditure above this level, for example, to provide heavier weight of rail, or replacement of wooden with concrete sleepers, should be treated as a capital expenditure and excluded from NFG 2 traffic costings.

25% of total track maintenance costs should be taken as being variable with traffic level, assuming a fixed track standard. This component therefore does not include the variability of the basic track standard with traffic, but only the variability of maintenance cost given that a particular standard is provided. In the longer-term, changes in traffic levels will also lead to changes in track standard and, in this case, systems should use a 40% variability factor.

For purposes of traffic costing, the level of traffic should be measured by GTK as defined in C above.

Other civil costs of, for example bridges, culverts, tunnels and buildings, should be regarded as invariant with traffic levels.

Where the fixed component of track and structure maintenance costs is required to be allocated to traffics, as in the calculation of fully-distributed costs, this should be on the basis of GTK, unless clearly associated with specific traffics (eg maintenance of stockyards, maintenance of container infrastructure, etc). Any such allocations of fixed track costs should be on a link-specific basis where possible and should be clearly distinguished from the variable component.

I. Electric Overhead Facilities Maintenance

The maintenance of catenary, substations and other electric overhead facilities is carried out for the passage of electric powered trains and, ideally, the cost should be allocated on electric powered train kilometres. Electric GTK can be used in the absence of electric train kilometre data.

Queensland Railways uses 25 000 volt AC equipment while 1 500 DC is installed in NSW and Victoria. Because of the different characteristics of the electrical systems, replacement of contact wire should be allocated on electric powered unit kilometre (or pantograph kilometre) in Queensland Railways and on electric GTK for the 1 500 volt DC systems.

Wherever possible, these costs should be allocated on a link specific basis.

J. Signalling and Communications Maintenance

These costs should be regarded as invariant with traffic levels. Where these costs are required to be allocated to traffic, this should be on the basis of train kilometres, on a link-specific basis where possible.

K. Signalling Operations, Safe-Working and Train-Control

Signalling operations, safe-working and train-control costs should be regarded as invariant with traffic levels. They should be expressed as a cost per train kilometre where they are required to be allocated to traffics.

L. Costs of Renewable Capital Assets

When estimating the annualised capital costs, asset lives should be based on anticipated utilisation and expected commercial life. Typical parameters are set out below:

Locomotives	22 years (diesel), 25 years (electric)
Wagons	15-30 years, depending on usage
Other capital items	depending on the asset.

For the purposes of estimating unit capital costs, locomotive utilisation should be measured by hours in traffic, as defined in D above. Wagon capital costs should generally be based on a life of 25 years.

Wagon utilisation should be measured by wagon days, taking into account wagon turnaround times, and allowing for spares. Where other information does not exist, an allowance of 10% extra wagon capital cost should be made for this purpose.

Other unit capital should be related to appropriate traffic units (e.g. cost/container).

M. Costs of Non-Renewable Capital Assets

These costs generally relate to specific items of infrastructure. Where possible, they should be calculated on a link-specific basis and allocated on the basis of GTK (track, structures and electrical overhead) or train kilometres (signalling and communications).

Where these costs are of a general nature (e.g. sundry plant) they should be allocated as a system-wide average on the basis of GTK.

N. Business Overheads

These costs, which comprise the costs of managing a business sector (e.g. freight marketing), should be allocated to traffics on a percentage mark-up on attributable costs. This should be done on a sub-sector basis where the relevant data is available.

O. Corporate Overheads

These should be allocated on a percentage mark-up on attributable costs.

A2.2.3 The Statistical Conventions

The source for train kilometres, seat kilometres, carriage kilometres and locomotive kilometres is "Operating Statistics". These and other operating statistics have been compiled by the NSW Railways since the 19th Century. Their formal collation as part of the official record commenced in July 1956, and their formal definition was undertaken in 1967 (NSW Department of Railways 1967).

Definitions of the operating statistics used in RAILDATA are given below, together with the "World Standard Definition" (International Union of Railways 1985).

Train Kilometres

NSW definition: Train kilometres represent the route kilometre distance travelled by a train during its journey from starting station to destination station. (Shunting kilometres are excluded, as are "trip" kilometres undertaken before the train is formed up at the starting station).

International definition: Route distance travelled from origin station to destination station are recorded as train kilometres, to the nearest kilometre. (Shunting kilometres are excluded).

Passenger Train Kilometres

NSW definition: A passenger train is defined as one which is listed in the timetable as such, even though it may haul goods vehicles to allow for such things as maximum loading for the class of engine hauling that train. Such a practice was undertaken in the 1950s and 1960s, but was abandoned thereafter. The timetable then facilitated segmentation by passenger market.

International definition: Passenger trains are those identified in the timetable as such, and are classified in accordance with the prime use to which they are put.

Loaded Carriage Kilometres

NSW definition: These are referred to as Coaching Vehicle Kilometres and measure the actual kilometres travelled on passenger trains, which are loaded with passengers.

International definition: These are referred to as coach kilometres and measure the distance covered by loaded passenger trains. Permanently coupled coaches are treated as one unit.

Locomotive (Engine) Kilometres

NSW definition: Locomotive (engine) kilometres represent the actual kilometres travelled by locomotives (engines) outside locomotive points, kilometres being added for shunting time at the assessed rate of 4 kilometres per shunting hour.

International definition: Locomotive and railcar kilometres are calculated on the basis of vehicles made into trains, and the distance travelled by these trains. Shunting (marshalling) distances are calculated on the basis of shunting hours, which are themselves worked out in accordance with the loco duty rosters. These hours are then converted into runs, taking the number of kilometres counted for one hour on marshalling duty. Every system has its own distance per hour, conversion factor.

In the case of NSW Railways, the above data is compiled from the Locomotive Drivers' Daily Sheets which give train kilometres, locomotive kilometres, locomotive hours, class of service, coaching kilometres (loaded and empty), goods vehicles (loaded and empty) and gross tonnage of vehicles.

The international statistics specify that the source documents which shall be used are journey reports, running schedules or work sheets of driving staff.

In conclusion, there is a close correspondence between the methodology and source documents used by NSW Railways and international rail systems.

The Output Indicator of Seat Capacity Kilometres is discussed at some length below, in the commentary on Indicators of Service Output.

Train kilometre statistics

Special mention needs to be made on the quality of the Train Kilometre statistics. This is because it is used throughout RAILDATA as a dissector of costs and other data, into market segments.

It has some significant advantages as a dissector, as follows:

1. No other basic operating statistics can be used as a common measure of both freight and passenger traffic.
2. Train kilometres may be dissected to individual services, if necessary, are verifiable from published working timetables, are accurate and are comparable over long periods of time.
3. Train kilometres are a good proxy for other useful train operating measures, such as train hours. This is because average speeds of trains have changed very little, over time, and are reasonably predictable.
4. Train kilometres are a reasonable proxy for the gross and net weight of passenger trains, but not for freight trains.

The collection of NSW passenger train kilometres has required some additional computation and this is explained below.

A2.3 THE PRINCIPAL GENERAL SECONDARY SOURCE DOCUMENTS

A2.3.1 Introduction

The principal general primary source documents, the Annual Reports and parts of the Operating Statistics, have been discussed above. Specific primary source documents, such as ticket sales, are discussed in the sections below, which relate to the particular statistical series for which these sources were used.

In the plethora of reports, studies and statistical series created inside and outside the NSW Railways since 1951/52, only a small number of documents may be regarded as useful secondary source data for the researcher. They have been used in this thesis and are discussed below:

A2.3.2 Expenditure Forecasts, 1977/78 –1981/82 Planning Division, Public Transport Commission of NSW

The forecasts aside, this study provides the following data, from the general ledger accounts of the Commission, for the years 1966/67 to 1976/77:

- Average Annual Remuneration of Employers, Rail Division, dissected into Wages and Salaries, by Branch (Way and Works, Signals and Communication, Electrical, Workshops, Mechanical, Locomotive Operations, Rail Operations, Trading and Catering; and Administration and General).
- Number of Staff Employed and Percentage Change in Staff, Rail Division, dissected into Wages and Salaries, by Branch.
- Way and Works Branch Expenditure for: Wages and Salaries (separately), Miscellaneous and Stores.
- Signals and Communications Branch Expenditure for: Wages and Salaries (separately), Miscellaneous and Stores.
- Electrical Branch Expenditure for Wages and Salaries (separately), Miscellaneous and Stores.
- Workshops Branch Expenditure for Wages and Salaries (separately), Miscellaneous and Stores.
- Mechanical Branch Expenditure for Wages and Salaries (separately), Miscellaneous and Stores.
- Loco Operations Branch Expenditure for Wages and Salaries (separately), Miscellaneous and Stores.
- Rail Operations Branch Expenditure for Wages and Salaries (separately), Miscellaneous and Stores.
- Trading and Catering Services Expenditure for Wages and Salaries (separately), Miscellaneous and Stores.

- Administration and Secretariat Division Expenditure for Wages and Salaries (separately), Miscellaneous and Stores.
- Marketing Division Expenditure for Wages and Salaries (separately), Miscellaneous and Stores.
- Personnel Division Expenditure for Wages and Salaries (separately), Miscellaneous and Stores.
- Planning Division Expenditure for Wages and Salaries (separately), Miscellaneous and Stores.
- Finance Division Expenditure for Wages and Salaries (separately), Miscellaneous and Stores.
- Rail Payroll Overheads (Superannuation, Accrued Leave and Payroll Tax).
- Rail Renewal Provisions and Interest Changes.
- Bus System Expenditure Tables.
- Ferry System Expenditure Tables.

Some notes, provided in the report, are useful for an understanding of the data collated therein.

First, wage and salary expenditure includes expenses, sick and recreation leave pay. It refers to all employees paid under Working Expenses (95 per cent).

Second, Miscellaneous and Stores Costs consist of a multiplicity of items. The larger Miscellaneous accounts include road motor vehicle hire charges, plant operating costs, electric power and telephone charges, compensation settlements, consultant's fees and the hire of equipment and machinery. The larger Stores accounts include metal ballast, rails and steel, sleepers and building materials and liquid fuel.

Since the published Annual Accounts are organised broadly on a functional basis, and these Branch Expenditure figures are also on a functional basis (i.e. the Branches themselves are organised functionally), the two sets of data complement each other. This has proved very useful in the verification process.

A2.3.3 Cost Reduction Programmes Chief Executive's Memorandum to Attendees of Management Meetings, 27 June 1986

This memorandum contains information on proposals to reduce costs. These are elimination of shunting throughout the state, close down of Sydney yard rollingstock maintenance facilities, reduction in the locomotive fleet through improved productivity, reduction in the white collar workforce through improved procedures, reduction in overtime; withdrawal of Way and Works staff from branch lines, reductions in

Workshops manufacturing cost, reduction in fuel and energy cost; reduction in late night suburban rail services, reduction in the road motor vehicle fleet and reduction in train crewing costs.

In particular, Appendices J1 and J2 contain details of Enginemen Hours Worked and Guards Hours Worked, as a basis for calculating annual paid hours, below.

A2.4 BUILDING THE OUTPUT DATABASE

A2.4.1 Introduction

This Section defines in detail the way in which the Output database of the Model has been developed, definitions of terms used, some of the difficulties encountered with data. and how these difficulties were overcome.

Four indicators of output are evaluated:

1. Seat capacity kilometres
These are the annual number of seats available to passengers for travel on the NSW rail system.

2. Passenger kilometres
These are the annual number of passengers carried times the average distance carried on the NSW rail system.

3. Passenger journeys
These are the annual number of passenger journeys made on the NSW rail system.

4. Passenger revenue
This is the total revenue earned by the NSW rail system.

The last three measures should be regarded as service consumption indicators, but their efficiency as output indicators is tested in the thesis.

A2.4.2 1951/52 as the Base Year

1951/52 is a significant choice as a base year. It is in the early post-war years of Australia's economic history when Australia's major railway system was severely debilitated from the wartime demands placed upon it, and the age of the road motor vehicle was dawning.

A2.4.3 The Market Segments

There are now four distinct market segments for rail passenger services in New South Wales: Suburban, Interurban, Country and Interstate.

The first two relate to the Sydney/Newcastle/Shoalhaven/Lithgow conurbation, containing the major part of the State's population. The Suburban segment is bounded by the Hawkesbury River in the north, Emu Plains in the West, Menangle Park in the South, and Waterfall on the Illawarra railway line. Newcastle's relatively small suburban network is also included in Sydney's suburban network, for statistical purposes. Stations in the Interurban category were initially on the periphery of the Sydney Metropolitan Area, in the Blue Mountains, Central Coast, and Illawarra regions. From the 1960s, these regions became dormitory suburbs for long distance commuters with employment in the Sydney region. They are a distinct market, with their own demand characteristics, and distinctly different supply responses by the NSW railway system which includes specialised rollingstock and timetables. This market segment has grown from less than 2 million passenger journeys in 1958/59 to 13.6 million journeys in 1990/91. Prior to 1958/59, the Interurban stations serviced areas which were little different from the rest of non-urban NSW. Consequently, for statistical purposes, they were treated as part of the NSW Country network. In 1951/52, the Country market segment contributed 7.4 million journeys. By 1990/91, this patronage had shrunk to about 2 million journeys due to declining demand, cessation of some services and replacement of others by road coach services feeding trunk rail services.

The other non-urban segment is the group of Interstate rail services. In 1951/52, these services carried about 900,000 persons, despite a break of gauge on the main corridor between Sydney and Melbourne. By 1990/91, the interstate segment carried about 600,000 persons. This market segment is sustained mainly by concession fare travellers who are mostly aged persons.

A2.4.4 Seat Kilometres

Seat kilometres is a supply side measure of output which is estimated by linking an operating statistic, loaded carriage kilometres travelled, with nominal capacity, seats per carriage. Seat kilometres is considered to be a refinement of the more commonly used train kilometres even though it has been used in deriving some estimates of loaded carriage kilometres. It needs to be noted, however, that seat kilometres are not a perfect substitute for train kilometres. An examination of the method of calculation, below, will reveal this.

Loaded carriage kilometres were collected from drivers' daily report sheets and (for suburban and interurban electric trains) train guards' daily reports on running. These are the same sources of information for train kilometres, locomotive kilometres and vehicle kilometres.

Seat kilometres were estimated as follows:

1. From archival sources (Operating Statistics) annual total loaded carriage kilometres were obtained for the years 1970/71 to 1989/90. For the years 1951/52 to 1969/70, annual total loaded carriage kilometres were estimated by applying the ratio of 6.0 loaded carriage kilometres to every train kilometre. This estimator was based on a study of Operating Statistics for the years 1970/71 to 1978/79. This showed that the mean ratio of train kilometres to loaded carriage kilometres was 5.885 carriage kilometres per train kilometre with an increasing trend in the earlier years of the study period. That is, the average passenger train, in service, was 6 carriages in length. This statistic was not collected after 1989/90. The trend in the ratio of train kilometres to loaded carriage kilometres between 1980/81 to 1988/89 was studied, and it was found that the ratio was decreasing slightly reflecting a growing incidence in the use of four-car train sets in suburban off-peaks. An estimate of 5.549 loaded carriage kilometres per train kilometre was obtained for 1989/90 and 1990/91.
2. The relative robustness of the ratios established in (1.) enabled the confident use of annual train kilometres to allocate total carriage kilometres into the four market segments.
3. The next step was to derive a weighted average of seats per carriage. All Annual Reports contain a listing of the numbers and types of carriages in use in the passenger fleet. Technical specifications are also readily available of nominal seating capacity by carriage type. However whilst Suburban and Interurban carriages are readily identifiable, the dissection cannot be made for the 40 years between the Country and Interstate segments. Consequently they were combined to obtain the same weighted average.

A2.4.5 Passenger Journeys

A major study needed to be mounted to obtain useful estimates of passenger journeys, for the four market segments. In the first instance, three of the four market segments were estimated:

1. Suburban and Interurban, together.
2. Country.
3. Interstate.

The Suburban and Interurban journey estimates are essentially a balancing item, after separate calculation of Country and Interstate journeys. Commentary on the separation of Suburban and Interurban journeys is given below. Data for the period 1949/50 to 1965/66 has also been changed from the Annual Reports, reduced by 12 per cent to allow for inflated journey multipliers used on periodical tickets. Other discontinuities have been removed also, and explanations are provided.

There are other discontinuities which cannot be readily explained, but which are identified below. Any percentage change (plus or minus) which exceeded 5 per cent on the previous year was assessed to see whether this was market-caused or an unexplained discontinuity, and adjusted if necessary (Table A2.2).

Table A2.2 Country and Interstate rail passenger journey estimates, 1971/72 to 1988/89

Year	'000 Journeys	
1971/72	14,161	
1972/73	13,616	
1973/74	8,665	
1974/75	4,253	
1975/76	2,935	
1976/77	3,306	(590) (b)
1977/78	3,521	(616) (b)
1978/79	3,670	(642) (b)
1979/80	3,860	(599) (b)
1980/81	5,049 (a)	(710) (b)
1981/82	4,879 (a)	
1982/83	4,269 (a)	
1983/84	3,400 (a)	
1984/85	3,298 (a)	
1985/86	3,706 (a)	
1986/87	3,644 (a)	
1987/88	3,950 (a)	
1988/89	3,209 (a)	

Notes:

Except where indicated, the statistics are taken from the Annual Report of that year, or the following year.

(a) The source for these statistics was the Annual Report of 1988/89, Appendix 6: Corporate Performance Indicators.

(b) The source for these statistics in brackets is the Annual Report of that year. The statistics are estimates of Interstate passenger journeys, and are included in the unbracketed number for that year.

(c) Finally, annual seat kilometres were obtained by multiplying weighted average seats per carriage and annual loaded carriage kilometres.

1966/67: Suburban and Interurban (-11.5%), Country (-10.7%) and Interstate (-11.3%)

The 1966/67 Annual Report notes:

> ...although country and major interstate rail journeys from Sydney showed slight increases over the previous year's figures, passenger traffic overall declined by about 1 per cent, journeys in respect of metropolitan services being down 0.8 per cent and for country services 0.2 per cent.

This does not explain the downturn of 10.7% to 11.5%. The journeys from 1951/52 to 1965/66, as they appeared in Annual Reports, were reduced by 12 per cent to account for inflated journey multipliers used on periodical tickets. However, this may not have been enough. Nevertheless, there is no alternative statistical evidence.

1970/71:
Suburban and Interurban (-10.3%), Country (-17.9%) and Interstate (-28.1%)

This reduction is confirmed in the 1971/72 Annual Report, and represents the fare increase of July 1971:

> Prices were increased by roundly 50 per cent for ordinary single journey tickets and by roundly 75 per cent for country return journey tickets, with commensurate increases for weekly and season tickets.

1975/76:
Suburban and Interurban (-5.9%), Country (40.3%) and Interstate (-20.8%)

Whilst the decline is verified in the Annual Report of 1975/76, little commentary is provided as to reasons for the decline, other than the comment:

> A number of passenger services was discontinued during the year and where necessary alternative services were provided.

1976/77:
Suburban and Interurban (13.7%), Country (39.2%) and Interstate (5.4%)

Whilst the increase in journeys is verified by the Annual Report for 1976/77, the reasons given are specious. The increase is attributed to the fare reduction of 20 per cent in June 1976 and sales promotion. The latter had some effect, but studies have shown (Hensher and Bullock 1979) that the former had no effect.

1979/80:
Suburban and Interurban (14.5%), Country (7.7%) and Interstate (-6.7%)

Suburban and Interurban patronage increased due to the opening of the Eastern Suburbs Railway on 23 June 1979, though probably not by as much as the 18.7 million journeys attributed to it in the Annual Report. Country and Interstate patronage changes are also verified in the 1979/80 Annual Report.

1980/81:
Country (32.9%) and Interstate (19.2%)

Whilst the Country patronage number is correct, the Annual Report states that this represents a 4.9% increase on the previous year and not the 32.9% increase recorded.

This is an unexplained discontinuity. The Interstate patronage increase has been verified.

1985/86:
Suburban and Interurban (9.1%), Country (14.9%) and Interstate (1.5%)

Country services increased as a result of the expansion of XPT services. The Suburban and Interurban patronage growth is also verified in the Annual Report.

Identified discontinuities in data

An estimate of NSW Country and Interstate rail passenger journeys appears, for the first time, in the first Annual Report of the Public Transport Commission, 1972/73. It also appears in subsequent Annual Reports of the Commission and the State Rail Authority, except where indicated.

Four discontinuities are apparent:

1. the decrease in passenger numbers between 1972/73 and 1973/74 which stood at 4,951,000 journeys (36%).
2. the further decrease in passenger numbers between 1973/74 and 1974/75 which stood at 4,412, 000 journeys (21%).
3. the further decrease in passenger numbers between 1974/75 and 1975/76 which stood at 1,318, 000 journeys (31%).
4. the increase in passenger numbers between 1979/80 and 1980/81 which stood at 1,189,000 journeys (31%). Explanations for these apparent discontinuities are given, and recommendations made for their treatment.

The apparent discontinuity between 1972/73 and 1973/74

No explanation is recorded in the actual material available of the downward adjustment of nearly 5 million journeys. It is not due to market factors:

- there were no changes in fares between July 1971 and September 1974 and
- whilst there were some service cuts to Country trains, train kilometres declined by only 3% from 16.2 million to 15.7 million in 1973/74.

The most logical explanation is that up to 1972/73, an accounting convention had been established to add about 5 million passenger journeys to account for country train tickets sold at metropolitan locations. There would have been no statistical basis for this convention and, at the discretion of the new Chief Commissioner (Philip Shirley), would have been discontinued. This adjustment (of 5 million journeys) is carried through to 1966/67.

The apparent discontinuity between 1973/74 and 1974/75

Major boundary changes were made between Country and Metropolitan markets in September 1974 and July 1975. From 1 July 1974, journey multipliers for Weekly tickets were reduced from 14 per ticket to 11, and for Monthly tickets from 60 to 48. The impact of these discontinuities is assessed.

Impact of boundary changes

Table A2.3 shows the Country stations transferred to metropolitan markets as a result of boundary changes. It shows that in 1974/75, Country dropped by about 1.6 million as a result of boundary changes.

Impact of journey multiplier changes

After allowing for the decrease of 1.6 million journeys, 2.8 million journeys out of the total 4.4 million remain to be accounted. If all of the 2.8 million journeys are attributed to journey multiplier changes, this represents a 40 per cent decrease (2.8 million as a percentage of 7.1 million—the balance after transfer due to boundary changes). A sample analysis suggests that reducing journey multipliers reduced total journey numbers by only 12 per cent.

Other possible reasons for the decrease in journey numbers

Passenger train kilometres on country services were decreased by 11%, indicating some service cuts. But, again, not enough to explain the difference. Accordingly, an alternative data source was investigated. This was found in a photocopy of two memoranda from the Superintendent of Statistics to the Planning Division, dated 30 August and 15 October, 1976, respectively. The photocopy appears in: *'First Cut' Passenger Forecast. Rail, Bus, Ferry* (Planning Division, Public Transport Commission of NSW 1976).

Table A2.3 Country stations transferred to other markets as a result of boundary changes

Stations transferred from country to other markets	Market to which country stations transferred	Date of transfer	Est. annual no. of journeys at time of transfer ('000)
NORTHERN NSW			
Airdale	Newcastle Suburban	September 1974	
Hilldale	Newcastle Suburban	September 1974	
Wollarabba	Newcastle Suburban	September 1974	
Wirragulla	Newcastle Suburban	September 1974	
Dungog	Newcastle Suburban	September 1974	
Branxton	Newcastle Suburban	September 1974	
Belford	Newcastle Suburban	September 1974	
Minimbah	Newcastle Suburban	September 1974	
Wittingham	Newcastle Suburban	September 1974	
Singleton	Newcastle Suburban	September 1974	
Sub-Total	Newcastle Suburban	September 1974	157
Narara	Sydney Interurban	September 1974	*
Niagara	Sydney Interurban	September 1974	*
Lisarow	Sydney Interurban	September 1974	*
Ourimbah	Sydney Interurban	September 1974	3
Tuggerah	Sydney Interurban	September 1974	7
Wyong	Sydney Interurban	September 1974	82
Warnervale	Sydney Interurban	September 1974	*
Wyee	Sydney Interurban	September 1974	8
Sub-Total	Sydney Interurban	September 1974	100
WESTERN NSW			
Medlow Bath	Sydney Interurban	September 1974	*
Blackheath	Sydney Interurban	July 1975	20
Mt. Victoria	Sydney Interurban	July 1975	12
Hartley Vale	Sydney Interurban	July 1975	*
Bell	Sydney Interurban	July 1975	*
Newcastle Junction	Sydney Interurban	July 1975	*
Clarence	Sydney Interurban	July 1975	*
Lithgow	Sydney Interurban	July 1975	*
Sub-Total	Sydney Interurban	July 1975	65
SOUTHERN NSW			
Menangle Park	Sydney Suburban	September 1974	*
Menangle	Sydney Suburban	September 1974	4
Douglas Park	Sydney Suburban	September 1974	*
Picton	Sydney Suburban	September 1974	20
Tahmoor	Sydney Suburban	September 1974	5
Bargo	Sydney Suburban	September 1974	4
Yanderra	Sydney Suburban	September 1974	*
Yerrimbool	Sydney Suburban	September 1974	*
Sub-Total	Sydney Suburban	September 1974	33
Aylmerton	Sydney Suburban	July 1975	*
Mittagong	Sydney Suburban	July 1975	13
Bowral	Sydney Suburban	July 1975	14
Burradoo	Sydney Suburban	July 1975	*
Moss Vale	Sydney Suburban	July 1975	13
Sub-Total	Sydney Suburban	July 1975	40
ILLAWARRA			
Stanwell Park	Sydney Suburban	September 1974	9
Coalcliff	Sydney Suburban	September 1974	*
Coalcliff South	Sydney Suburban	September 1974	*
Scarborough	Sydney Suburban	September 1974	1
Wombarra	Sydney Suburban	September 1974	10
Coledale	Sydney Suburban	September 1974	24
Austinmer	Sydney Suburban	September 1974	30
Thirroul	Sydney Suburban	September 1974	92
Bulli	Sydney Suburban	September 1974	62
Woonona	Sydney Suburban	September 1974	80
Bellambi	Sydney Suburban	September 1974	65

Table A2.3 continued

Corrimal	Sydney Suburban	September 1974	105
Towradgi	Sydney Suburban	September 1974	70
Fairymeadow	Sydney Suburban	September 1974	102
North Wollongong	Sydney Suburban	September 1974	59
Wollongong	Sydney Suburban	September 1974	392
Lysaghts	Sydney Suburban	September 1974	*
Coniston	Sydney Suburban	September 1974	10
Unanderra	Sydney Suburban	September 1974	8
Kembla Grange	Sydney Suburban	September 1974	*
Dapto	Sydney Suburban	September 1974	32
Yallah	Sydney Suburban	September 1974	*
Albion Park	Sydney Suburban	September 1974	32
Oak Flats	Sydney Suburban	September 1974	5
Shellharbour	Sydney Suburban	September 1974	3
Minnamurra	Sydney Suburban	September 1974	*
Bombo	Sydney Suburban	September 1974	4
Kiama	Sydney Suburban	September 1974	25
Sub-Total	Sydney Suburban	September 1974	1301

Note:

* indicates that no tickets were sold at the station although passengers joined and alighted at the station

Table A2.4 provides a comparison of the Annual Report and the 1976 revised journey statistics. The memoranda suggests that various errors and changes resulted in consistent overstatements of 1.6 to 1.9 million journeys appearing in the Annual Reports for the years 1971/72 to 1973/74. Therefore, the figures appearing in the memoranda are the correct ones. On this new basis, journeys declined by 2.7 million between 1973/74 and 1974/75. After accounting for losses of 1.5 million journeys due to boundary changes, only 1.1 million journeys need to be accounted for. This represents a 22 per cent decrease (1.1 million as a percentage of 5.1 million: the balance after transfer due to boundary changes).

Table A2.4 Comparison of Country and Interstate rail passenger journey estimates, 1971/72 to 1975/76 ('000s)

Year	Journeys in Annual Reports (a)	Journeys in Memoranda (b)
1971/72	14,161	12,403
1972/73	13,616	11,985
1973/74	8,665	6,716
1974/75	4,253	3,977
1975/76	2,935	2,511

Sources:

(a) Annual Reports

(b) Memoranda from Superintendent of Statistics to the Planning Division, dated 30 August and 15 October 1976

The August and October 1976 revisions which were carried through to 1966/67 were used in preference to the Annual Reports' figures which, in any case, only go as far back as 1971/72. Nevertheless, the 5 million journey downward adjustment recommended above should also be applied, together with a further 12 per cent reduction to account for the reduced journey multipliers.

There seems no point in adjusting the services for boundary changes, however. By the time of their transfer to the Metropolitan market, many of the major stations were in fact originating stations for long distance commuting to workplaces in the Metropolitan area. However, in 1966/67, they were essentially serving typical rural populations.

The apparent discontinuity between 1974/75 and 1975/76

Even in the revised series, there is still a drop of 1.4 million journeys. Table A2.5 shows that 0.1 million of this is accounted for by a further transfer of stations to the Metropolitan market leaving 1.3 million still to be accounted (a drop of 33%). Passenger train kilometres show a drop of 3.4 million (25%) reflecting a withdrawal of train services, some of which were replaced by road coaches. The remaining 8% is probably due to further adjustments made, but not recorded for posterity. The discontinuity of 8% should be noted as an "unexplained adjustment" representing some 300,000 journeys.

Table A2.5 Revised series of Country and Interstate rail passenger journeys, 1966/67 to 1975/76 ('000 journeys)

Year	Original official statistics (1)	Journey numbers reduced by 5 million pa (2)	Journey numbers further reduced by 12% (3)
1966/67	13,042	8,042	7,081
1967/68	13,012	8,012	7,051
1968/69	12,675	7,675	6,754
1969/70	13,267	8,267	7,275
1970/71	14,131	9,131	8,035
1971/72	12,403	7,403	6,515
1972/73	11,985	6,985	6,147
1973/74	6,716	6,716	5,910
1974/75	3,977	3,977	3,977
1975/76	2,511	2,511	2,511

Notes:

(1) The source of these statistics is: Memorandum from the Superintendent of Statistics to the Planning Division dated 30 August, 1976 photocopied in: *First Cut Passenger Forecast, Rail, Bus, Ferry* Planning Division, Public Transport Commission of NSW, December 1976.

(2) As recommended in A2.4.5, for the years 1966/67 to 1972/73.

(3) As recommended in A2.4.5, for the years 1966/67 to 1973/74.

The 22 per cent decrease may be explained as follows: 12% (600,000 journeys) due to journey multipliers, 10% (500,000 journeys plus) due to service reductions, giving 22% (1.1 million journeys) total.

The apparent discontinuity between 1979/80 and 1980/81

The 1.2 million journey increase was genuine. A great many sales promotions were undertaken including heavily discounted fares to introduce non-travellers to train travel.

The revised series of Country and Interstate rail passenger journeys, 1966/67 to 1975/76

Table A2.5 shows revisions to the series shown in the Memoranda of August and October 1976. Column (3) of the table provides a logical and consistent time series.

The separation of Interstate journeys from total Country and Interstate journeys, 1966/67 to 1976/77

The most comprehensive critique of available early estimates of interstate passenger journeys appears on pages 4 to 7 of an internal report (Planning Division, PTC 1976).

The estimates for Interstate passenger journeys are given in the Table A2.6.

Table A2.6 Estimated Interstate passenger journeys, 1966/67 to 1976/77

Year	('000 journeys) Unadjusted estimates from original report
1966/67	800
1967/68	800
1968/69	800
1969/70	800
1970/71	798
1971/72	582
1972/73	524
1973/74	644
1974/75	703
1975/76	746
1976/77	769

Notes:

The source of the statistics is Table 3.1, page 4 *The Accuracy and Usefulness of Statistics of Rail Passenger Journeys,* Planning Division, Public Transport Commission of NSW, 30 March 1978.

The figures were compiled as follows:

1966/67 to 1969/70:	No statistics are available prior to 1970/71. Because of this it was assumed that journeys were the same as 1970/71.
1970/71:	NSWGR Annual Report 1970/71.
1971/72 to 1973/74:	Planning Division estimates based upon interpolated adjustments made by Superintendent of Statistics to 1975/76. Annual Report figures quoting passenger journeys for 1974/75.
1974/75:	PTC Annual Report 1975/76.
1975/76:	ROA source.
1976/77:	ROA source.

However, these estimates in Table A2.6 are still not satisfactory, for the following reasons:

- Only a combined Country and Interstate estimate appears in the 1970/71 and 1975/76 Annual Reports.
- Railways of Australia (ROA) is given as the source for the 1975/76 and 1976/77 estimates.

However the estimates can be criticised on two counts:

- they contain passengers journeying to interstate destinations, and
- the system used for counting passengers, using on-board counts done by train staff, and they include free travellers. This may be a benefit from one point of view, since we are endeavouring to include unremunerative journeys in all market segments.

The most suitable source for interstate passenger journey estimates for the years 1971 to 1976 was one of the memoranda (NSWR 1976).

Year	Journeys
1971	798,169
1972	1,147,558
1973	1,033,064
1974	1,247,033
1975	703,405
1976	537,480

A footnote indicates that in July 1975, a formula used for calculating interstate journeys was found to be incorrect. Accordingly, the 1974/75 passenger journey estimates were reduced from 1,407,385 to 703,405, a decrease of approximately half.

The years 1971/72 to 1973/74, were similarly reduced, as follows:

Year	Journeys ('000)
1971/72	574
1972/73	517
1973/74	624

It is not considered that the 1970/71 estimate is in error. The Annual Report indicates that the year was a boom one for interstate services. The Indian Pacific service, commenced in early 1970, was increasing in popularity, and holiday periods showed a considerable boost on the previous year. By contrast, in 1971/72, journeys show a drop of 224,000, to 274,000: a drop of 48%. This is consistent with the average fare increase of 50 per cent, which applied from July, 1971.

There are also problems with these data and their sources which are discussed below.

Table A2.7 below shows an estimate of Interstate passenger journeys from 1966/67 to 1976/77, including notes on sources and methods of calculation.

Table A2.7 Revised estimates of Interstate passenger journeys, 1966/67 to 1976/77

Year	('000 journeys) Unadjusted estimates from original report
1966/67	760 (a)
1967/68	758 (a)
1968/69	743 (a)
1969/70	778 (a)
1970/71	798 (b)
1971/72	574 (c)
1972/73	517 (c)
1973/74	624 (c)
1974/75	703 (d)
1975/76	557 (d)
1976/77	587 (d)

Notes:

(a) 1966/67 to 1969/70: Since no statistics are available in any archival record, it was necessary to derive these from Annual Report percentage changes quoted. Thus in 1970/71, Country and Interstate journeys were "2.6% up on the previous year's figures". So 2.6% was applied to derive 1969/70 passenger journeys.

The factors for the other years were 1968/69: 4.7% increase; 1967/68: 2.0% increase; 1966/67: 0.2% increase.

(b) 1970/71: Superintendent of Statistics Memorandum, unadjusted.

(c) 1971/72 to 1973/74: Superintendent of Statistics Memorandum, adjusted by reducing by half, in accordance with the procedure adopted for 1974/75.

(d) 1974/75 to 1975/76: Superintendent of Statistics Memorandum. As indicated on pages 5 to 9, the Superintendent's figures exclude interstate travellers on interstate trains, and counting methods are better than those of ROA. Free travellers included.

Interstate passenger journeys, 1977/78 to 1988/89

Table A2.8 sets out the Interstate passenger journeys for the period 1977/78 to 1988/89, including the source of the statistics.

Country and Interstate passenger journeys, 1966/67 to 1988/89

Table A2.9 sets out Country and Interstate Passenger Journeys in NSW for the period 1966/67 to 1988/89. It also indicates the percentages these journeys represented of all train journeys in NSW for each year. Explanatory notes are set out at the end of the Table.

Country and Interstate passenger journeys, 1949/50 to 1965/66

Table A2.10 sets out Country and Interstate Passenger Journeys in NSW for the period 1949/50 to 1965/66. The method used to estimate the journeys is set out in the Notes at the end of the Table.

Interstate passenger journeys, 1949/50 to 1965/66

Table A2.11 sets out interstate passenger journeys in NSW for the period 1949/50 to 1965/66. The method used to estimate the Journeys is set out in the notes at the end of the Table. The relatively high level patronage has been confirmed from train timetables of the period.

It should be noted that there is a probable break in comparability in the Country and Interstate statistics from 1949/50 to 1965/66, and from 1966/67 onwards. This will be due to the statistical error inherent in the ratioing method used in the series up to 1965/66. The statistics indicate the following changes between 1965/66 and 1966/67.

	Country passenger journeys ('000)	% change	Interstate passenger journeys ('000)	% change
1965/66	7,076		857	
1966/67	6,321	-10.7%	760	-11.3%

The 1966/67 Annual Report notes, however:

> Although country and major interstate rail journeys from Sydney showed slight increases over the previous year's figures, passenger traffic overall declined by about 1 per cent, journeys in respect of metropolitan services being down 0.8 per cent and for country services 0.2 per cent.

Table A2.8 Estimated Interstate passenger journeys, 1977/78 to 1988/89

Year	Interstate journeys ('000)	Source of Statistics
1977/78	616	Annual Report 1977/78
1978/79	642	Annual Report 1978/79
1979/80	599	Annual Report 1979/80
1980/81	714 *	Annual Report 1980/81
1981/82	669	Unpublished records
1982/83	601	Annual Report 1983/84
1983/84	591	Annual Report 1983/84
1984/85	616	Unpublished records
1985/86	625	Unpublished records
1986/87	656	Unpublished records
1987/88	749	Annual Report 1987/88
1988/89	781	Unpublished records

Note:

* This 19% increase is verified as being due to a drop in industrial action, special tours and special promotions by the tourism industry.

Table A2.9 Country and Interstate passenger journeys as a percentage of all journeys, 1966/67 to 1988/89 ('000s journeys)

Year	Interstate (1)	Country (2)	Total NSW (3)	Total all journeys (4)	(3) as % of (4)
1966/67	760	6,321	7,081	200,744	3.5%
1967/68	758	6293	7,051	198,530	3.6%
1968/69	743	6011	6,754	193,897	3.5%
1969/70	778	6497	7,275	197,740	3.7%
1970/71	798	7237	8,035	200,513	4.0%
1971/72	574	5941	6,515	179,080	3.6%
1972/73	517	5630	6,147	176,990	3.5%
1973/74	624	5286	5,910	175,071	3.4%
1974/75	703	3274	3,977	171,845	2.3%
1975/76	557	1954	2,511	160,430	1.6%
1976/77	587	2719	3,306	182,881	1.8%
1977/78	616	2905	3,521	183,540	1.9%
1978/79	642	3028	3,670	182,750	2.0%
1979/80	599	3261	3,860	208,821	1.8%
1980/81	714	4335	5,049	212,911	2.4%
1981/82	669	4210	4,879	220,835	2.2%
1982/83	601	3668	4,269	207,201	2.1%
1983/84	591	2809	3,400	202,255	1.7%
1984/85	616	2682	3,298	200,275	1.6%
1985/86	625	3081	3,706	218,581	1.7%
1986/87	656	2988	3,644	224,255	1.6%
1987/88	741	3209	3,950	246,539	1.6%
1988/89	781	2428	3,209	249,296	1.3%

Notes:

(1) Statistics for 1966/67 to 1976/77 are obtained from Table 6 hereunder. The following years are obtained from Annual Reports with the exceptions of 1981/82, 1984/85 to 1986/87 and 1988/89. These latter are obtained from the old Passenger Development Section, now absorbed into the Countrylink organisation.

(2) Statistics for 1966/67 to 1976/77 are obtained by deducting Column 1 from Column 3. The following year are obtained from Annual Reports, again with the exception of 1981/82, 1984/85 to 1986/87 and 1988/89. These are obtained by deducting Column 1 from Column 3.

(3) Statistics for 1966/67 to 1975/76 are obtained from Table 4 hereunder. The following years are obtained from Annual Reports.

(3) Statistics for 1966/67 to 1973/74 required that Annual Report statistics for Suburban (including Interurban) journeys be adjusted downwards by 12% to account for lower journey multipliers used in periodical ticket sales. This made them comparable with Country and Interstate journeys for that year, and Suburban journeys in subsequent years. When Suburban journeys are added to Country and Interstate, a total NSW estimate is obtained.

Table A2.10 Country and Interstate passenger journeys estimated at 3.6% of all NSW journeys, 1949/50 to 1965/66 ('000)

Year ended 30 June	Total journeys in NSW (reduced by 12%)	Country and interstate journeys (3% of total journeys) (2)
1950	227,201	7,952
1951	236,337	8,272
1952	235,988	8,260
1953	239,094	8,368
1954	245,436	8,590
1955	247,647	8,668
1956	246,814	8,638
1957	231,560	8,105
1958	227,613	7,966
1959	223,568	7,825
1960	224,039	7,841
1961	223,109	7,809
1962	223,393	7,784
1963	226,825	7,939
1964	323,140	8,125
1965	230,279	8,060
1966	226,660	7,933

Notes:

"Total Journeys" are sourced from Annual Reports. Annual Report statistics are then reduced by 12% to account for reduced journey multipliers to make the statistics comparable with subsequent years.

Table A2.11 Interstate passenger journeys estimated at 10.8% of Country and Interstate passenger journeys, 1949/50 to 1965/66 ('000)

Year ended 30 June	Country and Interstate journeys	Interstate journeys at 10.8% of Country and Interstate journeys
1950	7,952	859
1951	8,272	893
1952	8,260	892
1953	8,368	904
1954	8,590	928
1955	8,668	936
1956	8,638	933
1957	8,105	875
1958	7,966	860
1959	7,825	845
1960	7,841	847
1961	7,809	843
1962	7,784	841
1963	7,939	857
1964	8,125	878
1965	8,060	870
1966	7,933	857

Notes:

- The source of these statistics is Table 9, where Country and Interstate passenger journeys were estimated as the ratio 3.5% of Total Journeys.
- The ratio of 10.8% is selected because it was found that this was the average annual percentage for the years 1966/67 to 1969/70, after which Interstate Journeys declined to an average 9.4% for the years 1970/71 to 1973/74.

The separation of Suburban and Interurban journeys

The objective of this exercise was to come up with reasonable estimates of Interurban journeys and then deduct these from Suburban and Interurban journeys. The residual here was Suburban journeys.

The Interurban market was first acknowledged in 1958/59 when some railway stations on the Central Coast and Blue Mountains NSW were transferred from Country to Metropolitan control. They were from Hawkesbury River to Gosford, and from Lapstone to Katoomba. At this time, there was little to distinguish them from country settlements, and they had not acquired the passenger characteristics, travel times, train operations, rollingstock and infrastructure that were to make the interurban market distinctly different from the Suburban market. Ticket sales data was available for interurban stations, for the years 1956/57, 1960/61, 1964/65 and 1965/66 (Suburban Passenger Statistics).

For the years 1966/67 to 1973/74, a survey was made of ticket sales at such interurban stations as Hawkesbury River to Gosford, and Lapstone to Katoomba (NSWR 1976).

Ticket sales data was available for the existing stations and the stations added to the Interurban segment from 1974/75 to 1984/85 as set out in Table A2.3. An extrapolation was made for the period 1985/86 to 1990/91, cross-checked against estimates made by Travers Morgan of 1987/88 passenger journeys.

Conclusion on passenger journey estimates

NSW rail passenger journeys, though the most robust measure of output of passenger services, are only estimates based on ticket sales. Because of changing conventions, errors and other changes, they have proved to be a very discontinuous series since 1949/50. The purpose of the foregoing analysis has been to identify as many of the causes of the discontinuities and adjust the series where possible. The estimates of patronage thus become the author's estimates, albeit cross-checked and verified, where possible. Where not possible, the discontinuity is still identified.

A2.4.6 Passenger Kilometres

Passenger kilometres is a demand side measure of output, estimated by linking annual passenger journeys with average trip length per passenger journey. This is considered to be a refinement of the more commonly used passenger journeys. It is the preferred measure because it takes account of the level of utilisation of the service, by introducing measures of the distance travelled by passengers. The difficulty is that it has never been collated by the NSW Railways in the past, for all market segments. However, in the 1990/91 State Rail Annual Report, a Countrylink passenger kilometre figure is provided for the years, 1981/82 to 1990/91. This estimate is compared with the author's estimate, in Table A2.12.

Table A2.12 Country passenger kilometres compared by source, 1981/82 to 1990/91

Year ended 30 June	Countrylink passenger kilometres (billion)		Difference between Column 1 & Column 2
	Annual Report (1)	Author's estimates (2)	(billion pass. kms)
1982	1.70	2.07	0.37 (0.3)
1983	1.48	1.82	0.34 (0.3)
1984	1.18	1.48	0.30 (0.3)
1985	1.15	1.45	0.30 (0.3)
1986	1.29	1.62	0.33 (0.3)
1987	1.27	1.61	0.34 (0.3)
1988	1.37	1.76	0.39 (0.3)
1989	1.00	1.48	0.48 (0.2)
1990	1.03	1.25	0.22 (0.2)
1991	0.98	1.20	0.22 (0.2)

Notes:

(1) Source: State Rail Annual Report 1990/91. The data refers to rail services only and excludes the Indian-Pacific.

(2) Source: Author's estimates. Refers to rail services and includes the Indian-Pacific. The figures in brackets are passenger kilometre estimates for the Indian Pacific.

No information is available on the method used in the State Rail estimates. However, the general closeness of the two sets of estimates indicates that State Rail used a very similar method to that used herein. There are exceptions in the year 1987/88 and 1988/89. In the latter year, the Countrylink estimate is shown as being exactly 1,000 million passenger kilometres. This suggests that State Rail varied their methodology in the two years so that 1988/89 could be used as a service-level benchmark, with the value of 1.00.

The critical element in deriving passenger kilometres for each market segment was to calculate a robust weighted average trip length for each year. These trip lengths were then multiplied by annual passenger journeys to obtain total annual passenger kilometres.

Suburban passenger kilometres

For 1980/81, the (NSW) State Transport Study Group (STSG 1983) developed an origin/destination matrix of rail journeys, by railway line segment for an average weekday. This matrix was used as the base-line for estimating similar matrices for the years: 1956/57, 1960/61, 1964/65, 1965/66, 1970/71, 1975/76 and 1984/85.

Using 1980/81 as the base-line, passenger journey estimates for each cell were obtained from annual ticket sales for each station, in each line section, for the years: 1956/57, 1960/61, 1964/65, 1965/66, 1970/71, 1974/75, 1975/76, 1980/81 and 1984/85 (NSWR, Suburban Passenger Statistics). Ticket sales in the Central Business District (CBD) (incl. Central and Redfern) line section have dominated total ticket sales for all the years reviewed. For example in 1956/57, ticket sales generated 162,000 journeys per weekday out of a total of 445,000 journeys in the suburban network, or 36 per cent. In 1984/85, the CBD generated 30 per cent of journeys. Thus, the fundamental radial pattern of rail travel, focussed on the CBD, has remained about the same. For the remainder of the suburban system, some line sections have increased significantly, while others have decreased. The major changes which were identified, were the passenger journeys generated by the commissioning of the Eastern Suburbs Railways and the expansion of the interurban line sections from 1975/76. The next step in the estimating process was to compute the average route length between originating line sections and destination line sections. Route lengths are readily available to the nearest metre (NSWR 1980). In each case, the median station within a line section was used to calculate route lengths. Intra-sectional travel is also significant. In this case, route distances were taken from the median station to the principal node station in that section. By multiplying total passenger journeys per average weekday, by route lengths, a weighted average estimate of passenger kilometres was developed for each line section. These were totalled for each year, for all suburban line sections, along with passenger journeys. When passenger journeys were divided into passenger kilometres, a weighted average journey length was obtained.

Average journey length was interpolated for the years intervening between the studied years. Extrapolations were made for the period 1985/86 to 1990/91, and the period 1951/52 to 1955/56.

The results are given in Table A2.13.

Table A2.13 Average Suburban trip length

Year ended 30 June	Trip length (kms)	Year ended 30 June	Trip length (kms)
1952	17.0	1973	17.4
1953	17.0	1974	17.4
1954	17.0	1975	17.4
1955	17.0	1976	17.8
1956	17.1	1977	17.8
1957	17.1	1978	17.8
1958	17.1	1979	17.7
1959	17.1	1980	17.7
1960	17.2	1981	17.7
1961	17.1	1982	17.8
1962	17.1	1983	17.8
1963	17.1	1984	17.9
1964	17.0	1985	17.9
1965	16.9	1986	17.9
1966	17.3	1987	17.9
1967	17.3	1988	17.9
1968	17.3	1989	18.0
1969	17.4	1990	18.0
1970	17.4	1991	18.0
1971	17.5	1992	18.0
1972	17.5		

Several attempts have been made in the past to calculate average trip lengths in the suburban network. In 1971, the Sydney Area Transportation Study (SATS) attempted to compute an average trip length, based on available survey data (SATS 1974). A "median public transport journey" of 2.5 miles (4 kms) was provided. But, this included buses where there is bias towards short-distance travel.

In its report on its 1981 Household Survey, the State Transport Study Group (STSG 1983) calculated "work trip" lengths as follows for public transport. Again, buses were included. Average trip lengths were given as 15.2 kms in 1971, and 16.8 kms in 1981. Again the short distance of bus travel will have biased the estimate downwards.

In 1987, State Rail's Metropolitan Strategy Study provided an estimate of "average journey distance" of 18 kilometres for 1986/87 (GHD Transmark 1987). However, in the Main Report released later (GHD Transmark 1987), the average passenger distances for the morning peak (0630 - 0930) are given as follows:

Market	Direction	Distance
Interurban	Up	55.8 kms
Interurban	Down	29.5 kms
Suburban	Up	16.4 kms
Suburban	Down	9.7 kms
Total		17.8 kms

Note:

- Up services are those travelling towards Sydney Central and intermediate destinations.
- Down services are those travelling from Sydney Central to other destinations.

Interurban passenger kilometres

For 1980/81, the State Transport Study Group (STSG 1983) included in their origin/destination matrix the following line sections: Mt. Victoria to Lapstone, and Wyong to Hawkesbury River. These two major sections were transferred from the Country market segment to Interurban, in 1975/76.

The 1980/81 Study indicates a weighted average trip length for the two sections, as follows:

	Average trip length
Mt. Victoria–Lapstone	88.7 kms
Wyong–Hawkesbury River	64.4 kms
Total	68.6 kms

Ticket sales data was available for all stations in these line sections for 1975/76. When converted to passenger journeys and passenger kilometres, the following weighted average trip lengths were indicated:

	Average trip length
Mt. Victoria–Lapstone	75.4 kms
Wyong–Hawkesbury River	64.5 kms
Total	68.6 kms

Ticket sales data were also available for all stations in these line sections for 1984/85, and weighted average trip lengths derived:

	Average trip length
Mt. Victoria–Lapstone	75.4 kms
Wyong–Hawkesbury River	64.1 kms
Total	68.0 kms

The reason for the average trip length for Mt. Victoria–Lapstone reverting back to the 1975/76 average is explained by the relative growth of ticket sales in the Lower Blue Mountains stations, caused by housing development. Average trip length was extrapolated from 1973/74 to 1958/59, and from 1985/86 to 1990/91. The total study period's results are shown in Table A2.14.

Table A2.14 Average Interurban trip length

Year ended 30 June	Trip length (kms)
1959 to 1974	68.6
1975	68.6
1976	68.6
1977	68.6
1978	68.6
1979	68.6
1980	68.6
1981	68.6
1982	68.4
1983	68.3
1984	68.1
1985	68.0
1986	67.9
1987	67.8
1988	67.7
1989	67.6
1990	67.5
1991	67.5
1992	67.5

Country passenger kilometres

As with Suburban and Interurban services, it is important to establish a baseline of data on the origins/destinations of passengers using Country services. These data are provided for 1977/78 in a Public Transport Commission review of Country and Interstate passenger services (NSWR 1978). In this review, a survey was undertaken of each service operated during the sample month of February 1978.

Data was collected on the numbers of seats and berths provided and a percentage occupancy was also given. The occupancy rate is a weighted average of the use of the seat or berth during the journey, and is explained as follows (NSWR 1978):

> It should be noted that the 'percentage occupancy' figure quoted took into account both number of seats occupied and the distance travelled for each journey. Thus, if a train had only 50% of its seats filled but every person travelled the complete distance that the train travelled, then the train would have a percentage occupancy of 50%. However, if a train had 100% of its seats filled but every person only travelled half-way, this train would also show a percentage occupancy of 50%.

Given that the occupancy rate is a proxy for a weighted average of passenger kilometres travelled on that service, it is a simple matter of multiplying route kilometres travelled by that service, and number of occupied seats and berths on that service, to obtain total passenger kilometres for that service. The data is then annualised by multiplying a month's data by the number of times the service was run during the year and obtained from the timetables with an allowance for cancellations.

Total annual number of occupied seats/berths are then divided into total annual passenger kilometres to obtain a weighted journey distance. Timetables were studied for each year to see if major timetabling changes were made, or where Country services were transferred to other market segments such as Interstate or Interurban. The total study period's results are shown in Table A2.15.

The rise in trip length reflects the replacement of rail branch line services with road coaches, and the concentration of rail services on trunk lines, operated by XPT trains.

Table A2.15 Average Country trip length

Year ended 30 June	Trip length (kms)
1952-1959	201
1960-1975	275
1976-1977	359
1978	379
1979	379
1980	381
1981	383
1982	385
1983	387
1984	389
1985	389
1986	391
1987	393
1988	395
1989	397
1990	399
1991	399
1992	399

Interstate passenger kilometres

The Interstate services were calculated in the same way as Country services, using the same sources for the 1977/78 baseline, and the same timetables. The total study period's results are shown in Table A2.16.

Table A2.16 Average Interstate trip length

Year ended 30 June	Trip length (kms)
1952-1957	560
1958-1960	595
1961-1963	665
1964-1970	657
1971-1982	664
1983-1986	662
1987-1992	665

A2.4.7 Passenger Revenue

The *Classification of Earnings and Working Expenses Accounts* (Australian Railways 1961) defines gross earnings from passengers as follows:

> Includes all earnings from transportation of passengers including sleeping car and excess fares and deposits in connection with periodical tickets, excursions and special trains.

It does not, therefore, include parcels or trading and catering revenues earned on trains.

However, in the New South Wales context, it includes an amount of money paid by the Government to the railways to cover so-called "unremunerative" passengers. These are a substantial group of passengers who travel free or at concessional rates. To coin a biblical phrase, "Their name is Legion". In the past, a special committee sat at the end of the financial year, with a so-called formula, which was then applied to determine what payment the railways should receive. This formula was founded on estimates of journeys made by each category of free or concession traveller. The journey estimates were not made on the most cursory of survey information. Documentation on these estimates has been sighted. Anecdotal information on the meetings also indicates that the final amount of money was basically determined by the bargaining strength of the railways, and its chief executive officer. This becomes clear when one looks at the variability in these numbers. The purist analysts would probably suggest that "unremunerative" revenue be excluded, so that we are left with fare box revenue only. They argue that "unremunerative" revenue has essentially been an outcome of the political process, and has no bearing upon the true revenue earning capacity of the railways. However, it is precisely for this reason that it should be included:

1. It is not a *subsidy* within the economic definition, and can in no sense be regarded, historically, as a "community service obligation".
2. It is an *economic rent* imposed on the taxpayer, through the government, for carrying an undetermined number of concession holders that (presumably) would vote in favour of the government in return for holding on to their concession. In terms of the accepted definition, "unremunerative" payments are made for the supply of railway passenger services over and above the minimum payment (fare-box revenue) to keep the services going. In the past, populist governments have used the railway concession fare with considerable effect. And, taxpayers have paid handsomely to the railways for this largesse. On the other hand, reformist governments have cut back on "unremunerative" payments.
3. The "unremunerative" payment variations are a very good proxy for measuring changes in the relative strength of the railways as a political institution, capable of keeping governments in power, or of changing governments. The payments are made on behalf of a very wide spectrum of society. The size of the payment is then inversely proportional to the level of efficiency. The irony of the situation is that the greater the sum received, the less the pressure to reduce costs.

Specific information on the unremunerative subsidy is only available from 1966/67 although it was almost certainly being paid before that, in accordance with some formula. The data is set out in Table A2.17.

Table A2.17 Estimated payment for unremunerative journeys

Year ended 30 June	Payment ($'000 current)	% change from previous year
1967	7,551	
1968	7,346	-2.7
1969	7,601	3.5
1970	8,225	8.2
1971	8,228	-
1972	8,833	7.4
1973	8,741	-1.0
1974	8,298	-5.1
1975	6,114	-26.3
1976	19,656 (1)	221.5
1977	2,750	-86.0
1978	13,248	381.7
1979	13,248	-
1980	21,348	61.1
1981	27,333	28.0
1982	39,917	46.0
1983	49,944	25.1
1984	57,439	15.0
1985	74,337	29.4
1986	80,700	8.6
1987	89,859	11.3
1988	100,548	11.9
1989	110,194 (2)	9.6
1990	100,000 (2)	-9.2
1991	100,000 (2)	-

Notes:

(1) The 1975/76 Annual Report recorded a payment of $7.3 million for unremunerative services under an agreement made under the outgoing Liberal/Country Party government. The 1976/77 Annual Report, the first under the Wran Labour government, showed the unremunerative payment to be $19.7 m.

(2) Reporting on the unremunerative payments ceased in the years under the Greiner Coalition government. These figures are estimates.

A number of observations may be made about the figures which lend support to the "political rent" argument:

1. In the years 1966/67 to 1974/75, the unremunerative payments were a modest call on government funds. In fact, they declined slightly in 1972/73 and 1973/74, in the years following the 30 per cent fare increase.
2. In the years of the Wran Labour Government when the railways became a centrepiece of policy (for both state economic development and state welfare policies), the unremunerative payments escalated rapidly. They continued to increase until they hit a ceiling of about $100 million.
3. The $100 million was maintained under the Greiner Coalition, probably because any reform of this financial monster, in parlous economic times, would have had severe electoral consequences. This would be especially true in country areas where the majority of passengers travel on concessions.

4. The gyrations in the year to year numbers above, tend to make a mockery of earnest attempts at, for example, guessing the number of times judges and magistrates on free passes use the train each year.
5. It is very important that it be included in the revenue figures because it holds a mirror up to the railways in its role as a political institution, but it is not a subsidy nor a "community service obligation" in the economic sense of the word.

For the years 1950/51 to 1965/66 only a single figure was available in Annual Reports, to cover revenue earned from all passengers market segments and unremunerative payments. An extrapolation was made from later years, of the percentage share of metropolitan and non-metropolitan passenger revenue. These extrapolated percentages were then used to split total revenue into metropolitan and non-metropolitan, for the years 1950/51 to 1965/66. Average revenues per journey were then calculated to test for any inconsistencies in this procedure.

Interurban revenue was extrapolated from 1965/66 to its very small base in 1958/59 and deducted from metropolitan passenger revenue. This procedure then gave relatively robust estimates of Suburban and Interurban revenue for the years 1950/51 to 1965/66.

Examination of the years 1966/67 to 1975/76 indicates that Interstate revenue was a very stable one-third of the combined Country and Interstate revenue. This arose partly because of publication of interstate agreements for the distribution of Interstate revenue. This ratio was adopted to separate Country and Interstate revenues for the period 1950/51 to 1965/66.

Revenue for each market segment for the period 1966/67 to 1975/76 was obtained from the December 1976 study (Planning Division, PTC 1976). An added advantage of these data was that the revenue was fare-box revenue, enabling the ready identification of unremunerative payments.

Country and Interstate revenues are separately identified in the Annual Reports from 1976/77 to 1979/80. For this period an extrapolation was made to obtain the Interurban proportion of metropolitan revenue, and cross checked by developing an average revenue per journey.

For the period 1980/81 to 1990/91, the 1988/89 Annual Report provides a time series of Countrylink (Country and Interstate) and Cityrail (Suburban and Interstate) revenue. Extrapolated ratios were used to split revenues into the four segments which were then cross-checked against average revenue per journey and other archival data. A similar method was used to obtain revenues for 1989/90 and 1990/91.

A2.5 BUILDING THE INPUTS DATABASE: PHASE I

The Input Database for the Productivity Study needed to be undertaken in two Phases. In the first Phase, the Annual Accounts for each year are reconstituted into the NFG 2 format, as described in Section A2.2.2. The remaining cost items (Corridor Fixed Costs, Business Management and Corporate Overheads) are collated in Phase II. The conventions of economics are used in the calculation of Capital Costs.

A2.5.1 Train Crew Costs

There are two components:

1. Train Crew.
2. On-train Crew.

Train crew

Train crew costs include salaries, wages and travelling expenses of personnel designated as train crew mainly drivers, observers and firemen in the case of steam trains. Also included are the costs of uniforms and other supplies, provided directly to the crew. The time taken by train crews for positioning and train preparation is included. NFG 2 requires this to be expressed, when in unit cost terms, as a rate per paid crew hour or train hour. Such a unit cost will only become necessary when we set up the output data, and develop unit costs therefrom.

On-train crew

On-train crew costs include salaries, wages, travelling and incidental expenses of guards, conductors, hostesses, ticket collectors on trains and employees engaged part of their time as guards etc., on trains. Also included are the costs of uniforms and other supplies provided directly to the on-train crew.

Again, NFG 2 requires the unit cost expressed in terms of rate per crew hour or train hour.

A2.5.2 Indirect Costs of Crews

A major innovation of NFG 2 is an attempt to include labour overhead costs with the direct labour cost item. The reasoning is that the overheads are costs which, in the long run, are likely to vary with the size of the labour force. This convention was not adopted in the General Ledger of the New South Wales Railways. So per capita estimates were made and then applied to the number of Train and On-train Crew. Overheads include pay-roll tax, workers compensation leave and long service leave provisions and superannuation. Other indirect costs include first-line supervision and an allowance for Branch administration.

NFG 2 also requires the inclusion of a portion of Corporate or Business Sector Services. These are not included on the grounds that these costs have only tenuous links with operations activity and are largely indivisible.

A2.5.3 Fuel Costs

There are two components:

1. Liquid and solid fuel.
2. Electricity.

Liquid and solid fuel

Liquid fuel and solid fuel includes, fuel oil, coal, wood, kindlers, diesel fuel, and petrol for motive power; fuel, oil, tallow and waste used in the running of rail motor cars, costs of inspection and handling of fuel for motive power, water for locomotives and oil, tallow, waste and other running supplies for motor power.

Electricity

Until January 1953, the Railways operated their own power stations mainly for the production of electricity used in traction. After this time, the power stations and associated assets were transferred to the Electricity Commission of NSW. A more realistic electricity pricing was implemented from this time for the Railways.

Since then, electricity cost has included the purchase of electrical energy and the cost of transmission and maintenance (but excluding the cost of maintaining buildings and structures). This convention is in contradiction to NFG 2 which places all maintenance of catenary, substations and other electric overhead facilities to Corridor Fixed Costs.

A further problem is the separation of electricity cost into Traction and Other uses. A survey in 1983/84, within the Authority, for the NSW Energy Authority showed, on a million kilowatt hour (million kWh) basis the dissection of electricity consumption:

	Million kWH electricity consumption		
Year	For Traction	For Other Use	Total
1981/82	357 (71%)	145 (29%)	502 (100%)
1982/83	396 (77%)	118 (23%)	514 (100%)
1983/84	414 (78%)	120 (22%)	534 (100%)

Source: Electrical Branch SRA of NSW for Energy Authority of NSW.

In this analysis, the view has been taken that electricity for traction is increasing, as high performance traction motors are increasingly used. This is despite the fact that such fuel-saving innovations as chopper control devices have been introduced in the Tangara suburban motor cars. Extrapolation from the Electricity Consumption estimates above, shows electricity consumption for traction purposes increasing from 60 per cent in 1951/52 to 82 per cent in 1989/90. It needs to be noted that unlike most industries which use electricity, railways must provide most of their own electricity transmission and distribution system. The cost of maintaining this system is a direct cost burden and needs to be treated as part of train running costs.

A2.5.4 Rollingstock Maintenance: Locomotives

The conventions adopted by NFG 2 include the costs of both depot/running shed and workshop maintenance. Unit cost of routine running shed servicing should be expressed as a cost per hour in traffic. The unit cost of workshop overhauls and unscheduled maintenance of a major nature should be identified by broad locomotive type and divided into the cost of 'above-frame' maintenance (body and traction motors); and the cost of 'below-frame' maintenance (underframe, wheels, brake-gear and axles).

Locomotive running sheds and depots are essentially locations where locomotives are stabled, cleaned and prepared for their next rostered runs. Minor maintenance and repairs are permitted including the cleaning, testing and adjusting of brakes. Such locations were particularly important in the age of steam locomotion where a labour intensive process was needed to clean locomotives of ash, wash out boilers and pipes, inspect and load fuel for the next run, etc.

A2.5.5 Rollingstock Maintenance: Self Propelled Units and Carriages

NFG 2 applies the same conventions as those in locomotive maintenance. This includes all non-engine maintenance of self-propelled vehicles. Also included are train examination, lubrication and carriage cleaning. As with locomotives, the two principal items of expenditure are labour and materials, with an allowance for General

Superintendence. (In accordance with the NFG 2 provision on First line supervision and Branch Administration). It includes the salaries, wages and expenses of Branch management, their staff, superintendence, District Inspectors, Foremen, and District Engineers.

A2.5.6 Variable Track Maintenance

NFG 2 has some very specific injunctions regarding Track and Structure Maintenance Costs. First, there is the question of differentiating between maintenance and capital expenditure:

> Track maintenance costs are defined as that level required to maintain track to its current standard...but any incremental expenditure above this level to provide, for example, heavier weight of rail, a replacement of wooden with concrete sleepers should be treated as a capital expenditure and excluded from NFG 2 traffic costings.

When it comes to dissecting total track maintenance into variable and fixed costs the convention is:

> 25% of total track maintenance costs should be taken as being variable with traffic level, assuming a fixed track standard. This component, therefore, does not include the variability of the basic track standard with traffic, but only the variability of maintenance cost given that a particular standard is provided. In the longer-term, changes in traffic levels will also lead to changes in track standard and in this case systems should use a 40% variability factor.

A reading of NFG 1 shows that the 25% rule was based on a V/Line study conducted in the 1970s, thus:

> Analysis conducted by V/Line indicates that of its total maintenance cost on inter-system lines, a proportion of 25% should be taken as being variable with traffic level. This is based on the assumption that decisions have already been made to provide a particular track standard on inter-system routes, and that the variable component should, therefore, not include the variability of the basic track standard with traffic, but only include the variability of maintenance cost given that a particular standard is provided. In the absence of more specific information, systems should use a 25% variability factor.

In 1981, Railways of Australia, in conjunction with the State Rail Authority of NSW, published the findings of their study of Vehicle/Track Interaction (Railways of Australia 1981). The study was an experimental one, undertaken at Wongarbon on the Main Western Railway line, near Dubbo, NSW. The study track was newly laid "good" track comprising 53 kilograms per metre, continuously welded rail, laid on timber sleepers. The condition of the track was then experimentally altered to produce dips in rails, misalignments, changes in curvature, and changes in jointings. The study vehicles comprised various train compositions comprising short rakes (4 to 6) of various freight wagons (loaded and empty), locomotive and brake vans, a recording van and two wagons (loaded and empty) used as mechanical test vehicles. A variety of bogies under these vehicles were also tested. This experimental method would ensure that the test results were as valid for passenger trains as they were for freight trains.

The main findings on Track conditions were:

> In both tangent and curved track, the primary emphasis of track maintenance practice should be to control misalignment and twist. Large misalignment errors can result in a marked increase in the lateral force imposed on the track (up to 800 per cent above that experienced on "good" track) and consequently the rate of track degradation; while single dips in one or both rails can cause complete wheel unloading and hence the possibility of derailment in empty vehicles travelling above 80 km/h...
>
> Both lateral and vertical forces imposed on the track increase with vehicle speed over all track conditions tested...

A caveat was also applied to the test data:

> 4. Track geometry recording cars are currently used as a track maintenance planning tool. The study has shown that the data obtained from such equipment is influenced by wheel loads and temperature. Therefore parameters must be taken into account when interpreting resulting data.

The main findings on Vehicles and Bogies were:

> 1. It is generally accepted that vehicle/bogie hunting or instability must be avoided to minimise the probability of derailment and lateral forces which lead to high wear in both vehicle and track. For standard three-piece bogies the upper limit for stability was found to be 80 km/h for empty vehicles and 110 km/h for loaded vehicles. It is, therefore, recommended that the operational speed of freight vehicles with three-piece bogies be limited to 80 km/h until such time as the appropriate changes can be made to the bogie system which reduce or eliminate hunting. It is also recommended that an economic evaluation be undertaken of freight vehicles with three-piece bogies travelling in the 60-75 km/h speed range.

Whilst the Study recommended a number of economic evaluations which would have clearly established more precise rules for track maintenance costing, these were not followed through. Nevertheless, the results are sufficient to cast doubt on the 25% Rule, and to provide a solid basis for further research. This research should determine if track wear is a function of the existing conditions of the track, train weight (i.e. wheel loads), speed of the train, rail temperature, and the type of bogies used on the rollingstock. This seems to show that the statement in NFG 1, in support of the 25% rule, is largely sophistry.

> This is based on the assumption that decisions have already been made to provide a particular track standard on inter-system routes, and that the variable component should therefore not include the variability of the basic track standard with traffic, but only include the variability of maintenance cost given that a particular standard is provided.

First, there is considerable pressure on all systems to increase both the train size, train weight and train speed up to acceptable technical limits of track and rollingstock. This, as we saw, substantially increases wear and tear on "good" track, and dramatically so on track with defects. The bulk of the trains travelling on interstate routes are freight trains, so that a fair dissection would be based on train kilometres: given that train speeds are the most critical element.

Second, most rollingstock in service is not fitted with the preferred three-piece bogies.

Third, for about six months of the year rail temperatures are likely to exceed 30°C. during long parts of the day while ambient spring, summer and autumn temperatures reach the mid-twenties. All of this leads the analyst to the conclusion that a 25% Rule is not appropriate, and should be higher at least up to the upper limit of 40% suggested in NFG 2.

However, it is not proposed to vary the 25% Rule until detailed economic evaluation of the ROA data is undertaken.

Dissection between Passenger and Freight is not based on train kilometres. It is extrapolated from the 1981/82 to 1986/87 Accounts dissected into Passenger and Freight. This dissection uses gross tonne kilometres. The outcome is that Passenger is allocated about 36 per cent of variable track maintenance costs.

A2.5.7 Terminal Costs: Passenger Duties

In the NFG 2 format, this item represents a conglomerate of costs including freight handling, passenger duties, shunting, train examiners and bogie exchange/transfer.

Passenger duties, include shunting costs, and even cover the salaries, wages and expenses of staff employed at stations and yards such as station masters, assistant station masters, station assistants, caretakers, yard masters, station agents, clerks, any staff who may be attached to the station or yard, porters, attendants, cleaners, shunters, and assistant shunters. NFG 2 requires that where duties are split between freight and passenger functions, costs should be attributed in proportion to time spent on different tasks. A unit costing approach of ultimate accuracy would require regular periodical surveys of staff time to assess the proportions. This is time consuming and costly, and a reasonable dissection could be obtained with train kilometres.

A further deviation from NFG 2 occurs with signalling staff. The convention prescribed is as follows:

> Signalling operations, safe-working and train-control costs should be regarded as invariant with traffic levels. They should be expressed as a cost per train kilometre where they are required to be allocated to traffics.

There is a practical problem here in that these employees have traditionally been controlled by the railway operations Branch, and their costs are incorporated as "Station, Yard and Signal Service" costs. Dissection of the Annual Accounts back to 1951/52 would be very difficult, and not necessarily affect the outcome a great deal. Here we may bear in mind Beesley and Kettle's assertion that distinctions between variable and non-variable costs can be thought of as artificial. Nevertheless, technological changes in signalling and safe-working are having a significant effect upon productivity, and it is worth studying this process as a specific case study. It is hoped to do this in the next stage. For the purpose of the thesis, the less than perfect methodology is to have them as part of station costs.

NFG 2 also requires that:

> Shunting costs should include the capital costs of shunting locomotives, locomotive maintenance, locomotive view, fuel, and yard crew.

Again, the Annual Accounts do not include this cost as a terminal cost, but as a train running cost. Again for the purposes of the present analysis, it is not worth the time and effort to dissect the shunting locomotive costs from other locomotive costs. Nevertheless, a real future issue will be the productivity of terminals, and it will be important to examine the efficiency of the shunting operation, in all its facets. This is best done as a case study, at a later stage.

Finally, NFG 2 indicates that train examination should be included as a carriage and wagon maintenance cost. However, in its External Reporting Format, later, NFG 2 includes it as a Terminal Cost. The NSW Railways Annual Accounts have always identified these as separate costs, and our analysis has followed this convention, ensuring that such costs are part of the "Long-Run Avoidable Cost" Total.

A2.6 BUILDING THE INPUTS DATABASE: PHASE II, LABOUR, FUEL AND MATERIALS

A2.6.1 Introduction

In Phase I, the principles were described on the methodology used to reconstitute Annual Accounts into the NFG 2 format, up to the level of Long Run Avoidable Cost.

In Phase II, described below, the NFG 2 items are taken to the next stage of unit costs that also includes estimates for Corridor Costs and Business Management and Corporate Overheads.

A2.6.2 Train Crew Costs

Personnel in the organisation designated as train crew are:

- drivers,
- firemen, observers, second persons, assistant drivers, which, over the years have been variously used to describe the second person in the driver's cab, and
- trainee drivers.

Cost of train crew

In accordance with the NFG 2 costing convention, both the direct and indirect cost of train crew are included. The direct costs are wages and salaries, overtime, travelling, incidental expenses, uniforms and other supplies. The indirect costs are payroll tax, workers compensation, leave and long service leave provisions superannuation, first line supervision and an allowance for administration.

Total train crew numbers

Total train crew numbers, for freight and passenger services, are available in the 1984/85 Annual Report, for the years 1980/81 to 1984/85. For the years 1972/73 to 1976/77, total numbers were available from the Expenditure Forecasts document (Planning Division 1978). The years 1977/78 to 1979/80 were interpolated.

A ratio of total train crew to total train kilometres was then calculated for the years 1972/73 to 1976/77. This ratio showed a steady increasing trend. It was extrapolated back to 1951/52, and was then used to calculate total train crew from 1951/52 to 1971/72.

Total train crew were also available for 1990/91 from a PERSY (Personnel Records System) Return (State Rail Authority 1991). Total train crew numbers were interpolated from 1985/86 to 1989/90.

It was found that train crew numbers have a direct relationship with train kilometres. Also that the ratio of train kilometres to total train crew numbers increased at an average annual rate of 2 per cent per year, between 1951/52 to 1990/91. This was due to the steady increase in the haulage capacity of locomotives starting first with the change from steam to diesel power, and then with the increasing horsepower of diesel units. A similar trend occurred with electric trains.

Train crew numbers by market segment

The objective was to establish an estimate for train crew, by market segment. It was calculated for each market segment, as follows:

1. Annual train kilometres by segment was converted to train kilometres per day by dividing by 365.
2. Train kilometres per crew day were then calculated at 2% annual increase from 1951/52, in line with the observation that total train kilometres per total train crew had been increasing since 1951/52, at 2% average per year. A datum point was also available for 1986/87 (Metropolitan Strategy Study, GHD Transmark 1988). Whilst it referred to Suburban and Interurban services only, it also provided a useful cross-check of non-urban estimates.
3. Division of train kilometres per crew day into the segment's train kilometres per day, gave number of crews per day. However, this number of crew relates only to those actually at work on trains during that day. There are many other crew "on the books" who may be rostered on as relief crews, in case of emergencies. There are others who are rostered off on leave of various kinds, light duties, etc.
4. Using 1990/91 crew numbers as a datum it was found that train crew numbers derived from train kilometres, in (3) above, needed to be expanded by a further 39.3%. An expansion factor of 1.393 was then applied to all crew numbers derived in (3), to obtain the total number of crew "on the books", by market segment. 1990/91 was considered to be reasonably representative for all other years. Whilst it will have contained a much more efficient set of rosters for train crew, it would also have been carrying some redundant train crews redeployed from Freight Rail.

Cost per train crew hour

A total annual cost of passenger train crew was established in a previous study (De Mellow 1991), for the years 1951/52 to 1989/90. This was expressed in both current and constant (1980/81) dollars. This report should be consulted regarding the methodology. It should be noted, however, that the sources of data were the annual accounts for each of the years. It should also be noted that the costs include indirect costs such as payroll tax; workers compensation, leave and long-service leave provision, superannuation, first line supervision and an allowance for Branch administration.

At this stage, also, all cost data is expressed in constant dollars. Also, calculations for the years 1990/91 and 1991/92 await the 1991/92 Annual Report.

An average "remuneration" per train crew was then obtained for all passenger services, as shown in Table A2.18.

These annual data were converted to an average hourly cost for all crew by dividing by 1976 hours per year (Chief Executive Memorandum 1986). These are the average rostered hours available for train crew, each year. It should be noted that over the years this has varied due to non-significant changes in awards and conditions.

This common hourly rate was then multiplied by estimated crew numbers in each market segment to obtain a total cost.

Table A2.18 Average "remuneration" per train crew, 1951/52 to 1988/89

Year ended 30 June	Average remuneration $ current	$1980/81
1952	3,219	15,330
1953	3,441	15,049
1954	4,010	17,292
1955	4,334	18,552
1956	4,764	19,738
1957	5,131	19,869
1958	4,994	19,106
1959	5,344	20,249
1960	5,635	20,878
1961	5,949	21,297
1962	5,949	21,237
1963	6,062	21,494
1964	6,605	23,210
1965	7,372	25,016
1966	7,424	24,403
1967	6,858	22,012
1968	6,836	21,247
1969	8,009	24,168
1970	8,571	24,857
1971	9,524	26,190
1972	10,835	27,540
1973	12,302	29,509
1974	15,830	33,591
1975	20,460	37,272
1976	23,468	37,823
1977	28,537	41,007
1978	32,221	42,474
1979	32,594	39,573
1980	37,340	40,946
1981	43,943	43,943
1982	38,885	35,271
1983	39,227	31,798
1984	42,658	32,612
1985	44,127	32,455
1986	40,689	27,566
1987	44,330	27,467
1988	49,263	28,351
1989	57,207	30,471

A2.6.3 On-Train Crew Costs

Personnel in the organisation designated as on-train crew include:

- guards, and
- conductors, hostesses, ticket collectors on trains, and other personnel who may be engaged for part of their time on trains as guards, etc.

Cost of on-train crew

In accordance with the NFG 2 costing convention, both the direct and indirect costs of on-train crew are included. The direct costs are wages and salaries, overtime, travelling, incidental expenses, uniforms, and other supplies. The indirect costs are: payroll tax, workers compensation, leave and long-service leave provisions, superannuation, first line supervision and an allowance for administration.

Total on-train crew numbers

Total on-train crew numbers for freight and passenger services are available in the 1984/85 Annual Report, for the years 1980/81 to 1984/85. Total on-train crew were also available for 1990/91 from a PERSY Return (State Rail Authority 1991).

A ratio of on-train crew to total train kilometres was then calculated for the years 1980/81 to 1984/85. As with train crew, this ratio showed a steady increasing trend. It was extrapolated back to 1951/52, and was then used to calculate total on-train crew, from 1951/52 to 1979/80. Total on-train crew numbers were interpolated from 1985/86 to 1989/90.

As with train crew, it was found that on-train crew numbers have a direct relationship with train kilometres. The ratio of train kilometres to total on-train crew numbers increased at an average annual rate of 4.2% per year between 1951/52 to 1990/91. This was due to the steady withdrawal or amalgamation of services, particularly on branch lines and the steady elimination of on-train functions such as conductors, hostesses, etc.

On-train crew numbers, by market segment

As with train crew, the objective was to establish an estimation for on-train crew, by market segment. It was calculated for each market segment.

1. Annual train kilometres by segment was converted to train kilometres per day by dividing by 365.

2. Train kilometres per on-train crew day were then calculated at 4.2% annual increase from 1951/52, in line with the observation that total on-train kilometres per total on-train crew had been increasing since 1951/52, at 4.2% average per year. A datum point was also available for 1986/87 (Metropolitan Strategy Study, GHD Transmark 1988). Whilst it referred to Suburban and Interurban services only, it also provided a useful cross-check of non-urban estimates.
3. As with train crew, the division of train kilometres per on-train crew day into the segments' train kilometres per day gave number of on-train crew per day. However, this number of on-train crew relates only to those actually at work on trains during that day. There are many others "on the books" namely relief crews, on leave of varies kinds, light duties, etc.
4. Using 1990/91 crew numbers as a datum, it was found that on-train numbers derived from train kilometres, in (3) above, needed to be expanded by a further 45.3%. An expansion factor of 1.453 was then applied to all on-train crew numbers derived in (3), to obtain the total number of on-train crew "on the books", by market segment. 1990/91 was considered to be reasonably representative for all other years. Whilst it will have contained a much more efficient set of rosters for on-train crew, it would also have been carrying some redundant guards etc. re-deployed from Freight Rail.

Cost per on-train crew hour

A total annual cost of passenger on-train crew was established in a previous study, by the writer (De Mellow 1991), for the year 1951/52 to 1989/90. This was expressed in both current and constant (1980/81) dollars. This report should be consulted regarding the methodology. It should be noted, however, that the sources of data were the annual accounts for each of the years. It should also be noted that the costs include indirect costs such as payroll tax, workers compensation, leave and long-service leave provisions, superannuation, first-line supervision and an allowance for Branch administration.

All cost data is expressed in constant 1980/81 dollars.

An average "remuneration" per on-train crew was then obtained for all passenger services (Table A2.19).

These annual data were converted to an average hourly cost for all on-train crew by 1976 hours per year (Chief Executive Memorandum, June 1986). These are the average rostered hours available for on-train crew, each year. It should be noted that over the years this has varied due to changes in awards and conditions. However, these changes are not considered statistically significant, for our purposes.

This common hourly rate was then multiplied by estimated on-train crew numbers in each market segment, to obtain a total cost.

Table A2.19 Average "remuneration" per on-train crew, 1951/52 to 1984/85

Year ended 30 June	Average remuneration $1980/81
1952	3,007
1953	3,257
1954	3,674
1955	3,872
1956	4,115
1957	4,297
1958	4,449
1959	4,536
1960	5,116
1961	5,099
1962	5,659
1963	5,829
1964	6,242
1965	7,111
1966	7,380
1967	7,479
1968	7,908
1969	8,570
1970	10,124
1971	10,197
1972	11,146
1973	11,970
1974	13,548
1975	15,942
1976	16,500
1977	17,893
1978	18,557
1979	18,458
1980	19,099
1981	21,192
1982	21,253
1983	20,600
1984	21,628
1985	21,423
1986	21,423
1987	21,339
1988	21,997
1989	25,141
1990	27,097
1991	na
1992	na

A2.6.4 Fuel Costs

This includes solid fuel, electricity and liquid fuel.

The productivity model requires the estimation, by market segment, of the following:

- Quantity of solid fuel used, in gigajoules.
- Unit price of solid fuel.

Definition of solid fuel and its conversion to Gigajoules

The elements used in the production of steam for locomotives are coal, wood and "kindlers" and water.

The first three are generically termed solid fuels. However, the fuel component of the three elements is coal, wood and "kindlers" (flammable materials used to kindle the fire box, are essentially used to initially stoke the boiler in the locomotive). Water is the element used to convert to steam.

It is only relevant to measure the quantity of coal used. However, the cost of water, wood and kindlers is a relevant part of the cost of solid fuel.

The quantity of coal used for traction was measured in long tons, which are readily convertible to metric tonnes.

The "joule" is used as a common unit of quantity for all forms of fuel. It is a unit of energy generated by a current of one ampere acting for one second against a resistance of one ohm.

To convert from metric tonnes of coal to Gigajoules (1 000 000 000 joules), we have adopted the Energy Authority of NSW *Energy Survey Information Sheet* (1982) Conversion Factors. These, in turn, were based on the International System of Units. In this document, a kilogram of coal yields 25 megajoules of approximate energy equivalent at 100% Conversion Efficiency. However, the document goes on to note that NSW black coal (used in NSW steam locomotives) varies in energy content in the range 21-35 MJ/kg. And further: "If actual values are not available (from the supplier), a value of 25 MJ/kg should be used". Some information on this was available in the Annual Reports from 1951/52 to 1954/55.

Solid fuel cost

The costs, readily identified in the Annual Reports, for solid fuel include coal, wood, kindlers and water.

Having obtained a total cost of solid fuel, the next step was to obtain a unit cost. The tonnage of coal used in traction was available from Annual Reports, was converted to gigajoules and then divided into total cost.

Dissection of traction solid fuel usage into market segments

The unit of output directly related to solid fuel usage is the locomotive kilometre. Total steam locomotive kilometres were divided into coal, used for traction purposes, to obtain coal usage per locomotive kilometre. This gave a result each year of 0.03 metric tonnes (30 kilograms) per locomotive kilometre.

Steam locomotives were only used for Suburban and Country passenger services from 1951/52 to 1973/74 when they were phased out.

Steam locomotive kilometres were obtained for Suburban and Country passenger services from Operating Statistics (1969/70 to 1973/74) and Annual Reports (1951/52 to 1968/69). Coal usage was then calculated by multiplying by 0.03. This quantity was then converted to gigajoules.

Electricity

The productivity model requires the estimation, by market segment, of the following:

- Quantity of electricity used, in gigajoules (EFGJ).
- Unit price of electricity (EFGPJ).

Gigajoules and Kilowatt Hours

A megajoule (1,000,000 j) is a comparatively small unit of energy, e.g. one sixty-watt electric light bulb burning continuously for 24 hours would consume 5 megajoules.

Electricity consumption is measured in kilowatt hours (kWh). The watt is a unit of electric power, rate of working in circuit when electromotive force is one volt and intensity of current is one ampere. So kWh is a thousand watts working thus for one hour.

To convert from kWh to Gigajoules (1,000,000,000 joules), we have adopted the Energy Authority of NSW *Energy Survey Information Sheet* (1982) Conversion Factors. These, in turn, were based on the International System of Units.

To convert kilowatt hours to megajoules, we have multiplied kWh by 3.6 and to convert to gigajoules, it has been rounded to the nearest thousand.

Electricity cost

In NSW, the cost of electricity has included the purchase of electrical energy only. In accordance with the NFG 2 convention, the costs of transmission and maintenance of catenary, substations and other electric overhead facilities are treated as Corridor Fixed Costs.

Also, the NSW railways has always sold electricity which has been surplus to its requirements. Until January 1953, it was the State's principal electricity generating authority and therefore, sold substantial quantities of electricity. At that time the responsibility of electricity generation passed to the Electricity Commission of NSW, and electricity sales by the Railways dropped substantially. This electricity cost is net of surplus electricity re-sold to other consumers.

In addition there is a need to include in electricity cost only that which is used for traction purposes as we are determining train running costs only, at this stage.

The next step after this is to dissect traction electricity cost by market segment.

Table A2.20 sets out, in pro-forma, the method used in deriving the data. It was the same method used by the Costing and Special Projects Section, State Rail Authority of NSW, to apportion Electrical Branch expenditure for the NSW Energy Authority Energy Surveys, 1978/79 to 1983/84 (Mimeos).

Table A2.20 Schedule for annual apportionment of electricity usage by end use

Steps to apportion electricity use				
1. Total Electricity (generated/purchased) (mWh)				
2. Total cost of Electricity ($m)				
3. Unit cost of Electricity (¢ per kwh)				
4. <u>Less</u> sale of Electricity ($m)				
5. Quantity sold Electricity (mwh)				
6. Quantity price of (5) (¢ per kwh)				
7. <u>Less</u> Electricity used for non-traction (mwh)				
8. <u>Less</u> % of Electricity for traction (%)				
9. Quantity for traction (mwh)				
10. Traction electric passenger trains				
Segment	Loco kms. ('000)	Quantity (mwh)	Cost ($m)	Unit cost (¢ per kwh)
10.1 Suburban:				
10.2 Interurban:				
10.3 Country & Interstate:				
10.4 Total passenger:				
10.5 Freight:				
10.6 Grand total:				

The total cost of electricity generated and purchased is available from Annual Reports, for all years.

Unit costs of electricity are available for the years 1978/79 to 1983/84, and 1952/53 and 1953/54. By interpolation and extrapolation, unit costs were obtained for the remaining years.

Data in respect of total megawatt hours of electricity were available for the years 1978/79 to 1983/84 and 1951/52 to 1954/55. Data for total megawatt hours for the remaining years was obtained by dividing unit cost of electricity into total cost.

The total revenue and megawatt hours of electricity sold was available for 1978/79 to 1983/84, and 1952/53 and 1953/54. The total revenue was available for all remaining years. When unit price (about 0.03 cents per kWh higher than cost) was divided into total revenue, a megawatt hour was obtained.

Dissection of traction electricity usage and cost, by market segment

Megawatt hours and cost were available, by market segment, for the years 1978/79 to 1983/84. When related to locomotive kilometres, these provided kilowatt hours per locomotive kilometre. By extrapolation kWh/loco km were obtained for the remaining years. When multiplied by locomotive kilometres, a megawatt hour usage for each year was obtained. When multiplied by unit cost, a total cost of electricity was obtained for each market segment.

Liquid fuel

The productivity model requires the estimation, by market segment, of the following:

- Quantity of liquid fuel used, in megajoules.
- Unit price of liquid fuel.

Definition of liquid fuel and its conversion to megajoules

Liquid fuel is principally automotive distillate used to power locomotives, but does include some motor spirit used for traction purposes, motor fuel, kerosene and industrial diesel fuel used in the 1950s to power locomotives.

The quantity of automotive distillate and other liquid fuels is recorded in thousands of litres. To convert from litres to megajoules (1,000,000 joules), we have adopted the Energy Authority of NSW *Energy Survey Information Sheet* (1982) Conversion Factors. These, in turn, were based on the International System of Units, as follows:

One Litre of...	Number of Megajoules (Mj)
Motor spirit:	
98 octane	34.4
87 octane	33.7
Lighting Kerosene	36.7
Automotive Distillate	38.4
Industrial Diesel Fuel	38.9

Liquid fuel cost

The total liquid fuel costs are available in the Annual Reports. The next step was to obtain a unit cost. This was available on a cents per litre paid, for the years, 1973/74 to

1986/87 (Mimeo 1988). Extrapolations were made for the years 1951/52 to 1972/73 and 1987/88 to 1991/92, using the Prices Surveillance Authority's Minimum Endorsed Wholesale Price of Distillate, New South Wales.

Dissection of liquid fuel usage into market segments

The unit of output most related to liquid fuel usage is the locomotive kilometre. Mechanical Branch Operating Statistics from 1951/52 to 1986/87 were used to obtain locomotive kilometres by locomotive type. In the main, particular types of locomotives and traction units were used in particular markets.

A2.6.5 Locomotive Maintenance Cost

The costs included here relate to costs incurred at two locations namely the workshop and the depot/running shed. In the workshop, the maintenance consists of overhauls and unscheduled maintenance of a major nature. Locomotive depots and running sheds are locations where locomotives are stabled, cleaned and prepared for the next rostered runs. Minor maintenance and repairs are permitted including the cleaning, testing and adjusting of brakes. These locations were particularly important in the age of steam, where a labour intensive process was needed to clean locomotives of ash, wash out boilers and pipes, inspect and load fuel for the next run, etc.

The Productivity Model distinguishes between two costs only:

- Labour cost.
- Non-labour costs (materials etc.).

Labour cost includes salaries and wages of workshop and depot/running shed staff engaged in locomotive maintenance, their travelling and incidental expenses, work clothing and supplies. In accordance with NFG 2, an allowance is also made for the on costs of these staff including superannuation, long service leave, compensation etc.

Also in accordance with NFG 2 an allowance is made for the cost of first line supervision and Branch administration. It includes a proportion of the cost of these personnel such as salaries, wages and expenses of Branch management, their staff, superintendence, District Inspectors, Foremen, and District Engineers.

Non-labour costs include a variety of stores and supplies used in the maintenance of locomotives.

Dissection of locomotive maintenance cost by market segment

Two market segments only carry the full cost of locomotive maintenance: Country and Interstate. A relatively small proportion of locomotive kilometres have been run in Suburban and Interurban services, but we have adopted the concept of the "prime-user" bearing the full cost of the service.

Multiple unit trains, which include motor carriages, are included in Carriage Maintenance, in conformity with NFG 2.

Dissection of total locomotive maintenance cost was undertaken by applying the percentage of train kilometres of each market segment, to the total of the two segments.

Dissection of total maintenance cost (by segment) into labour and non-labour cost

An actual percentage labour cost was obtained for the years 1966/67 to 1979/80 from the study: *Rail—Workshops Branch—Actual and Forecast Expenditure, 1966/67–1981/82*, Page 36. Expenditure Forecasts (Planning Division, Public Transport Commission of NSW 1978). Extrapolations were made for the years 1965/66 to 1951/52 and 1980/81 to 1991/92.

Labour locomotive maintenance hours and unit price

An average direct salary/wage per person was obtained for the years 1966/67 to 1976/77 from the study: *Rail—Workshops Branch—Actual and Forecast Expenditure, 1966/67–1981/82*, Page 36. Expenditure Forecasts (Planning Division, Public Transport Commission of NSW 1978). Extrapolations were made for the years 1965/66 to 1951/52 and 1977/78 to 1991/92, using the same percentage changes as the average annual remuneration per employee, appearing in the Annual Reports.

To the direct salary/wages was added percentages for payroll overhead, supervision and maintenance. These percentages were determined in a previous study by the author, when calculating the global input costs of passenger services.

The totals of these salary/wages costs were then deflated by a CPI deflator to convert them to 1980/81 costs.

The average salary/wage cost was then divided into total labour cost to obtain a nominal number of persons. This number was then multiplied by the standard annual railway hours of 1976, to derive an average cost per hour.

Maintenance cost per locomotive kilometre

The most appropriate, readily available unit cost of non-labour maintenance is cost per locomotive kilometre. Locomotive kilometres were obtained from Operating Statistics for the years 1970/71 to 1991/92, and Annual Reports from 1951/52 to 1969/70.

A2.6.6 Carriage Maintenance Costs

As with locomotives, the costs included here relate to costs incurred at two locations namely the workshop and the depot. In the workshop, the maintenance consists of a major nature. Depots are locations where carriages are stabled, cleaned, examined, lubricated and prepared for the next rostered runs. The maintenance of the motor carriages of multiple-unit trains is also included in carriage maintenance cost.

Again, the Productivity Model distinguishes between two costs only:

- Labour cost.
- Non-labour costs (materials).

Labour cost includes salaries and wages of workshop and depot staff engaged in carriage maintenance, including cleaning, examination etc., their travelling and accidental expenses, work clothing and supplies. In accordance with NFG 2, an allowance is also made for the on costs of these staff including superannuation, long service leave, compensation etc.

Also in accordance with NFG 2 an allowance is made for the cost of first line supervision and Branch administration. It includes a proportion of the cost of these personnel such as salaries wages and expenses of Branch management, their staff, superintendents, District Inspectors, Foremen and District Engineers.

Non-labour costs include a variety of stores and supplies used in the maintenance of carriages.

Dissection of carriage maintenance cost by market segment

All four market segments carry the cost of carriage maintenance. Multiple Unit Trains, which include motor cars, are included in Carriage Maintenance, in conformity with NFG 2 including engine maintenance, which is not in conformity with NFG 2 but is included, in conformity with the "prime user" concept.

Dissection of total carriage maintenance cost was undertaken by applying the percentage of train kilometres of each market segment, to the total of the four segments.

Dissection of total carriage maintenance cost (by segment) into labour and non-labour cost

An actual percentage labour cost was obtained for the years 1966/67 to 1979/80 from the study: *Rail—Workshops Branch—Actual and Forecast Expenditure, 1966/67–1981/82*, Page 36. Expenditure Forecasts (Planning Division, Public Transport Commission of NSW 1978). Extrapolations were made for the years 1965/66 to 1951/52 and 1980/81 to 1991/92.

Labour carriage maintenance hours and unit price

The same average salary/wage used for locomotive maintenance was used here. This was considered legitimate even through the mix of trades used in maintenance is different, the differences being assumed to average themselves out.

The average salary/wage costs were then deflated by CPI deflator. The deflated figure was then divided into total labour cost to obtain a nominal number of persons. This number was then multiplied by the standard annual railway hours of 1976, to derive an average cost per hour.

Non-labour maintenance cost per loaded carriage kilometre

The most appropriate, readily available unit cost of non-labour maintenance is cost per loaded carriage kilometre.

The statistic is obtained from Operating Statistics and was used in the calculation of seat kilometres (See Output Measures: Seat Kilometres). The statistic relates to carriage kilometres run in service, carrying passengers. This is slightly lower than total carriage kilometres, which includes empty running at the beginning and end of Runs.

A2.6.7 Variable Track Maintenance Cost

It is first necessary to distinguish between maintenance and capital expenditure. Track maintenance usually refers to work undertaken in order to maintain the track to its current, safe standard. However, any incremental expenditure above the current standard level is usually regarded as capital expenditure.

The convention adopted in NFG 2 was to take 25 per cent of total track maintenance cost as variable with traffic level, assuming a fixed track standard. NFG 2, however, notes that in the longer term changes in traffic levels lead to changes in track standard and therefore a 40 per cent variability factor should be used. A reading of Appendix 1 of the predecessor of NFG 2, NFG 1, shows that this convention was based upon an undisclosed V/Line study in the 1970s.

A Railways of Australia Study (ROA/SRA of NSW 1981) suggests that track maintenance costs have a complex dependency upon:

1. conditions of the track, train weight (i.e. wheel loads), speed of trains, rail temperature and the types of bogies used on the rollingstock, and
2. climatic conditions.

This conclusion suggests the establishment of statistical cost functions. Nevertheless, in the absence of further research, the 25 per cent convention is followed.

The critical dissection of track maintenance costs is based on gross tonne kilometres and established in the 1981/82 to 1986/87 Annual Accounts. In this, passenger traffic is allocated about 36 per cent of variable track maintenance costs.

Dissection into labour and materials cost

The Productivity Model distinguishes between two costs only:

- Labour cost
- Material cost.

Labour cost includes salaries and wages (working expenses) of staff engaged in track maintenance; their travelling and incidental expenses; work clothing and supplies. In accordance with NFG 2, an allowance is also made for the on costs of these staff, including: superannuation, long service leave, consumption, etc.

Also in accordance with NFG 2, an allowance is made for the cost of first line supervision and Branch administration.

Material costs include a variety of items used in the maintenance of track.

Dissection of variable track maintenance hours and unit price

Dissection of total variable track maintenance cost by market segment was obtained by applying the percentage of train kilometres of each market segment, to the four segments. In passenger train terms (where train weights are not a significant factor), train kilometres are a close enough proxy for gross tonne kilometres.

Labour variable track maintenance hours and unit price

An average direct salary/wage per person was obtained for the years 1966/67 to 1976/77 from the study *Rail—Workshops Branch—Actual and Forecast Expenditure, 1966/67– 1981/82*, Page 36. Expenditure Forecasts (Planning Division, Public Transport Commission of NSW 1978). Extrapolations were made for the years 1965/66 to 1951/52 and 1977/78 to 1990/91, using the same percentage changes as the average annual remuneration per employee, appearing in the Annual Reports.

To the average direct salary/wage was added percentages for payroll overhead, supervision and administration. These percentages were determined in a previous study by the author.

The totals of these salary/wage costs were then deflated by our CPI deflator to convert them to 1980/81 costs.

The average salary/wage cost was then divided into total labour cost to obtain a nominal number of persons. This number was then multiplied by the standard annual railway hours of 1976, to derive an average cost per hour.

A2.6.8 Terminal Running Cost

In the NFG 2 classification, this item represents a conglomerate of costs including freight handling, passenger duties, shunting, train examiners and bogie exchange/transfer.

Passenger duties, including shunting duties, cover the salaries, wages and expenses of staff employed at stations and yards such as station masters, assistant station masters, station assistants, caretakers, yard masters, station agents, clerks, any staff who may be attached to the station or yard, porters, attendants, cleaners, shunters and assistant shunters. NFG 2 requires that where duties are split between freight and passenger functions, costs should be attributed in proportion to time spent on different tasks. A unit costing approach of considerable accuracy requires regular periodical surveys of staff time to assess the proportions. These surveys are costly and time consuming. A reasonable dissection can be obtained by proportioning on the basis of train kilometres run in a year, since these measure traffic levels over time and distance, and consequently determine the disposition of staff to handle that traffic.

A further deviation from NFG 2 conventions occurs with signalling staff. NFG 2 prescribes as follows:

> Signalling operations, safeworking and train-control costs should be regarded as invariant with traffic levels. They should be expressed as a cost per train kilometre where they are required to be allocated to traffics.

Signalling employees have traditionally been controlled by the Operations Branch, and their costs included in "Station, Yard and Signal Service" costs. It would not be possible, with any accuracy, to dissect signalling costs from station and yard costs. Also, such a dissection would not alter the resulting analysis very significantly.

A further deviation from NFG 2 conventions occurs with shunting costs. NFG 2 prescribes as follows:

> Shunting costs should include the capital costs of shunting locomotives, locomotive maintenance, fuel and yard crew.

Again, for the purposes of the present analysis, it is considered not worth dissecting Annual Accounts to separate shunting locomotives from train running costs.

Finally, NFG 2 initially regards train examination as a carriage and wagon maintenance cost. However, later, in its External Reporting Format, NFG 2 includes it as a Terminal Cost. Our analysis follows the latter convention including it as a Terminal Running Cost.

Dissection into labour and materials cost

The Productivity Model distinguishes between two costs only:

- Labour cost.
- Material cost.

Labour cost includes salaries and wages, travelling and incidental expenses, work clothing and supplies. In accordance with NFG 2, an allowance is also made for the on costs of the staff including superannuation, long service leave, compensation etc. Supervision and Branch Administration costs are also included.

Material costs include a variety of items used in the running of terminals, stations, yards etc.

Dissection of terminal running cost by market segment

Dissection of total terminal running cost by market segment was obtained by applying the percentage of train kilometres of each market segment, to the four segments. A rationale for this was given earlier.

Labour terminal running hours and unit price

An average direct salary/wage per person was obtained for the years, 1966/67 to 1976/77 from the study *Rail—Operations Branch. Actual and Forecast Expenditure Division* (Public Transport Commission of NSW 1978). Extrapolations were made for the years, 1965/66 to 1951/52 and 1977/78 to 1990/91, using the same percentage changes as the average annual remuneration per employee, appearing in the Annual Reports.

The totals of these salary/wage costs were then deflated by a CPI deflator to convert them to 1980/81 costs.

The average salary/wage cost was then divided into total labour cost to obtain a minimal number of persons. This number was then multiplied by the standard annual railway hours of 1976, to derive an average cost per hour.

A2.6.9 Corridor Fixed Costs

In the NFG 2 classification, this item includes:

Track and Structure Maintenance
It will be noted, under Variable Track Maintenance Costs, that 25 per cent of total track maintenance costs should be taken as being variable with traffic level, assuming a fixed track standard. Thus 75 per cent is held as fixed.

NFG 2 also requires that other civil engineering costs (bridges, culverts, tunnels and buildings) should also be regarded as fixed costs.

Electrical Overhead Facilities Maintenance
The maintenance of catenary substations, and other electric overhead facilities should be regarded as a fixed cost.

Signalling and Communications Maintenance
These costs are also invariant with traffic levels.

Other Non-Renewable Capital
These relate to various items of infrastructure, buildings and plant, and are generally regarded as invariant with traffic.

In the Annual Accounts the item "Maintenance of Track and Structures" covers all the items mentioned above and includes maintenance and renewals of: permanent way, fences, gates, cattle guards, roadways, crossings, slips and flood repairs, bridges, tunnels, culverts, retaining walls and drains signals and signal boxes, telegraph and telephone lines and instruments, weigh-bridges, scales and lifting cranes, electricity substation buildings other buildings, platforms and fixtures, masts and structures, stockyards and water services and station gardens.

A note needs to be made about the distinction between maintenance and capital expenditure, in the area of Corridor Fixed Costs. In the railway context, the distinction is, historically, somewhat artificial. Railway civil engineering budgets have, historically, been moderately to severely constrained, due to a number of causes. Because of the exigencies of a wartime economy, the NSW railway was left in a severely debilitated state after the war, particularly in the case of track and structures. In the post-war years, the allocation of funds for capital works was a politicised process, particularly civil works (e.g. Eastern Suburbs Railway). As funding for capital works was given priority on the basis of political expediency rather than benefit/cost ratios, more deserving projects needed to await some major event or crisis before they could attract funds (e.g. the large metropolitan re-railing program needed a Granville Train Disaster before funds were forthcoming). It may be noted here that the availability of capital funds in any given year is very much a function of the State's capacity to borrow money (which has been highly variable over the post-war years) and that civil engineering works are very expensive, and use up money in large amounts. So, if budgetary cuts are necessary, these works represent easy targets for cuts or delays. One consequence of this is that railway civil engineers have undertaken works as maintenance which rightfully belonged in the classification of capital works. Consequently, there has been a blurring between maintenance and capital expenditure. And, a commonsense approach on historical costs suggests that the analyst should accept what the audited accounts say is capital or maintenance.

Dissection into labour and materials cost

The Productivity Model distinguishes between two costs:

- Labour cost.
- Material cost.

Labour cost was calculated in two parts, direct and indirect. Direct cost includes the salaries and wages, travelling and incidental expenses, work clothing and supplies of employees in such Branches as way and works, signals and communications, and electrical. Also, in accordance with NFG 2, an allowance was made for the on costs of the staff, including superannuation, long service leave, compensation, supervision and branch administration.

Materials cost are essentially a balancing item.

Dissection of corridor fixed costs by market segment

In accordance with the convention established with previous cost items, dissection of this item was obtained by applying the percentage of train kilometres of each market segment, to the four segments.

Labour corridor fixed costs, hours and unit cost

An average direct salary/wage per person was obtained from Annual Reports, for the years 1951/52 to 1965/66; and from the study *Expenditure Forecasts, 1966/67–1981/82* (Planning Division, Public Transport Commission of NSW 1978). Average salaries and wages were extrapolated for the years 1977/78 to 1991/92, using the same percentage changes as the average annual remuneration per employee, appearing in the Annual Reports.

The totals of these salary/wage costs were then deflated by a CPI deflator to convert them to 1980/81 costs.

The average salary/wage cost was then divided into total labour cost to obtain a nominal number of persons. This number was then multiplied by the standard annual railway hours of 1976, to derive an average cost per hour.

A2.6.10 Business and Corporate Overhead Costs

In the NFG 2 classification, this represents:

> N. BUSINESS OVERHEADS
> These costs, which comprise the costs of managing a business sector (e.g. Freight marketing) should be allocated to traffics on a percentage mark-up on attributable costs. This should be done on a sub-sector basis where the relevant data is available.
>
> O. CORPORATE OVERHEADS
> These should be allocated on a percentage mark-up on attributable costs.

It will be noted from a study of labour costs in the previous sections that the following labour overheads were allocated:

- Payroll overheads.
- Direct labour overheads.
- First line supervision.

- Branch administration costs, which vary with the number of employees in the branch.

In compliance with NFG 2, the costs taken from the Annual Accounts and included in Business and Corporate Overhead Costs.

1. Labour represented by:

- salaries and wages paid to employees in non-operational and maintenance functions, including administration, accounting, stores and supply, legal and security, and personnel.
- payroll tax, contributions to retirement and superannuation funds, and provision for leave, compensation etc., not previously allocated to labour cost.

2. Materials represented by the non-labour component of those costs, attributable to business and corporate overheads.

Dissection into labour and materials cost

The Productivity Model distinguishes between two costs only:

- Labour cost.
- Material cost.

Labour cost was calculated in two parts, direct and indirect. Direct cost includes the salaries and wages, travelling and incidental expenses, work clothing and supplies of staff such non-operational/maintenance areas as administration (incl. Secretariat), accounting and statistics, stores and supply, personnel, planning and marketing and a "sundry item which occurred in later years and which included such items as consultants' fees". Where some interest charges were included in "sundry", these were taken out. Also, in accordance with NFG 2, an allowance was made for the on costs of the staff, including superannuation, supervision and branch administration. These latter costs were labelled "indirect" labour costs and added to superannuation etc., costs not allocated to previous labour cost items i.e. a balancing figure, essentially.

Material costs are essentially a balancing figure to make the total of all costs (i.e. fully distributed costs) balance to the total of Working Expenses allocated to passenger services.

Dissection of business and corporate overhead costs by market segment

In accordance with the convention established with previous cost items, dissection of this item was obtained by applying the percentage of train kilometres of each market segment, to the four segments. This approximately conforms with the convention laid down by NFG 2, in that it gives a similar result.

Labour business and corporate overhead hours and unit price

An average direct salary/wage per person was obtained for the years, 1966/67 to 1976/77 from the study *Expenditure Forecasts, 1966/67–1981/82* (Planning Division. Public Transport Commission of NSW 1978). Average salary and wages were also available from the Statistical Appendices in the Annual Accounts, 1951/52 to 1965/66. Extrapolation were made for the years, 1977/78 to 1990/91, using the same percentage changes as the average annual remuneration per employee, appearing in the Annual Reports.

The average salary/wage was available for each of the following Branches namely Administration and Secretariat (1966/67 to 1975/76), incorporating, the Marketing, Personnel, Planning and Finance Divisions. These latter Divisions were separated out for the year 1976/77.

The totals of these salary/wage costs were then deflated by a CPI deflator to convert them to 1980/81 costs.

The average salary/wage cost was then divided into total labour cost to obtain a nominal number of persons. This number was then multiplied by the standard annual railway hours of 1976, to derive an average cost per hour.

A2.6.11 A Comparison of Rail Labour Cost Per Hour with Average Weekly Total Earnings

The key data in RAILDATA is that pertaining to the labour force numbers, total labour cost and hourly cost. The first step was the verification of hourly cost with some external indicator of labour cost. By implication, this would verify the methodology by which the hourly labour cost was derived, as well as labour numbers and total labour cost.

The statistical series selected was contained in the Australian Bureau of Statistics publication: *Average Weekly Earnings, Australia, 1941–1990* (ABS Catalogue No. 6350.0). The particular series selected was in Table 2: All Males: Average Weekly Total Earnings (Not Seasonally Adjusted), Australia, September Quarter 1941 to November 1990. Data for 1990/91 and 1991/92 was obtained from *Average Weekly Earnings, States and Australia* (ABS Catalogue No. 6302.0).

The comparison is set out in Table A2.21. The first two columns shows the Grand Total Labour Cost on an hourly basis, expressed in 1989/90 dollars. This statistic is a weighted average of total hours paid in NSW passenger services, divided into total labour cost. In order to achieve comparability with Average Weekly Earnings, total labour cost is adjusted downwards by an average 22 per cent to remove labour overheads, which were added to conform with the NFG 2 conventions.

Table A2.21 Comparison of labour cost per hour with average weekly total earnings ($1989/90)

Year ended 30 June	Hourly ($1989/90)	Weekly ($1989/90)	All Males Av. Weekly Total Earnings	% difference
1952	8.60	254.90	256.54	0.6
1953	8.42	249.57	257.96	3.4
1954	8.51	252.24	266.78	5.8
1955	9.06	268.54	280.43	4.4
1956	9.78	289.88	289.50	0.0
1957	9.40	278.62	284.25	2.0
1958	9.07	268.83	285.23	6.1
1959	9.16	271.50	294.23	8.4
1960	9.59	284.25	310.00	9.1
1961	10.13	300.25	313.04	4.3
1962	10.62	314.78	322.32	2.4
1963	10.33	306.18	328.63	7.3
1964	11.17	331.08	343.43	3.7
1965	11.53	341.75	356.76	4.4
1966	11.48	340.27	360.53	6.0
1967	11.09	328.71	374.55	13.9
1968	11.20	331.97	383.84	15.6
1969	12.09	358.35	402.45	12.3
1970	12.69	376.13	418.24	11.2
1971	13.57	402.21	441.23	9.7
1972	13.64	404.29	448.71	11.0
1973	14.27	422.96	460.44	8.9
1974	15.93	472.17	475.00	0.6
1975	16.58	491.43	509.78	3.7
1976	16.05	475.72	516.50	8.6
1977	16.25	481.65	518.08	7.6
1978	21.55	638.74	522.01	-18.3
1979	21.41	634.59	517.93	-18.4
1980	19.81	587.17	514.37	-12.4
1981	20.49	607.32	531.70	-12.5
1982	22.20	658.01	558.93	-15.1
1983	21.63	641.11	555.84	-13.3
1984	20.75	615.03	569.15	-7.5
1985	20.58	609.99	584.18	-4.2
1986	19.81	587.17	572.63	-2.5
1987	19.89	589.54	559.41	-5.1
1988	21.21	628.66	550.76	-12.3
1989	22.79	675.50	546.52	-19.1
1990	23.16	686.46	542.30	-21.0
1991	22.29	660.68		
1992	21.43	635.19		

Average Weekly Total Earnings represent the average gross (before tax) earnings of employees and do not relate to average award rates nor to the earnings of the "average person". Estimates of Average Weekly Total Earnings are derived by dividing estimates of weekly total earnings by estimates of employment. Changes in the averages may be affected not only by changes in the level of earnings of employees but also by changes in the overall composition of the employed wage and salary earners segment of the labour force. Average weekly total earnings statistics are the sum of Average Weekly Ordinary Time Earnings and Average Weekly Overtime Earnings. Consequently, the varying levels of overtime payments can cause both level changes and relativity changes, between Average Weekly Total Earnings and Ordinary Time Earnings. The level of overtime payments can be influenced by such aspects as the economic climate and seasonal variations.

Average Weekly Total Earnings and Weekly Adjusted Grand Total Labour Cost are considered the most comparable because Average Weekly Earnings represent similar components of earnings, thus:

1. rates of pay paid to employees under awards and agreements registered with the various wage fixing authorities as agreed between the employer and the employees.
2. overtime for additional hours worked above the prescribed minimum set out in awards, etc. and agreements and
3. other payments made to employees.

There is no direct relationship between movements shown by the Average Weekly Earnings Series and the pay increases awarded by wage fixing authorities from time to time. Nevertheless, the decisions made by wage fixing authorities have had a significant influence on the Average Weekly Earnings Series. Grand Total Labour Cost has been similarly influenced by changes in awards and conditions.

The figures in brackets, after the Average Weekly Total Earnings figures, represent the percentage difference between this figure and the Grand Total Labour Cost. The general trends in the variation between the two sets of figures are readily apparent where one examines the percentages.

One further source of systematic variation needs to be noted. Average Weekly Total Earnings is an Australian Average, whereas Grand Total Labour Cost reflects NSW averages. NSW averages are consistently higher than Australian averages. However, if one looks at the trends over the forty year period, it is clear that the principal reason for differences was the major shift which occurred in relative earnings rates in 1977/78.

A2.6.12 Labour Numbers and Notes on Their Verification, 1951/52–1991/92

It was considered necessary to verify the labour numbers estimates, and by inference, the methodology, of RAILDATA.

Verification was achieved by reference to Branch labour statistics provided in: "Expenditure Forecasts, 1977/78–1981/82". These statistics covered the period 1966/67–1976/77.

These statistics were compiled from the records of the individual Branches. Generally, the Branch's functions fit into the sub-systems dissection used in RAILDATA, which in turn is based on NFG 2. Each of the Branches was treated in the following way:

Way and Works Branch

Total Branch labour was dissected by train kilometres to obtain the proportion attributed to passenger rail. Allocation of passenger rail labour to sub-systems was based on the NFG 2 proportions:

- 25% variable track maintenance.
- 75% fixed corridor cost.

This still yielded an overenumeration of some 2,200 to 2,900 employees, above the RAILDATA estimate. Further analysis showed that the Branch statistics included employees on "Capital Account", i.e. employed on capital works. However, as noted elsewhere, these employees can also be used on maintenance, from time to time.

Electrical Branch

Total Branch labour was dissected by train kilometres to obtain the proportion attributed to passenger rail. 100% of this number was allocated to fixed corridor cost.

Signals & Communications Branch

Treated in the same way as Electrical Branch.

Mechanical Branch

Total Branch labour was dissected by number of rollingstock (excl. locomotives and service stock). This was a proxy to reflect the relative share of maintenance workload. 100% of this number was allocated to train running cost.

Workshops Branch

As with the Mechanical Branch.

Locomotive Operations

As with the Mechanical Branch.

Rail Operations Branch

Principally a Terminals cost, a proportion needed to be allocated to Train Running cost. The latter was treated as a balancing item. Train kilometres was used to make the initial dissection into passenger and freight.

Administration, Secretariat etc. Branches

Total Branches' labour was dissected by train kilometres to obtain passenger labour. 100% of this number was allocated to business and Corporate Overheads. The result was an under-enumeration of about 2,000 per year. A cross-check with Annual Reports from 1951/52 to 1964/65 showed that the under-enumeration resulted from exclusion of a number of Branches in the Expenditure Forecasts documents Purchasing and Supply (Stores), Investigation and Legal, and Roads and Motor Vehicles.

Conclusion

When the changes are made, there is a very close correspondence between the two data sets, and RAILDATA may be regarded as having been verified. A further verification was achieved from "Top-Down" estimates of labour cost derived from Annual Accounts. These were compared with the product of Labour Numbers and Labour Unit Costs.

A2.7 BUILDING THE INPUTS DATABASE: PHASE II, CAPITAL

Because the method used in this study bypasses the Annual Accounts of the NSW Railways, there is no Phase I in the calculation of Capital Input Costs, and it is possible to move directly to Phase II.

In the Sections below the methods used to derive Capital Input Costs attributable to each sub-system are explained.

The Annual Reports and archives are rich in information about capital asset acquisitions. Consequently it is possible to provide separate information on capital dissected into: land, infrastructure, rollingstock (locomotives and carriages), and plant and equipment (including workshops).

A2.7.1 Components of Railway Capital

In this study, railway capital has been dissected into four broad classes, with further sub-divisions made later:

1. Land.
2. Infrastructure.
3. Rollingstock.
4. Workshops and equipment.

Land

Neither the Canadian Study nor other railway productivity studies include Land as an item of capital. It is therefore important to understand why it is included in this study.

The land assets held by the Railways in NSW are a legacy of the development of the rail system since 1855.

The 1850s saw the laying down of the metropolitan spinal columns of the railway system in Sydney and Newcastle including 15 kilometres of quadruple track in a wide corridor in the inner West. Some stations, such as Parramatta, have become the centre of major commercial areas where potential airspace development over railway property places a high value on railway land. Also, surplus land such as Darling Harbour Goods Yard, on the western edge of Sydney CBD is currently worth many hundreds of millions of dollars to the NSW Government. Its transfer price from the NSW Railways to NSW Treasury is, however, reported to have been only about $50 million. But, these highly valued parcels of property account for only a small fraction of the Railway's total land holdings.

The land acquisition program which supported the development of the Railways of NSW created a number of problems in later years as follows:

- Land which is designated as railway property vests ownership with the State Rail Authority, but this does not create a documentary title which is recognised by the NSW Registrar General.

- Even now much railway land is held without: documentary evidence and survey documents; proper definition of boundaries, information or topographical details, or current occupation plans.
- Railway land has been acquired since the 1850s, and where documented, is recorded in a variety of repositories.
- There is a wide gap between the market value and historical cost of some land and airspace. For some sites market value is 91 times historical cost. In 1989/90, a study of surplus railway land determined a market value of $518 million, which had an historical cost of $5.7 million. The airspace at selected metropolitan sites was valued at $253.8 million with an historical cost of $2.8 million.
- In addition, the market value of property rented out was put at $284 million.

The potential importance of railway land, either as a saleable surplus asset, as a rental income earning asset, as a corridor for use in some alternative transport mode or as a privatised railway, makes it very important that it be included as an income earning asset, along with the other assets.

Infrastructure

Infrastructure includes buildings of all kinds, the permanent way, signalling and communications, water supply, and electrical constructions.

In the computations, total infrastructure is dissected into buildings (including stations) and other infrastructure. From 1951/52 to 1964/65 buildings (including stations) were separately identified in statements of assets from other infrastructure. The percentage of total infrastructure comprising of buildings and stations was on a constant increasing trend. This trend was extrapolated to 1991/92. These percentages were then applied to Total Infrastructure to obtain a dissection.

Rollingstock

In this study, rollingstock capital has been dissected into locomotives and carriages. XPT trains are included with carriages, for the purpose of calculating capital cost. They are treated as discrete units and include these power units. The same method is applied to some other rollingstock capital such as diesel trains and rail motors, motor equipment of rail motors and the motor cars of electric trains.

Workshops and equipment

This item is something of a "catch-all" and includes workshops, plant and equipment used in workshops and all other sub-systems of the railways including, train running, corridor, terminals and stations, and administration (e.g. computers).

A2.7.2 The Formula for Calculating Capital Cost

$$P_t^i = r_t V_{t-1}^i + dV_t^i$$

where

V_t^i = value of investment asset in time period t, i.e. the current cost of replacement of the depreciated portion of the asset.

r_t = the discount rate. The 10 Year Commonwealth Treasury Bond rate is used.

d_i = the depreciation rate.

P_t = the service price of the investment asset.

Note: In the Canadian Study the following identity is also included:

$\left(V_t^i - V_{t-1}^i\right)$ = the capital gain on the value of the asset.

This unmodified version of the Canadian study formula was used to calculate capital cost.

This identity was excluded, because there are no capital gains to be made on railway assets which are retired. A few are placed into museums, historical societies etc., but most sold for scrap.

A2.7.3 The Capital Service Price

This identity is the most critical element in the calculation of Capital Cost. Whilst in the first instance it is based on current dollar values, all assets are later expressed in 1989/90 dollars. This requires the establishment of an Asset Price Deflator. This is achieved with a Rail Cost Index.

Development of Rail Cost Index

There emerged a need to develop a reliable asset price deflator to be used in estimating the real stock of railway passenger infrastructure from 1856. There is also a need for a long term price index in other areas of analysis, but these have not been pursued in the thesis.

From 1975/76, the Public Transport Commission developed a Rail Cost Index measuring payroll costs, stores, distillate, electrical energy and miscellaneous expenditure. The compilation of this Index is explained in detail below. Essentially, however, it measures the principal items in railways' Long Run Avoidable Cost. Consequently, for the period from 1856 to 1974/75, a compatible methodology and data base needed to be found, which would essentially measure the same components of cost as the Rail Cost Index. This seemed to be best done by obtaining Long Run Avoidable Cost (less capital charges), and then expressing this as a unit cost per gross tonne kilometre. Accordingly, this was done for each year, from 1856 to 1974/75. The compilation of these data is also explained below.

The Rail Cost Index is set out in Table A2.22.

Table A2.22 Rail cost index, 1856-1989/90 (1989/90=100)

Year ended	% change	Index No.	Year ended	% change	Index No.	Year ended	% change	Index No.
1856		3.21	1916		1.1	1977	12.0	32.8
1857		3.19	1917		1.1	1978	12.1	36.8
1858		3.19	1918	12.5	1.2	1979	7.5	39.6
1859		3.17	1919	11.1	1.3	1980	15.0	45.5
1860		3.15	1920	30.0	1.7	1981	13.9	51.8
1861		2.49	1921	7.7	1.8	1982	18.9	61.6
1862		1.99	1923		1.8	1983	14.6	70.6
1863		1.77	1924		1.8	1984	4.5	73.8
1864		1.07	1925		1.8	1985	6.9	78.9
1865		1.07	1926		1.8	1986	3.8	81.9
1866		1.07	1927		1.8	1987	4.2	85.3
1867		1.07	1928		1.8	1988	6.7	91.0
1868		1.07	1929		1.8	1989	4.0	94.6
1869		1.07	1930	14.3	2.1	1990	7.3	100.0
1870		1.07	1931	12.5	2.4	1991	4.9	104.9
1871		1.07	1932	11.1	2.7	1992	1.7	106.7
1872		1.07	1933	10.0	3.0			
1873		1.07	1934	4.5	3.1			
1874		1.07	1935	4.3	3.2			
1875		1.07	1936	4.2	3.3			
1876		1.07	1937	8.0	3.6			
1877		1.07	1938	7.4	3.9			
1878		1.07	1939	3.4	4.0			
1879		1.07	1940	6.7	4.3			
1880		1.07	1941	3.1	4.5			
1881		1.07	1942	6.1	4.8			
1882		1.07	1943	5.7	5.1			
1883		1.07	1944	2.7	5.2			
1884		1.07	1945	5.3	5.5			
1885		1.07	1946	2.5	5.6			
1886		1.07	1947	7.3	6.0			
1887		1.07	1948	4.5	6.3			
1888		1.07	1949	6.5	6.7			
1889		1.07	1950	4.1	7.0			
1890		1.07	1951	5.9	7.4			
1891		1.07	1952	3.7	10.0			
1892		1.07	1953	5.4	10.5			
1893		1.07	1954	3.4	10.9			
1894		1.07	1955	4.9	11.4			
1895		1.07	1956	3.1	11.8			
1896		1.07	1957	1.5	12.0			
1897		1.07	1958	1.5	12.0			
1898		1.07	1959		12.0			
1899		1.07	1960		12.0			
1900		1.07	1961		12.0			
1901		1.07	1962	6.0	12.7			
1902		1.07	1963		12.7			
1903		1.07	1964		12.7			
1904		1.07	1965		12.7			
1905		1.07	1966	4.3	13.2			
1906		1.07	1967		13.2			
1907		1.07	1968		13.2			
1908		1.07	1969	12.3	14.8			
1909		1.07	1970	2.4	15.2			
1910		1.07	1971	10.7	16.8			
1911		1.07	1972	12.9	19.0			
1912	10.6	1.08	1973	11.4	21.2			
1913		1.08	1974	13.7	24.2			
1914	14.3	1.1	1975	10.0	26.6			
1915		1.1	1976	10.0	29.3			

Rail Cost Index, 1975/76–1991/92

This Index was established by the State Rail Authority of NSW, with the assistance of the Australian Bureau of Statistics. It was constructed to assist railway managements to measure the effects of changes in cost levels on the operation of the Authority, and because externally available indexes do not adequately reflect the cost structure of railways. The Index was constructed from internal data.

The Index is a composite one, consisting of a number of component indexes, each of which measures the average cost of a major item of railway expenditure in NSW. The weighted indexes are combined to form the composite Index. The Index measures changes in railway costs at the point of purchase or input, so that it is not directly influenced by changes in technology, operations procedures etc.

The expenditure items selected from the data base of each Component Index, are classified into four groups:

- Labour: payroll expenditure.
- Materials: stores expenditure.
- Energy: distillate and electricity.
- Other: miscellaneous expenditure.

Weightings of each component did not need to be changed in the period from 1975/76 to 1991/92.

The Rail Cost Index is a Laspeyre's index, similar to the Consumer Price Index and other indexes used in Australia. The composition of each Component Index represents the quantities of goods and services purchased in 1975/76. The index numbers for a given period can be expressed as:

$$P^{La}_{\sigma 1} = \frac{\Sigma p1\, q\sigma}{\Sigma p\sigma\, q\sigma}$$

where:

$\Sigma p1\, q\sigma$ = cost of base-year purchases at given year prices.

$\Sigma p\sigma\, q\sigma$ = cost of base-year purchases at base year prices.

Rail Cost Index, 1856–1974/75

The problem was to develop an index which was compatible with the official Rail Cost Index which was commenced from 1975/76.

No satisfactory data was available on the weightings used in the official Index or on unit costs prior to 1951/52.

It was considered that the closest approximation to the official Index would be a single number based upon Total Long Run Avoidable Cost of NSW Railways per gross tonne kilometre (passenger and freight).

Both costs and gross tonne kilometres were available from annual reports.

The advantages of this identity were as follows:

- It was available on a consistent basis back to 1856.
- Long run avoidable cost is directly related to the production of rail services and contains all the items of expenditure used in the official Index, in their correct proportions. It also includes a capital cost which needs to be deducted.
- Gross tonne kilometres is a standard measure of the production of rail services and when used to derive an index number, it acts as an implicit price deflator, i.e. it enables the expression of a relationship between the current price values (of Long Run Avoidable Cost) and constant price values implicit in the measure, gross tonne kilometre. It also converts labour, fuel and materials purchased into rail services provided.
- Most importantly, the index numbers derived by this method reflect the fall in unit costs resulting from the economies of scale which derived from the rapid expansion of the NSW rail network from 1862 until the outbreak of World War I. This yielded a static Rail Cost Index from 1864 to 1910/11. It also reflects the Railway's monopsony (monopoly buying power) in labour and materials markets, a major factor in helping it control costs and keep down rates and fares and thus foster the rapid economic development of the State. An external price index would not have identified this phenomenon.

Base Year 1989/90

The Rail Cost Index was expressed as a Base Year, 1989/90, to bring it into line with the current Consumer Price Index which is used as a deflator for all other time series in RAILDATA.

Linking the 1856 Series to the 1975/76 Series

The linking of these two indexes was achieved by developing a link factor for 1975/76, comprising Long Run Avoidable Cost per gross tonne kilometre.

Other value indexes

The method used to value land from 1860 to 1991/92, at market value, is explained in Chapter 5.

For the rest, the Consumer Price Index (CPI) is used, where 1989/90 = 100. It is therefore, consistent with the other Index, in terms of the Base Year. The Sydney CPI is the reference index selected. As a measure of Pareto price change (i.e. price change excluding the effects of any change in quality or quantity of goods and services), it is considered to be the most appropriate general indicator of price changes.

The discount rate (r_t)

The Discount Rate selected is the 10 Year Commonwealth Bond Rate, shown on an annual end of June basis in the Reserve Bank of Australia Bulletins. The rates shown are the theoretical yields on a non-brokerage basis, based on averages for the week centred on the last Wednesday of June.

The depreciation rate (d)

The nature and significance of the depreciation rate were fully covered in Chapter 5.

A2.7.4 Capital Input Cost

The total Capital Input Cost of each asset, is calculated by multiplying the current stock of each asset at the beginning of the year by the capital service price. This is then converted to a constant 1989/90 dollar value by a CPI deflator, to make it comparable to other factor costs.

A2.7.5 Further Dissection of Capital Input Cost

It is necessary to further dissect capital input cost into sub-systems and market segments.

Sub-systems dissection

In the case of land and infrastructure, corridor sub-system costs were obtained, by separately identifying buildings (incl. stations) from other infrastructure. In the Annual Accounts from 1951/52 to 1964/65, these were separately identifiable. Since the proportion of building etc. assets to total infrastructure was steadily increasing, the trend was extrapolated to 1991/92, and the percentages applied to obtain buildings etc. Infrastructure not allocated to buildings was allocated to Corridor sub-system costs.

Buildings etc. and infrastructure were allocated to either Terminals (Stations) or Administration sub-systems on the basis of labour numbers, housed in the buildings, obtained from labour costs. The allocation was based on the assumption that building space allocation is essentially a function of the numbers of staff who fill the space.

The whole of locomotives and carriages input cost is allocated to the train running sub-system.

In the case of Workshops and Equipment, allocation is as follows:

- Terminal and Administration are assigned a nominal 10 per cent for each year, except Terminals in 1991/92, which are assigned 41 per cent to take account of Automatic Fare Collection equipment purchases.
- The principal purchases of equipment capital relate to the Train Running and Corridor sub-systems. Assignment is based on a careful study of information contained in Annual Reports and other archival information.

Dissection by market segment

In the case of land, infrastructure, workshops and equipment, train kilometres are used to further dissect sub-system capital costs by market segment.

In the case of rollingstock, it was relatively easy from the Asset Register to identify the numbers and values of rollingstock and classify them by market end use.

A2.8 TRAIN KILOMETRES PER TRACK KILOMETRE: A MEANS OF CALCULATING TRAFFIC DENSITY

In the study of Australian Railway Productivity (Hensher et al. 1995), an attempt was made to measure the traffic density effects of the different railways. This was undertaken on the grounds that each railway system was markedly different, in a structural, network sense, than every other, and that economies of density may apply in some railway systems. A distinction is made between economies of density and economies of scale. Economies of density occur when unit costs fall as output grows within a given network. Economies of scale occur when output growth is due to the expansion of the network.

The difficulty with measuring traffic density effects is finding a suitable set of statistics which accurately reflect traffic density on a railway system. The Australian Railways study (Hensher et al. 1995) used net tonne kilometres of freight per route kilometre is,

> ...our best proxy for the density of traffic over the network, provided we assume that the average train weight has increased imperceptibly over time.

The proxy was sufficient for that study, but would clearly be inadequate for the present study, for the following reasons:

1. The present study is concerned with one railway system dissected into four market segments.
2. Train density should be measured by a statistic which covers passenger train activity. This should apply even though passenger trains are timetabled between freight trains on the same track for Interurban, Country and Interstate passenger services. In the case of Suburban services a daytime curfew is imposed on freight train operation in the Suburban passenger train network.
3. Track kilometrage is the preferred measure of the network size, to route kilometrage, because routes consist of considerable sections of dual, triple and denser track configurations. These are in place to handle trains running in different directions. There are, however, considerable statistical problems involved in compiling data on track kilometrage, in NSW. This is partly due to the fact that the overall figure is not available in the public record. Also, allocation of track kilometrage on a market segment basis requires a careful study of timetable changes through the study period, together with train working information relating to particular lines. An explanation is provided below as to the derivation of track kilometres used in this study.

The estimation of track kilometres

Appendix XIII of the Annual Report of NSW Department of Railways for 1951/52 contains a "Statement Showing the Dates of Opening and Length of Line of the Various Sections to the 30th June 1952", dissected by Quadruple, Treble, Double and Single Line category. This table provided a datum point for the classification of track, by length in track kilometres, into each market segment. To a significant extent, the NSW rail network was completed by 1951/52. There were, however, some important changes which occurred in the study period and these are commented upon, below:

Year	Changes in network
1953/54:	Closures of Richmond/Kurrajong and East Maitland/Morpeth railway lines.
1958/59:	Interurban services were commenced. This involved the transfer of the following sections from the Country market segment to Interurban: – Hawkesbury River/Gosford. – Lapstone/Katoomba. Included in the new market segment were track kilometres in the Suburban system which carried Interurban trains.
1970/71 and 1971/72:	Construction of crossing loops to be used by Country and Interstate services.
1973/74:	The Newcastle Suburban network was extended to Singleton and Dungog. The Sydney Suburban network was extended from Menangle Park to Yerrinbool in the South and from Stanwell Park to Kiama on the Illawarra. The Interurban network was extended from Narara to Wyee in the North.
1974/75:	The Interurban network was extended from Blackheath to Lithgow in the West. The Sydney Suburban network was extended from Aylmerton to Moss Vale in the South.
1978/79:	A crossing loop was constructed between West Ryde and Epping. A major extension of the Suburban network occurred with the opening of the Eastern Suburbs Railway.
1980/81 and 1982/83:	Crossing loops were constructed in the Sydney Suburban network.
1983/84:	Duplication of the railway line between Padstow and Revesby.
1985/86:	Duplication of the railway lines: – Revesby to East Hills. – Gymea to Caringbah.
1987/88:	A major extension of the Suburban network occurred with the opening of the East Hills to Glenfield Railway.
1988/89 to 1990/91:	A significant number of Country Branch Line services were replaced by road coaches, causing a significant reduction in track kilometres attributed Country services.

The estimation of train kilometres

A full explanation of this statistic has already been provided in Section A2.4.

Train kilometres per track kilometre

Train kilometres per track kilometre were calculated for each market segment and the total system, from 1951/52 to 1991/92. A total figure was also calculated, but it is the market segments which are more important. It should be made clear, also, that the total is not additive across the four market segments. This is because some sections of track are traversed by passenger train services from more than one market segment. This applies particularly to track in the Suburban System of Sydney. These railway lines are usually known as Main Lines.

The salient points to note are as follows:

- By 1991/92, Suburban density was about 16 times greater than Country density and 35 times Interstate density. By 1991/92, whilst density had fallen by 15.6% in the Suburban segment, it had fallen by 46.6% in the Country segment, and 56.2% in the Interstate segment. Thus, whilst there had been some service rationalisation in the Suburban market, this had been more marked in the case of Country and Interstate due to conversion of branch line services to road coaches, train amalgamations, etc.
- The Interurban market segment displays particularly interesting characteristics. Starting in 1958/59, Suburban densities were nearly double that of Interurban. By 1991/92, Interurban densities were 44% higher than Suburban densities. This reflects the considerable growth in peak period demand for Interurban services and the fact that these services have had to be provided on restricted sections of track. This has created servicing issues and experimentation by train operations including 10-car trains, Interurban trains operating on Suburban lines (e.g. North Shore). The market has also developed its own responses. For example, many Central Coast passengers disembark at Hornsby to join suburban services.