Infrastructure Performance Indicator Framework Development

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Prepared for

National Infrastructure Unit, The Treasury
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1 Introduction

The purpose of this report is to develop recommendations for a set of New Zealand infrastructure indicators relating to the performance of infrastructure sectors and informing the development of future versions of the National Infrastructure Plan (NIP). This will improve the information that can be used for infrastructure policy development and analysis. Consistent with the NIP’s external focus, these indicators will also help to increase the transparency of infrastructure policy development.

The NIP is a strategic document with a long-term focus. The overall objectives of the NIP are to make better use of existing infrastructure, and to promote better allocation of new infrastructure investment.\(^1\) The NIP’s objectives are consistent with increasing the total welfare (or wellbeing) of New Zealanders, as embodied in the Treasury’s Living Standards framework.\(^2\) Welfare provides a useful foundation for indicators as it forces us to think about what is ‘better’, how this can be measured, and any trade-offs. Accordingly, we adopt the living standards framework to guide selection of indicators.

The indicators developed in this report can be used to help evaluate progress against the NIP’s objectives, and to guide future development of plans and objectives for individual infrastructure sectors. It is also possible that, over time, the framework may be used to standardise measurement and evaluation of performance across different infrastructure sectors, and to facilitate productivity and efficiency comparisons.

The indicators are intended to capture the overall performance of New Zealand’s infrastructure, and highlight key trends and patterns. Of particular interest are the critical determinants of infrastructure performance. There is a preference for simple indicators, but with sufficient depth to tell a meaningful story.

Two broad types of indicators can be distinguished. Activity or stock indicators measure the level of activity and the quantity of infrastructure, but cannot be unambiguously interpreted such that an increase is ‘better’ or ‘worse’ in terms of welfare or living standards (because, for example, it is possible to have “too much” infrastructure given its cost). However, such indicators can be useful for understanding what is going on in infrastructure sectors, and for forecasting future needs. Performance indicators, often expressed as ratios or percentages, measure factors such as productivity and efficiency, and increases or decreases do have a meaningful interpretation in terms of welfare.

The framework developed in this report includes both types of indicators, but we are careful to distinguish between activity and performance indicators, as these two types of indicators must be interpreted differently. Indicators must be interpreted with regard to

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1 If this includes improving investment allocation across sectors then it will be helpful if indicators for different sectors are similar.

2 Working towards higher living standards for New Zealanders, New Zealand Treasury Paper 11/02.
trade-offs, as it is not always possible to increase one indicator without reducing one or more others.

To guide the classification of indicators, we adopt the OECD’s pressure-state-response (PSR) model. This separates indicators into measures of external pressures on infrastructure, such as demand and costs, from the current state of infrastructure activity and performance, from responses to changes in pressure and state such as government policy and investment.

The next section of this report expands on these ideas to develop the foundations of an indicator framework. The framework establishes the link between infrastructure and living standards, and review the PSR model. The subsequent sections develop indicators for individual infrastructure sectors around a set of common themes.

This report is intended to act as a guide for the NIU to develop a robust indicator framework. We have not been asked to populate indicators with actual data, to comment on the actual performance of New Zealand infrastructure or policy development and decision-making processes.

This report summarises our advice on national infrastructure performance measurement but it is not a decision document.
2 Indicator framework development

In this section we develop foundations for the infrastructure indicator framework. The objective is to establish principles that will be used in the subsequent sections to select indicators for individual sectors.

The overall vision of the NIP is that “by 2030 New Zealand’s infrastructure is resilient and coordinated and contributes to economic growth and increased quality of life.” This is further expressed in two objectives:

- **“Better use of existing infrastructure”**: We must make better use of our existing assets. … Getting more from the current stock of infrastructure is about looking at how assets are used, identifying opportunities for improved management, finding better ways of managing demand, and ensuring users’ expectations are understood.”

- **“Better allocation of new investment”**: New Zealand needs to be smarter about investing in new infrastructure. Allocation of new investment in economic infrastructures (water, transport, energy and communications) needs to prioritise economic growth, particularly the export sector. … Investment in new infrastructure, as with the management of existing assets, must focus on delivering services and outcomes rather than just building assets.”

The NIP therefore has a relatively long-term view, and is focused on the outputs delivered by infrastructure and the way that new infrastructure is provided for. At a high level, the infrastructure indicators need to align with these objectives.

To achieve this, we first discuss the needs of the NIU, including some general considerations for the selection of indicators under this project, and the generic properties that good indicators should exhibit. We then review the particular characteristics of infrastructure sectors, as understanding these characteristics is important for indicator selection. We conclude this section by translating the objectives of the NIP into general objectives for infrastructure indicators, and discuss the application of the PSR framework.

2.1 Needs assessment

As discussed above, the NIU requires a set of indicators that will allow it to better assess infrastructure performance against the objectives of the NIP, and to help with future development of infrastructure plans and policies. In particular, the indicator framework will be used to:

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5 To some extent, these objectives reflect the policy settings of the current government, e.g. the focus on economic growth and exports. As discussed below, our indicator framework is consistent with these objectives while also being relatively robust to future policy changes.
- Measure and track progress against the NIP’s objectives of better use of existing infrastructure and better allocation of new investment;
- Allow assessment of outcomes in individual infrastructure sectors against the two objectives, and aggregation into an overall assessment of New Zealand’s infrastructure performance;
- Facilitate the identification of infrastructure sectors or areas where performance can be improved or where constraints may be having a significant effect on outcomes; and
- Assist with assessment of the best allocation of future infrastructure investment and further development of infrastructure policy.

As well as use by the NIU, the indicators will be published, and may be of interest to infrastructure users, infrastructure providers, infrastructure funders, and other central and local government authorities. It is intended that the indicators will be updated annually, although some indicators may only be available at a lesser frequency.

The NIU has also expressed the following preferences:
- A relatively simple indicator framework that focuses on critical drivers of infrastructure performance, rather than providing a highly detailed analysis of performance in each sector;
- The choice of indicators in practice will be constrained by available data (that can be obtained and published by the Treasury) – while there may be some scope to develop new data sources over time, the indicator framework needs to be able to be implemented quickly; and
- The indicators should help to communicate the government’s analysis of infrastructure policy to businesses, investors and the public, consistent with the external focus of the NIP.

### 2.2 Properties of good indicators

A number of basic issues arise in the selection and design of indicators:

- Indicators must be carefully selected to provide useful and balanced information, and this usually requires a set of indicators rather than a single indicator. However, greater detail must be balanced against greater difficulty in interpretation.
- Ease of calculation and data availability must be considered – some potential indicators may be too costly to create, relative to the information they provide.

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Different indicators reflect different perspectives and assumptions, but the set of indicators should be representative. We must also be careful that some factors are not over-represented by being captured by multiple indicators, but that the indicators are sufficiently comprehensive.

Many types of impacts or outcomes are best measured using relative rather than absolute indicators, such as time trends, comparisons between groups, ratios of outputs to inputs, and utilisation rates.

The selection of reference units to facilitate comparisons (e.g. per-year, per-capita, per-kilometre, etc.) can affect the interpretation of indicators, so these reference units need to be chosen appropriately; the same is true for time frames used to calculate averages and totals.

The OECD (2003) also suggested two major functions of indicators:

- They reduce the number of measurements and parameters that normally would be required to give a detailed presentation of a situation. As a consequence, the size of an indicator set and the level of detail contained in the set need to be limited. A set with a large number of indicators will tend to clutter the overview it is meant to provide.

- They simplify the communication process by which the results of measurement are provided to the user. Due to this simplification and adaptation to user needs, indicators may not always meet strict scientific demands to demonstrate causal chains. Indicators should therefore be regarded as an expression of “the best knowledge available”.

However on this latter point we stress that selected indicators must be able to be backed up with a defensible scientific or technical foundation. We have translated these issues into criteria for selecting infrastructure indicators:

- **Relevant to objectives of the NIP**: Indicators must have a clear connection to the two main objectives of the NIP, and to the particular objectives for each infrastructure sector.

- **Policy and/or industry relevance**: Indicators should be relevant to the actual infrastructure policy ‘levers’ available to the government and/or to private sector.

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9. There may be a tension between indicators that can survive changes to the NIP’s objectives and measuring the current objectives of the NIP. In such cases it is preferable to choose indicators that reflect the current objectives as other indicators may be too generic to be useful.
decision-makers, but indicators should also be robust to changes in policy direction over time.

- **Data availability and quality**: In order to avoid new large-scale data collection, the design of indicators should consider the availability of suitable data. The quality of the data is also important, and data should be robust across different populations and across time, so that it is accurate and consistent. For these reasons we have avoided indicators based on customer satisfaction and opinion surveys in favour of factual quantitative data on delivered service quality.

- **Comparable across jurisdictions and sectors**: Where possible, indicators should be comparable across regions within New Zealand and/or countries, to facilitate benchmarking.

- **Simplicity and transparency**: Indicators should not be unnecessarily complex, and the method of their calculation should be transparent and reproducible.

- **Cost effectiveness**: The cost of any necessary new data collection processes or data manipulation to generate indicators should be balanced against the added value of the information they provide.

- **International practice**: Where possible, indicators should be consistent with international best practice for measuring infrastructure performance in each sector.

Figure 1 summarises the desired criteria for selecting indicators and classifies them by primary or secondary importance.

Figure 1 Criteria for selecting infrastructure indicators.
In practice, it will not always be possible to find indicators that satisfy all of these criteria. As an example, relevant indicators may not be internationally comparable due to differences in definition and application. In our view, international comparability and benchmarking across jurisdictions and sectors are desirable criteria, where possible, but should not be binding constraints on indicator selection. This is because in many cases, data definitions and collection and analysis methods are not standardised across jurisdictions or sectors, may not be thoroughly documented and may reflect innate characteristics of the countries from which they come, making meaningful benchmark comparisons difficult.

2.3 The pressure-state-response framework

The OECD developed a framework for its environmental indicators based on the concepts of pressure, state and response. In the context of environmental indicators, these were defined as:\textsuperscript{10}

- **Pressures** are human activities that affect the underlying state of the environment;
- **State** is a measure of the current quality of the environment; and
- **Response** is the set of societal responses to tackle environmental problems.

This framework has been widely used and copied, and in our view it provides a useful way of classifying and imposing structure on infrastructure indicators. Our adaptation of the PSR framework to infrastructure is as follows:

- **Pressure** indicators reflect external changes or forces that affect the welfare obtained from infrastructure.
- **State** indicators occupy a central position – these seek to measure the contribution of infrastructure to the welfare of New Zealanders.
- **Response** indicators measure the public and private responses to changes in pressures and state. This can be in how resources are applied, reflected in investment allocation, and Government’s regulatory actions.

Over time, data on pressure, state and response can be examined to reveal how responses have related to changes in pressure on the state of infrastructure\textsuperscript{11}.

Thus the PSR model is potentially useful in providing an insight to cause-and-effect relationships, and as a framework that separates the external forces that cannot be controlled (pressures) from observations about the subject of interest (state) and from public and private responses.

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\textsuperscript{11} However, such analysis will be complicated by other confounding factors that have changed over time. In principle, statistical techniques (e.g. regression analysis) can be used to isolate these effects, but in practice this is often not straightforward.
The following sections elaborate on the pressure and response indicators as applied to infrastructure, and in subsequent sections we develop principles for state indicators similarly.

### 2.3.1 Pressure indicators

In the context of infrastructure, pressure indicators can be usefully separated into those that affect the demand and those that affect the supply of infrastructure. Many of these are generic to most or all infrastructure sectors, and we summarise these indicators in Section 2.7.

It may be noted that there is a degree of feedback between supply and demand, e.g. water is both an input to the supply of infrastructure as well as an output of the water supply infrastructure.

#### Activity Measures

When measuring pressure, there is a question of whether measures of activity or volume (e.g. GWh of energy production, million cubic metres of water supply, million vehicle-kilometres of vehicle travel) are appropriate pressure indicators. For example, total electricity consumption could be used as an indicator of pressure on electricity infrastructure, rather than the seemingly indirect demand and supply indicators discussed above.

However, in our view such indicators must be interpreted carefully, as an increase in the quantity of electricity consumed could correspond to an increase in demand driven by increased population (which is a true pressure), or a response of demand to a fall in price induced by an increase in supply (which is not a pressure but a change in state).

Thus while the links between demand and supply drivers and the actual physical pressure on infrastructure are less direct, in our view they are better pressure indicators than activity measures. Activity measures do find a place, however, when considering state indicators, such as capacity utilisation and are discussed later.

### 2.3.2 Response indicators

For infrastructure, the key government responses to changes in pressure and state have financial implications, and may involve an increase or decrease in capital, maintenance and operating expenditure depending on the situation. In some cases, other regulatory responses may be appropriate, particularly in sectors where infrastructure is provided by non-competitive private firms such as electricity and gas.

We focus on government responses because one of the aims of the framework is to inform government policymaking and analysis. A wide range of private responses will also occur, however these may be more difficult to observe and measure.
Potential response indicators include:

- Expenditure on new infrastructure, where appropriate expressed per unit of output or per person or household
- Operating expenditure to provide extra services using existing infrastructure
- Expenditure on maintenance and renewals of existing infrastructure
- Extent and number of regulatory actions by Government bodies overseeing operation of the infrastructure sectors (such as the Electricity Authority and the Gas Industry Company).
- Extent and number of regulatory actions taken by Government bodies overseeing market competition and operation more generally, in particular the Commerce Commission Schedule 3 (telecoms) and Part 4 (energy & transport) processes and investigations.
- In many infrastructure sectors, key government responses are regulatory. Such responses are difficult to summarise as indicators due to their varying nature. The number of regulatory changes could be tracked in principle, but this is not a useful indicator as it ignores the scope of each regulation. Similarly, changes in welfare from changes in RMA processes can be subjective. Instead we suggest that legislative or regulatory responses for each sector could be recorded as an annual summary list. This cannot be interpreted easily but would provide useful context for analysing future changes in infrastructure performance.

### 2.4 General characteristics of infrastructure

In order to develop principles for state indicators, we need to translate the objectives of the NIP into things that can be measured directly or indirectly. We must define what are ‘better’ or ‘worse’ outcomes in relation to the objectives of the NIP. In order to do that, it is first useful to understand the unique characteristics of infrastructure sectors, as these characteristics affect the definition of ‘better’ and ‘worse’, and will determine how performance should sensibly be measured.

In general, physical infrastructure, infrastructure businesses, and infrastructure markets have at least some of the following characteristics. In each case, we derive some implications of the infrastructure characteristics for the development of indicators.

#### 2.4.1 Long asset lives

Infrastructure assets typically last for a long time, over 50 years in some cases. This means that decisions to build and invest must be based on long-term forecasts, and there can be significant risks involved if the demand for the infrastructure over that period is uncertain.

*Implications:* Given long time horizons and the need to base investment decisions on forecasts, it is inevitable that some investments will not live up to expectations and performance will be poor. This is not necessarily a problem unless there are systematic biases in forecasts or investment analysis. In addition, over the long term, supply of...
infrastructure will have some effect on demand for it and its use, and thus investment performance may not be able to be separated from private responses to its existence.

Furthermore it may be counterproductive to assess infrastructure investments only on their observed (i.e. *ex post*) performance, as this could reward inefficiently low levels of risk-taking in infrastructure sectors. Rather, performance measurement should recognise that some investments will not perform as well as expected, but that some level of risk-taking is a necessary feature of investment under uncertainty.

Overall, in order to evaluate investment decisions it may be helpful to focus on the investment decision-making process, including the analytical disciplines used, to attempt to assess whether appropriate levels of risk are being taken and whether expected returns are commensurate with the risk.

### 2.4.2 Long payback periods

Related to long asset lives, for some infrastructure investments the ‘payback’ period may be relatively long, with the returns to the investment relatively low in initial years, compensated for by greater returns in later years. This is common in telecommunications, for example, where returns to investment in new technology depend on the rate at which consumers adopt the new technology, and adoption can take several years to gather momentum.

*Implications:* Care must be taken when evaluating the performance of new infrastructure investments in the years immediately following the investment. Consideration must be given to the appropriate payback period, and this should be used to moderate the interpretation of performance if necessary.

### 2.4.3 Relatively large capacity increments

For practical and cost efficiency reasons, infrastructure capacity is generally built or augmented in fixed increments, and the size of these increments may be substantial relative to the change in demand over the short term.

*Implications:* Immediately following investment in new infrastructure, there will probably be excess capacity. This should be kept in mind when interpreting indicators of capacity utilisation. It may be more useful to focus on trends in capacity utilisation. However, this problem may not be very significant if capacity is being measured at a network level across many infrastructure assets.

### 2.4.4 Economies of scale and scope

The combination of long asset lives and lumpy capacity generates economies of scale, i.e. that the average cost of a unit of output falls as output increases, at least until the next capacity increment is required. Economies of scope arise when the same infrastructure assets can be used to produce multiple outputs, as is the case in communications, transport and energy infrastructure.
Implications: Economies of scale and scope mean that average costs reduce with activity, so increased activity in infrastructure sectors could be associated with a performance improvement. However this is not necessarily the case and increased activity could also cause more capacity to be required. Therefore it is better to measure capacity utilisation where economies of scale and scope are important. Furthermore, in defining utilisation measures it is important to think about the appropriate activities to aggregate, if economies of scope are significant.

2.4.5 Network structure

Economies of scale and scope partly reflect the network structure of many infrastructure sectors. Networks provide value by connecting things, and the efficient structure of these connections usually involves sharing infrastructure across users and services.

In addition, in most cases the value of network infrastructure depends in part on the breadth of coverage, as this gives users greater opportunity to use the infrastructure. For example, the value of a metropolitan rail network depends in part on the number of locations served by the network, since greater coverage gives more travel options to travellers. More generally, the value of network infrastructure depends in part on the options that it provides to users.

Implications: Consideration should be given to the value of the options created by network infrastructure sectors in measuring the performance of these sectors, e.g. improvements in connectivity in transport and telecommunications.

2.4.6 Infrastructure outputs are often inputs to other sectors

Frequently, the output of infrastructure sectors is used as an input in production of other goods and services, or is used by consumers in combination with other products. For example, most users of transport infrastructure do not obtain wellbeing from transport itself, but rather from the activities that it facilitates, such as work, school, participation in community activities, and so on.

Implications: When output is an input, we must be very careful when interpreting indicators that measure the volume of output. This is the main reason why we recommend a clear distinction between infrastructure activity or stock indicators and infrastructure performance indicators.

For example, if total electricity consumption increases, this could correspond to an increase in wellbeing, if it arises from greater consumption of goods and services and other activities that people value and that use electricity. However, a decrease in total electricity consumption could also be associated with an increase in wellbeing, if it is caused by greater efficiency of electrical appliances and the like, such that the same activities can be obtained with less electricity usage and thus at less cost.

When outputs are inputs, the most useful performance measures will be expressed as ratios and proportions, rather than absolute levels. For example, infrastructure productivity will be more useful than total output.
2.4.7 Externalities

The nature and scale of activities in infrastructure sectors means these often give rise to externalities, i.e. effects of the existence and usage of infrastructure on others aside from the users that the users don’t take into account.

These effects can be positive, for example in communications networks, one person’s decision to join a network can make that network more valuable to other existing and potential users. Such positive externalities (known as ‘network effects’ or ‘network externalities’) mean that network growth may be very rapid once the network reaches a certain size, but also mean that networks may fail to reach a reasonable size if they do not achieve ‘critical mass’ relatively quickly.12

Externalities can also be negative. Negative externalities may affect the users of the same infrastructure, as with congestion externalities in transport, caused by the fact that road users do not consider the effect of their use of roads on travel times of other road users. Negative externalities may also affect non-users, as with the effects of emissions on the environment and human health.13

Implications: The existence of externalities means that we need to look beyond the immediate users of infrastructure when defining indicators that measure wellbeing.

2.4.8 Efficiency / equity trade-offs

Economic efficiency generally requires that infrastructure users face the marginal cost of their actions, including any externalities. For example, the efficient price of using a road should include the direct marginal costs in terms of additional road maintenance required, plus the marginal external congestion and environmental costs.

However, infrastructure often provides essential services, and equity considerations can make it difficult to impose the full marginal costs on all users. This results in prices that do not reflect marginal costs, and equity therefore often comes at a cost of economic efficiency. However, such efficiency losses to promote equity are a legitimate social choice, and represent costs that society is willing to bear for the sake of greater equity.

Implications: While the objectives of the NIP primarily relate to efficiency, the choice and interpretation of indicators should also take equity into consideration, particularly when evaluating outcomes that are partly dependent on equity-driven policy choices.

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12 For more discussion of these issues, see O. Shy (2001), The Economics of Network Industries, Cambridge University Press.

13 Externalities are only a problem to the extent they are not subject to an appropriate price or a quantity restriction, such as under the Emissions Trading Scheme.
2.4.9 Demand volatility

The level of demand for the services provided by infrastructure often exhibits peaks and troughs driven by time of day, holidays, seasons, the weather, and so on. Capacity is generally built with peak demand in mind, but this means that costly excess capacity must be carried in off-peak times.

Thus the performance of infrastructure should consider times of peak demand, but we must also consider the cost of peak capacity, and the frequency and severity of the peaks. These factors will be different across sectors. For example, in electricity it is critical that the network be able to handle peak demand levels, while transport congestion in peak times is a problem but may be somewhat less critical.

*Implications: Volatility of demand means that demand management can be an important tool in efficient provision of infrastructure services. Typically this involves the use of price signals to shift demand away from peak periods. While this will cause some lost activity in the peak time, with an associated cost, these costs may be less than the cost of building additional capacity to serve the peak. Again the importance of these issues will vary across sectors, but in general the effectiveness of demand management should be considered in the selection of indicators.*

2.4.10 Demand for reliability

Users of infrastructure also generally demand reliability of the service, i.e. that it will be available almost all of the time when they want to use it. This involves building costly redundant capacity and facilities to handle demand in case of failure, but these costs are efficient to the extent that users are willing to pay for reliability.

*Implications: Infrastructure indicators should consider reliability to the extent possible and to the extent that it is valued, as well as the costs of reliability. As a general principle, it is useful to recognise that there will be an efficient level of reliability that balances the benefits against costs, and this will usually involve occasional failures.*

2.4.11 Imperfect market provision

Markets and private businesses do not always do a good job of providing infrastructure and related services, for a variety of reasons:

- In some cases, such as local roads, it is technically difficult to charge a price for usage and restrict access only to those who pay\(^\text{14}\). Private businesses will generally fail to adequately provide such infrastructure if sufficient revenue cannot be generated to cover costs. (This does not mean that private provision of local roads is always impossible, for example in the construction of

\(^{14}\) Economists refer to these as *non-excludable* goods and services.
subdivisions by a single developer, the developer may have the incentive and ability to provide roads for residents.)

- Even if usage can be charged for, this may not be the most efficient pricing mechanism, for example if infrastructure costs are mostly fixed or if commercial pricing strategies lead to excessive mark-ups over cost. Usage-based pricing would reduce usage, and if fixed-fee pricing is not feasible, public provision funded by taxes can be more efficient.\(^{15}\)

- If private infrastructure provision is feasible, economies of scale and scope may mean that adequate competition is not workable, e.g. some telecommunications services, and electricity transmission and distribution. In such cases, regulation may be necessary to substitute for the lack of a competitive constraint on prices.

**Implications:** Indicators of infrastructure performance should take into account the relative merits of public versus private provision, as appropriate for each sector. The effectiveness of regulation may be an important feature to capture in some sectors.

### 2.4.12 Place matters

The demand for almost all infrastructure services is located at a specific place, and the infrastructure must physically exist at that place to serve the demand. Furthermore, the level of demand for infrastructure varies significantly at different places, due to differences in local populations, economic activity, and so on.

**Implications:** National aggregate indicators are very likely to obscure critical issues at specific places, by averaging across locations where infrastructure is adequate and locations where infrastructure is inadequate. Consideration should be given to the importance of local conditions and whether, for example, performance should be defined by the worst performing location, or some other metric that takes spatial variation into account.

### 2.4.13 Summary

Figure 2 summarises the characteristics of infrastructure discussed above and the implications of each characteristic for the development of indicators. Not all characteristics will apply to all infrastructure sectors, but in general these characteristics should be borne in mind when developing infrastructure performance indicators.

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\(^{15}\) It is important to note that most tax funding imposes efficiency costs in terms of activity that is suppressed by the taxes, and this must be taken into account when assessing efficiency of tax funding.
Figure 2 Characteristics of infrastructure and implications for indicators.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Implications</th>
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<tbody>
<tr>
<td>Long asset lives</td>
<td>• Recognise that some investments will not perform as well as expected</td>
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<td></td>
<td>• Focus on the investment decision-making process and systematic biases in forecasts</td>
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<tr>
<td>Long payback periods</td>
<td>• Take care when interpreting performance of infrastructure in the period immediately following investment</td>
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<td></td>
<td>• Interpretation of indicators needs to align with realistic payback period</td>
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<td>Relatively large capacity increments</td>
<td>• Excess capacity is normal after new infrastructure is built</td>
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<td></td>
<td>• Look at trends in capacity utilisation</td>
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<tr>
<td>Economies of scale &amp; scope</td>
<td>• Measure capacity utilisation rather than activity, where economies of scale &amp; scope are important</td>
</tr>
<tr>
<td></td>
<td>• Consider appropriate activities to aggregate across if economies of scope are important</td>
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<tr>
<td>Network structure</td>
<td>• Value of networks partly depends on coverage</td>
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<td></td>
<td>• Consider the options created by network infrastructure</td>
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<tr>
<td>Outputs are inputs</td>
<td>• Greater output or activity in infrastructure sectors does not necessarily correspond to greater wellbeing</td>
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<td></td>
<td>• Focus on measures that are ratios or proportions</td>
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<tr>
<td>Externalities</td>
<td>• Need to look beyond the immediate users of infrastructure to measure the overall contribution to wellbeing</td>
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<td>Efficiency/equity trade-offs</td>
<td>• Choice and interpretation of indicators should take equity issues into consideration</td>
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<td>Demand volatility</td>
<td>• Include indicators of demand management, where relevant</td>
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<td>Demand for reliability</td>
<td>• Measure reliability to the extent that it is valued by users, and the cost of reliability</td>
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<td></td>
<td>• Efficient level of reliability involves occasional failures</td>
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<td>Imperfect markets</td>
<td>• Indicators should take into account relative merits of public versus private infrastructure provision</td>
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<td></td>
<td>• In some sectors, effectiveness of regulation may be an important feature to measure</td>
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<tr>
<td>Place matters</td>
<td>• National indicators may obscure critical issues at specific places by averaging across good and bad outcomes</td>
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<td></td>
<td>• Consider the importance of location conditions and spatial variation in outcomes</td>
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2.5 General objectives for New Zealand infrastructure indicators

In this section we develop general objectives for infrastructure state indicators, bearing in mind the characteristics of infrastructure that were discussed above. The aim is to understand and make explicit what is meant by better use of existing infrastructure and better allocation of new investment. In other words, we seek to understand the directions in which improvements can be made.

To do this, we first briefly discuss the basic theory of welfare economics (or living standards), and the general relationship between infrastructure and welfare. We then discuss in more detail the two objectives of the NIP and what these imply for indicators.

2.5.1 Welfare economics and infrastructure

Welfare, also known as wellbeing or living standards, refers to the total benefits that people obtain from all that they value. This includes but is not limited to the value that people obtain from consumption of goods and services, participation in individual or communal activities, their environment, health and overall contentment with their life and actions.

Welfare can be defined at an individual or an aggregate level. The theory of welfare economics seeks to understand the effects of events and policy changes on the welfare of individuals and of society as a whole. While it is an abstract concept, welfare provides a useful framework for thinking about what is ‘better’. For infrastructure, this involves thinking about how benefits are created directly and indirectly by infrastructure, and identifying the characteristics of infrastructure that determine the value created.

Policy analysis often focuses on aggregate welfare, and seeks to measure whether policy changes increase overall welfare\(^{16}\). This recognises that any given policy or event may create winners and losers, but over time any individual will sometimes be a winner and sometimes a loser. Thus maximising aggregate welfare is equivalent to maximising the expected welfare of individuals over time\(^{17}\). However, in many cases, the distribution of welfare across individuals is also of concern, giving rise to equity issues as discussed above. Policies that do not maximise overall welfare are sometimes favoured if they result in a more equal distribution of welfare.

The New Zealand Treasury’s Living Standards Framework provides a welfare economics foundation for policy analysis. The Treasury’s framework is based on five elements:\(^{18}\)

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\(^{16}\) When quantified, such analysis is known as cost-benefit analysis.

\(^{17}\) This argument is based on Kaldor-Hicks efficiency, see http://en.wikipedia.org/wiki/Kaldor%E2%80%93Hicks_efficiency.

• There is a broad range of material and non-material determinants of living standards;
• Freedoms, rights and capabilities are important for living standards;
• The distribution of living standards across different groups in society is a valid concern for the public and for governments;
• The sustainability of living standards over time is important; and
• Measuring living standards using self-assessed subjective measures provides useful information on what is important to individuals.

These five elements essentially break down ‘the total benefits that people obtain from all that they value’ into greater detail. The Treasury’s framework takes this even further by using a ‘capital stocks’ and ‘welfare flows’ model (figure 3). In this model, stocks of physical, financial, human, social and natural capital create flows of consumption, employment, leisure, freedom, environmental services, and so on, that generate welfare. In turn, such activities can increase or decrease the stocks of capital, and so affect the level of welfare in future.

Figure 3 Treasury’s Living Standards Framework.

The Treasury’s Framework lists infrastructure as an example of physical capital, which helps to create activities (flows) that generate welfare. For developing infrastructure indicators, it is useful to adopt and extend the Treasury framework to explicitly recognise the impact of infrastructure on non-users via externalities, and the impact of infrastructure on other types of capital, e.g. facilitating the accumulation of human capital, effects on human health, or effects on natural capital.

Adopting the Treasury’s Living Standards Framework, figure 4 expands on the ways in which infrastructure contributes to the welfare of New Zealanders. In the figure, we have separated infrastructure capital stocks from other types of financial and physical capital. The figure shows the links between changes in the stock of infrastructure capital on other types of non-infrastructure capital, and the resulting welfare flows that determine the living standards of New Zealanders.
Since infrastructure is a type of capital, it is directly linked to capital stocks:

- Construction of new infrastructure directly increases capital stocks, eg rural expanded irrigation systems add to capital available in the agriculture sector.
- Deterioration or depreciation of infrastructure, such as through wear and tear, directly reduces infrastructure capital stocks.

Since infrastructure is an input into so many activities, it also affects the stocks of other types of capital:

- Infrastructure may facilitate the accumulation of other types of capital, for example transport infrastructure facilitates the accumulation of human capital by allowing students to travel to school.
- The externalities associated with infrastructure use may reduce other types of capital, for example particulate emissions from power plants cause respiratory diseases and reduce the stock of health capital, while carbon dioxide emissions from burning fossil fuels reduce environmental capital and indirectly future infrastructure capital through climate change risks.

The stock of infrastructure capital contributes to the welfare of New Zealanders in various ways:

- Direct welfare from services provided by some types of infrastructure, such as phone calls.
• Indirect welfare from activities facilitated by infrastructure, such as driving to a sports match or to the shops.

• Option value from the ability to use infrastructure when and where desired, for example the option to take the train to work, or make mobile phone calls in various locations.

• The positive and negative externalities associated with infrastructure use, such as noise from motorways and other roads that affects nearby residents.

The welfare flows generated by infrastructure capital combine with the welfare flows generated by other types of capital to comprise the welfare flows of New Zealanders.

As discussed above, we must be careful when developing indicators that relate to welfare arising from indirect use of infrastructure. As the welfare in such cases comes from the facilitated activity, rather than from use of infrastructure itself, it is not necessarily the case that more use of infrastructure corresponds to more welfare from the facilitated activities. In simple terms, ‘better’ use of existing infrastructure does not necessarily mean ‘more’ use of infrastructure.

For some types of infrastructure (such as transport), measures of activity cannot be separated into activity that provided direct welfare and activity that provided indirect welfare. In such cases, activity indicators must be used with caution as measures of the welfare generated by existing infrastructure.

With these things in mind, the links between infrastructure and welfare illustrated in Figure 4 correspond closely to the two objectives of the NIP:

• **Better use of existing infrastructure** relates to maximising the welfare flows generated by existing infrastructure capital stocks, reducing deterioration of infrastructure capital where possible, and maximising the contribution of infrastructure to accumulation of other types of capital stocks.

• **Better allocation of new investment** relates to targeting new investments to maximise the welfare flows generated by new infrastructure capital stocks, and maximising the contribution of new infrastructure to the accumulation of other types of capital stocks.

Having established the channels by which infrastructure contributes to welfare, and the relationship to the objectives of the NIP, in the following subsections we expand on the two objectives of the NIP to derive general objectives that infrastructure indicators should aim to measure.
2.5.2 Better use of existing infrastructure

Making better use of the existing infrastructure capital stock involves (figure 5):

- Facilitating more welfare-generating use of existing infrastructure, i.e. where the benefits generated exceed the marginal costs of additional use;
- Increasing option values associated with potential uses of existing infrastructure (i.e. increased connectivity);
- Reducing negative externalities and encouraging positive externalities associated with use of existing infrastructure;
- Facilitating more accumulation of other types of capital through the use of existing infrastructure stocks; and
- Reducing negative effects of existing infrastructure on other types of capital.

Figure 5 Ways that better use of existing infrastructure can contribute to living standards.

Table 1 outlines the types of indicators that can be used to measure better use of existing infrastructure in terms of the contribution of infrastructure to the welfare or living standards of New Zealanders. For each category of indicators, the table refers back to the links between existing infrastructure and living standards that were highlighted in figure 5. Depending on the sector, such indicators may be expressed as averages, trends, and/or segmented by time and location.
Table 1 Potential indicators of better use of existing infrastructure

<table>
<thead>
<tr>
<th>Indicator category</th>
<th>Contributions to living standards</th>
<th>Potential indicators</th>
<th>Notes</th>
</tr>
</thead>
</table>
| **Capacity utilisation** | • Direct welfare from use  
• Accumulation of other capital | • Ratio of used to available capacity | Only appropriate where direct welfare from infrastructure use is significant |
| **Productivity** | • Direct welfare from use  
• Indirect welfare from use  
• Accumulation of other capital | • Output per dollar of capital assets  
• Output per worker | Greater productivity means fewer resources used to produce infrastructure outputs, ie lower opportunity costs |
| **Costs and prices** | • Direct welfare from use  
• Indirect welfare from use  
• Accumulation of other capital | • Trends in costs of supply & prices faced by users  
• Benchmarks of costs & prices against other countries | Lower costs and prices are assumed to increase welfare from infrastructure, everything else equal |
| **Cost/price alignment** | • Direct welfare from use  
• Indirect welfare from use  
• Externalities | • Extent to which prices faced by users reflect costs adjusted for externalities  
• Implementation of pricing to reflect externalities  
• Use of peak-load pricing or demand management | If prices and costs are aligned (given externalities), usage of infrastructure will maximise welfare |
| **Quality & coverage** | • Direct welfare from use  
• Indirect welfare from use  
• Accumulation of other capital | • Failure rates  
• Availability rate  
• Variability of service  
• Geographic availability | These indicators are important only to the extent that infrastructure users value quality and coverage |
| **Options & usability** | • Option value | • Availability of (real-time) information about services  
• Alignment between service availability & demand, eg geographic coverage & service frequency | These indicators focus on the possibilities for infrastructure use and people's knowledge of these possibilities |

2.5.3 Better allocation of new investment

As illustrated in figure 4, an increase in the stock of infrastructure capital will facilitate greater welfare flows and greater accumulation of other types of capital. However, some allocations of new investment will perform better than others in this regard. Indicators in this category therefore seek to measure the effectiveness of new infrastructure at generating additional welfare flows and facilitating the accumulation of other capital.

It is somewhat difficult, although not impossible, to evaluate the effects of individual infrastructure investments. The difficulty arises because the effects of an investment occur over time, but other external factors will also change during that time. Thus ex post
evaluation of investments requires separating the effects of the investment from all other changes that have happened at the same time. This requires careful quantitative analysis to isolate the effects of the investment.

Furthermore, as discussed above, solely focussing on *ex post* performance of investments may have an unintended consequence of excessively reducing incentives to take risks. Given that failure of some investments is a necessary feature of decision-making under uncertainty, it is more helpful to focus on investment decision-making processes, rather than specific outcomes. The key is to test whether investment decisions and the processes that generate these decisions are robust and make the best use of available information, given the uncertainties that exist at the time.

Finally, much infrastructure investment is undertaken by the private sector, and it is difficult to observe the actual performance of these investments.

These facts mean that quantitative indicators of better allocation of new investment are more difficult to define than indicators of better use of existing infrastructure. Data constraints also mean it will be easier to define such indicators for public sector investment rather than private sector investment. For competitive reasons, private infrastructure providers may be reluctant to release detailed information about their investment decision-making processes and the performance of specific investments.

In regulated industries, such as electricity and telecommunications, the interplay between regulation and private infrastructure investment is important. In such cases, the returns to private investment will depend on expected regulatory interventions over the life of the asset. Regulation can serve to increase or decrease returns to investment, and may also affect the risk of investment. The latter comes from uncertainty about future regulatory decisions. If regulatory decisions are unpredictable, the risk of investment in assets that are regulated (or might be regulated in future) is increased, reducing the incentive to invest.

With the above factors in mind, indicators of allocation of new investment in a given infrastructure sector could include the following.

**Use of quantitative analysis in investment decision-making**

In general the use of quantitative analysis to evaluate investments will lead to better investment decisions, and/or better allocations where alternative investments are possible. Thus a possible indicator is the proportion of investments in the sector for which quantitative cost-benefit analysis or business case analysis is used to make investment decisions. If possible, the quality of the quantitative analysis could be evaluated, however this may be time-consuming.

**Benefit-cost ratios**

Particularly for government investment, benefit-cost ratios (BCRs) are often calculated. These measure the ratio of net welfare or economic benefits to the cost of that
investment, i.e. they are a measure of the benefit obtained per dollar of investment. Higher BCRs indicate more valuable investments are being undertaken.

However, care must be taken when interpreting trends in BCRs. These may fall over time simply because, in a sector, the most valuable investments are rationally undertaken first. If this is the cause of a fall in BCRs then it does not necessarily indicate that the allocation of new investment is poor.

Instead, it would be better to establish a BCR threshold (1 is a minimum, or perhaps 2 could be used) and calculate the proportion of dollars invested that have a BCR in excess of that threshold.

BCRs can also be measured on an *ex ante* and *ex post* basis, with *ex ante* BCRs giving some information about the quality of investment decision-making, and *ex post* BCRs giving information about the actual performance of investments and potentially also revealing information about the strength or weakness of the *ex ante* analysis.

*Infrastructure capital stock*

Infrastructure assets are long lived and when first put in place have an expected life before requiring replacement or renewal. The range of expected life can vary from less than 5 years to 50 years or more depending on the physical components involved (heavy concrete construction, concrete and steel structures, mechanical equipment, electrical equipment, etc.). The asset management plans that are a normal requirement for monitoring the condition and maintenance needs of infrastructure will record the year of first provision, or latest major rehabilitation from which the nominal remaining years of expected life can be calculated. Periodic inspections will also often lead to a new assessment of residual life.

The residual life is a measure of the physical (as opposed to book) depreciation of the asset and it should be possible to calculate a composite percentage remaining life where elements are weighted by their replacement cost and life expectancy. This would help identify infrastructure that may be performing satisfactorily but which faces major renewal costs in the short term (or risk of failures if not attended to) and distinguish it from relatively new infrastructure which has a long remaining service life and no major maintenance requirements in the near term.

This indicator can be thought of as the residual invested capital stock.

*Forecast accuracy*

Due to the long asset lives (see section 2.4.1 above), infrastructure investment decisions are usually made on the basis of long term forecasts of crucial factors such as the demand for the infrastructure and operating costs. For example, investment in a bridge will depend in part on forecasts of traffic volumes on the bridge over its life. Given the importance of forecasts in investment decision-making, the accuracy of forecasts will be a useful indicator of the quality of investment decision-making.
Many government agencies produce forecasts, for example of road traffic volumes, water usage, electricity usage, and so on. In principle it is relatively straightforward to collect these forecasts and compare to the actual observations after the fact. Standard measures of forecast accuracy such as root mean squared error (RMSE) or mean absolute prediction error (MAPE) can be calculated and tracked over time.

It is important to recognise that forecasts will always be wrong, but should not be systematically biased (i.e. not systematically optimistic or pessimistic), and forecast accuracy should not worsen over time.

Change in return on capital

In the private sector, additional investments should improve (or at least not reduce) the return on assets. Of course, many other factors can affect returns (e.g. changes in competition or changes in demand), so care must be taken when evaluating such indicators. Furthermore, investments with long lives may have long payback periods, and may not cover costs in the initial years after investment. Analysis of such indicators will therefore require careful consideration of the conditions in each sector, including possible asset revaluations.

Regulation

There are existing frameworks available to assess regulatory quality, such as the one developed in the UK by the Better Regulation Commission.

2.6 Aggregation of indicators

There is a question of whether individual indicators can and should be aggregated into higher level indicators. For example, the indicators in each infrastructure sector might be aggregated to derive an overall indicator for that sector, which in turn might be aggregated to derive an overall infrastructure performance indicator for New Zealand. The attraction of doing this is that it allows multiple levels of information to be presented, and those who are interested in the high level indicators do not need to be concerned with all of the individual indicators. However, aggregation may obscure differences across sectors.

While potentially desirable, aggregation of indicators faces two technical challenges:

- **Scaling**: Different indicators will have different numerical scales and different units of measurement. In order to aggregate these, the values of some indicators will have to be adjusted so that all indicators have the same order of magnitude. Failing to do this will result in the aggregate indicators mostly reflecting the individual indicators that happen to have large numerical values, potentially overstating the importance of these.

- **Weighting**: In calculating an aggregate indicator, some individual indicators may be more important than others, and the weights used in the aggregation need to reflect this.
There is no simple and non-arbitrary way to address both of these issues with a diverse set of indicators. Mathematical ‘transfer functions’ can be used to transform the values of individual indicators so they are on similar scales. However, the use of such functions requires making some arbitrary assumptions about the type and form of adjustment. The aggregate indicator will reflect these assumptions to some extent, and it is also difficult to make the adjustment process transparent to users of the indicators. In can also be difficult to justify the assumptions used for the adjustment, particularly when a diverse range of indicators are being combined.

The weighting issue is equally difficult. There is little, if any, empirical evidence on which to base the weighting of indicators. Using an equal weighting is a natural choice, however this is just as arbitrary as any other choice of weights.

Furthermore, aggregation in this fashion implicitly assumes that it is possible to trade off across all indicators that have been aggregated, but this is not always possible.

In our view, the problems of scaling and weighting are complex and not easy to overcome. Any scaling and weighting method that is used will necessarily have some arbitrary components that will make the results subjective and be difficult to explain to the users of the indicators. This will introduce a ‘black box’ element into the indicators that may result in a lack of trust and acceptance of the indicators.

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However, aggregate indicators may be quite useful for some purposes, provided these can be generated in a reasonably robust way. Instead of trying to define a precise methodology or formula for aggregation of indicators, in our view it is better to recognise these difficulties and accept that a degree of judgement is necessary to generate aggregate indicators. Rather than prescribing a strict formula for calculating aggregate indicators, expert judgement can be used to generate commentary and summaries on the basis of all the information that is available in the individual indicators.

2.7 **Infrastructure pressure indicators – common features**

Several of the pressure indicators apply in some measure to all of the infrastructure sectors and these potential common indicators are discussed below. Pressure indicators specific to each sector are discussed in later sections of the report. The common demand pressure indicators are essentially population-related, as population, household formation and their geographic distribution are the end users of infrastructure services. Other common demand indicators are general measures of economic activity expressed on a per capita basis, with real GDP growth being the most readily available measure.

On the supply side, all physical infrastructure depends on inputs of resources for construction, maintenance and renewal. These are basic natural resources such as construction materials, energy, land, and human resources in the form of time inputs of labour with the appropriate mix of skills.
2.7.1 Demand Pressure Indicators

- *Population growth rates* - in the most recent 5 years and forecast 20 year growth, focusing on the urban population and growth rates in those urban areas with the highest rates of growth – from (normally) 5 year Census data and Statistics NZ Central Projection (central fertility, mortality and migration assumptions)

- *Household growth rates and change in mean household size* - similarly to population – from (normally) 5 yearly Census data and projections

- *Employment participation rate* – employment participation underpins household economic activity and is more directly a driver of demand in the transport sector. The source is Stats NZ National Labour Force Survey and Projections

- *Changes in national economic activity* – the demand for infrastructure services in all sectors is influenced to some extent by economic activity, commonly measured as GDP and probably best expressed as real GDP/capita, since population growth is a demand indicator in its own right. In some sectors, such as freight transport and electricity, demand elasticities have been established with respect to real GDP growth. It is useful to track this indicator and forecasts, which are available from the Treasury fiscal and economic statements

- *Changes in regional economic activity* - estimates of GDP at the regional level are available from various sources but in our view these are not sufficiently reliable due to data gaps and the degree of estimation required. Indicators based on change in the regional employed population are recommended instead as a proxy indicator for regional economic activity. The source is Stats NZ Labour Force Survey. Projections in regional employment are not available on a consistent basis across the country.

- *Outlook for key commodities* – the outlook for production of key commodities, particularly exports, has implications for freight transport demand and the transport infrastructure, and also for rural water supply to agriculture. MPI publishes an Annual Situation and Outlook for primary industry including dairy, meat and wool, horticulture and forestry export prices and volumes and medium term projections

- *Exchange rate* – the value of the NZ dollar against the currencies of the main trading partners affects the competitiveness of NZ exports and the affordability of imports, including inputs to infrastructure such as oil products. The Trade Weighted Index monitored by the Reserve Bank is a convenient data source.

2.7.2 Supply pressure Indicators

- *Cost indexes for infrastructure construction* – Statistics NZ Producer Price Index for heavy engineering construction outputs SQUEE1200, quarterly (nominal available only); NZTA also publish composite index factors for updating cost estimates for road construction, maintenance, bridge works, bitumen etc. based on PPI inputs

- *Limitation of key input resources* - e.g. water, construction aggregates can increase the cost of infrastructure or change investment decisions on national or regional
basis. The relevant sources of data include Statistics NZ Producer Price Index (SQUEE1200); NZTA (roadwork & material costs); Regional Councils on water allocation.

- **World crude oil price** – NZ is significantly dependent (about 60% in net terms) on crude oil imports for refinery feedstock and the oil price feeds into infrastructure investment costs as well as influencing demand in the transport sector. The spot price of NZ crude (also Brent, West Texas and Dubai) is reported by MOBI in the Energy Data File. As the NZ crude price closely tracks the international spot prices and is of interest as a substitute or offset for imports as new NZ fields come on stream, the price of NZ crude in real terms could provide an appropriate indicator.

- **Human resources, in particular key skill shortages** – the availability of appropriately qualified, trained and experienced people to participate in infrastructure development and in the introduction of new technology can be a brake on the supply of infrastructure services. Ideally a source of data that monitors current and projected future employment demand in the skill sets needed for infrastructure construction, maintenance and operation would be used to construct an indicator of human resource capacity, so that existing or future under- or over-capacity problems can be anticipated.

- **Climate change** – climate change has potential implications across most infrastructure sectors, with effects including increased rainfall intensities, possibly more extreme and/or more frequent flooding and drought events, and gradual atmospheric temperature and sea level rise. Design margins are already being incorporated when planning and designing long lived infrastructure. The progression of changes could affect conceivably affect the operability of existing long lived coastal infrastructure so constitutes a risk and cost that may need to be managed. NIWA is the agency responsible for monitoring and assessing the implications for NZ and have developed a guidance manual for local authority use. While not of immediate impact, inclusion of appropriate indicators such as measured sea level and average temperature changes and comparison against scenarios may be useful over the longer term.

- **Changes in technology** – are hard to measure at global level. Some like, UFB rollout could affect infrastructure sectors other than telecoms.

### 2.8 Infrastructure response indicators – common features

The Resource Management Act is relevant to all significant infrastructure operation and development. The Resource Management Act 1991 (RMA) provides for the Minister for the Environment to intervene in the decision-making process for proposals of national significance. One option is that the Minister can call in a proposal that has been lodged with a local authority by giving a direction in writing, stating the reasons for referring the matter to a board of inquiry or the Environment Court. The Environmental Protection Authority (EPA) serves the Minister’s direction on the local authority and applicant. The EPA also gives public notice of the Minister’s direction and receives submissions on the proposal. Following the close of the submission period, the EPA provides the
board of inquiry or Environment Court with all submissions received and all relevant material collected by the local authority.

This can then have the effect of streamlining the process of resource consent for infrastructure of national significance. A potential indicator is the percentage of nationally significant projects which are called in under the ministerial intervention provisions.

Any changes to the RMA can affect welfare in a subjective manner, depending on varying priorities placed on different outcomes. This subjectiveness in welfare may confound quantified RMA indicators.
3 Transport

3.1 Key characteristics of the sector

Most physical transport infrastructure in New Zealand is provided by central and local government agencies, although private businesses such as airlines, public transport operators, and shipping lines provide transport services, in some cases supported by public subsidies. There is some private provision of physical infrastructure at ports and airports. Demand for transport comes from households and businesses, and in most cases transport is a complementary input to other activities or production of other goods and services.

The main components of transport infrastructure are:

- Sea ports and maritime navigation systems, facilitating international and domestic sea freight services and passenger (mainly cruise) vessels.
- Airports and the air traffic management (ATM) system, facilitating international and domestic passenger and freight services.
- Railways, providing metropolitan and inter-city passenger and freight services.
- Roads, provided by both central and local government, enabling local, regional and inter-city transport.

3.1.1 Structure of the transport sector

Transport infrastructure naturally subdivides by mode – roads, ports and airports (airways and sea lanes and associated navigation and communication infrastructure could also be considered but is deemed peripheral to the main objective). Transport vehicles are owned and operated by system users rather than infrastructure owners with the exception of rail under the KiwiRail regime where fixed infrastructure and freight rolling stock are largely owned by the same company. Consequently, transport users make vehicle ownership and operation decisions based on the fixed infrastructure provided. The infrastructure providers are responsive to vehicle technology change (e.g. channel and berthage requirements for larger ships, runway strength/dimensions and terminal requirements for new aircraft, longer and heavier road freight vehicles).

An alternative subdivision of the sector that could be considered is by transport task (passenger or freight) and location (urban, inter-urban/rural and international) – say: (i) urban passenger transport (private car, motorcycle, cycle, walk; public transport – bus, suburban rail and associated road and rail infrastructure); (ii) inter-urban and rural roads; (iii) surface freight transport (road, rail, port and, airport freight terminals); and air passenger (domestic and international airports). These four sub-markets overlap to some extent, in that roads carry both freight and passenger traffic, but air freight is a relatively small portion of total air transport demand and is carried partly on passenger aircraft, whereas seaports are almost entirely freight apart from the inter-island and harbour ferries and cruise ships which are in any case catered for largely separate from the freight terminals.
While this second form of market sectioning is attractive, in that it could point to indicators that apply across modes of transport (in particular freight indicators and urban passenger travel indicators), in practice the available data is held on a modal basis.

In the following paragraphs we consider potential indicators primarily by mode for the state and response indicators, but also discuss some cross-modal possibilities.

### 3.1.2 Some aspects of transport demand and supply

**Urban Personal Travel** - For personal travel in urban areas, household numbers and structure together with income form the basis for forecasting of person-trip demand, with private vehicle ownership forecasting and public transport availability and their respective costs an intermediate step in forecasting vehicle travel demand. Personal trip making delivers welfare benefits through the activities undertaken at the trip ends and information and communication technology can substitute for physical travel in some cases. Also the congruence between urban form and location, design and cost of transport systems, including the road, rail, bus, cycle and walking infrastructure influences modal availability and attractiveness. Urban development that takes advantage of opportunities for coordinating transport system development with urban density controls, leading to compact multi-use development around public transport nodes and main routes is more likely to facilitate public transport and non-motorised travel, provided good urban design and amenity qualities are achieved including provision of adequate private outdoor space and accessible public parkland. As previously noted, volume indicators such as kilometres travelled are not in themselves a good guide to social benefits. Desirably, the best indicators will reflect how well the transport infrastructure provides destination and mode choices, and limits the distance and time required for travel.

Other issues surrounding the question of an optimum urban form and well adapted transport system include the effect of urban area size – whether there is an optimum size that gives the connectivity benefits of agglomeration while still being economically supportable by other infrastructure services such as power, water and waste disposal without incurring excessive costs and reducing resilience, and while still providing the population with sufficient accessibility to the wider region and beyond. The unique topography and legacy of building development and infrastructure in each urban area make generalised comparisons difficult.

**Freight Transport** – The surface transport of export goods and the distribution of domestic and imported goods is predominantly by road and road freight must co-exist alongside passenger transport, often leading to greatly dissimilar and incompatible traffic sharing the same road space (such as heavy trucks and cyclists) with limited opportunities for physical segregation. Rail is predominantly freight traffic, and best serves long distance large consignments and lower value bulk commodities, particularly where rail can directly serve the origin or destination of the goods (e.g. a large industrial processing plant or port). There are some local compatibility issues where freight movements pass through urban centres on line that also carries urban passenger rail (Auckland and Wellington).
The urban distribution of freight also poses compatibility issues where truck deliveries must pass along residential streets. There are economies of scale in increasing the consignment size where the volume and required frequency of deliveries permits, so there is ongoing pressure to allow larger and heavier trucks onto the road network, and to accommodate large semi-trailers for deliveries to local retail centres.

It is desirable that the indicator set include those that measure how well the transport infrastructure serves road freight, while recognising that there are negative social welfare aspects to road freight movement and that the ongoing development of the transport system will seek to improve freight efficiency while limiting adverse impacts on other road users and local communities.

Infrastructure used for transporting freight to and handling through the main ports is part of the transport sector of particular importance for NZ as a trade-dependent island nation. The highway, rail and port networks and their freight terminal interfaces that support the main export freight flows needs to be well integrated, resilient to closure risks, and balanced in terms of capacity and quality so that weak links and bottlenecks are avoided as far as possible. This implies the need for indicators that consider the national freight network as a whole as well as the functioning of its parts.

**Inter-Urban and Rural Travel** – the state highway network and local rural roads supports mainly personal travel by private vehicle by residents and visitors to NZ, relatively few inter-urban bus services, and local access for commercial vehicles other than the main freight flows noted above. Shifting use of heavy vehicles for forestry activities on local roads is a known problem for pavement wear and a source of safety risk; other rural servicing such as fertiliser deliveries, milk collections and stock movement also must be catered for. Tourists unfamiliar with NZ roads, including an increasing number of cycle tourists, must mix with rural servicing traffic. Road traffic crashes are particularly high on parts of the rural network, often involving single vehicle loss of control and alcohol impairment, with NZ’s often hilly and winding terrain and relatively narrow carriageways a contributing factor. Due to low traffic volumes on local rural roads and high engineering costs, the economic efficiency of providing higher standard geometry is often relatively low. Ensuring that rural roads are maintained to a good operable condition in terms of surface integrity is an important feature and should form part of the indicator set.

### 3.1.3 The use of productivity indicators

Productivity indicators measure the welfare producing transport outputs as a ratio of inputs. Inputs are most readily valued as costs, and could be expressed as output per dollar of employed capital or per dollar of recurrent operational and maintenance costs. As transport infrastructure are long-lived assets and have already been constructed to a degree of maturity, and because of the inherent difficulties in ensuring consistency in asset valuations which are in any case generally irreversible and sunk investments, an indicator for productivity as output per dollar of recurrent cost is probably the more useful indicator.
The labour component of inputs, expressed as person-hours or staff numbers could also be used as a measure of labour productivity but is less likely to be accessible. Also, where organisations find it more cost-efficient to outsource parts of their inputs, then the remaining labour input will only be a partial measure of labour productivity, unless the scope is enlarged to include the labour inputs of suppliers. Whether labour productivity is in fact a useful measure above the individual enterprise level is also debatable. Within an enterprise, the decisions on whether to substitute labour with technology, or to outsource certain services, will be made with regard to the market conditions and circumstances of the enterprise and will not necessarily be a useful comparator for infrastructure as a whole.

For new infrastructure investment a productivity measure of additional welfare created against capital employed is a more useful measure. In the case of road infrastructure this is given by the B/C ratio of the project, or an aggregation of the benefits divided by costs over all projects financed on an annual basis. Where SOEs, such as KiwiRail or mixed ownership companies such as the airports and ports are concerned, then the parallel measure would be a financial B/C ratio or, alternatively, rate of return on invested capital (although this will be second-best as it excludes benefits and costs external to the corporation or company). These can be quite significant for rail, as there are often traffic diversion implications for the road system, so that increasing the rail modal share reduces the need to invest in roads (and vice versa) as well as either increasing or reducing the welfare of other road users (congestion, safety, and amenity). For ports and airports there are no significant diversions to other modes but there is still the opportunity for the infrastructure entities in a market dominant position to maximise their own rate of return on investment, reducing the welfare of the airlines, shipping lines and ultimately the passengers and shippers of freight (hence the Commerce Commission scrutiny and regulation of the airports). It is quite possible for rail, port and airport capital spending to be evaluated within a national economic social cost benefit analysis framework as well as from the more narrow financial viewpoint, but if there is no requirement that this be done (which it is not, at least not as a matter of course), then no data will be available.

3.2 Relationship to welfare

As discussed above, the relationship between transport and welfare is largely indirect, in that transport facilitates other activities that generate welfare. Transport therefore generates more welfare if it facilitates activities more efficiently, more safely, and at lower cost. The following characteristics of the transport system reflect its ability to facilitate activities. The welfare generated from transport increases if there are improvements in any of the following dimensions, everything else equal:

- Safety
- Speed (efficiency)
- Reliability
- Coverage (geographic and temporal)
- Comfort
Externalities

Cost

### 3.3 Existing data sets and indicators

Existing data sets and indicators in the transport infrastructure sector that satisfy the criteria noted in Section 2.2 include:

- **Ministry of Transport** - transport indicators\(^\text{19}\) which include volume, network reliability (as a congestion index), travel time variability, prices, health and safety, amount and quality of transport infrastructure and carbon dioxide emissions. Not all of the indicators have been implemented due to lack of continuous and reliable data collection, and those in use apply mainly to roads and road transport with fewer for rail, sea and air. Also there is an emphasis on transport equipment and users more than on infrastructure.

  MOT also maintains an Excel data series describing the composition, utilisation and fuel consumption of the road vehicle fleet, drawn from vehicle registration, road user charges and other data.

- **Statistics NZ** – is the main source for demand-side demographic and economic indicators and activity indicators for ports and airports. Statistics NZ also reports capital, labour and combined productivity indicators at industry sector level for the transport and construction sectors, but sufficiently detailed to identify productivity of operation and investment activities in roads, ports and airports.

- **NZTA** – reports condition, reliability (including road closures), congestion, safety and unit cost indicators for maintaining and operating the state highway network and operates a transparent process for investment prioritisation using economic efficiency and effectiveness criteria. It also reports similar information for local authority roads. NZTA reports public transport patronage, revenue, cost and cost-efficiency data. Data are reported at a local authority level, and aggregated to a regional and national basis.

- **KiwiRail** – since its formation has published more financial and operational data through its annual reports than was previously the case. The reporting on rail freight volumes, revenues, reliability and productivity gives a number of potentially useful indicators.

- **NZ Ports** – the ownership circumstances of the commercial ports vary as does their form of public reporting and consistency of information published from year to year. There are competitive pressures between ports and some of the more definitive information needed to develop comparative indicators is either not analysed or held confidential. Certain data, such as container crane handling rates, which have a recognised standard for measurement, are available across all of the main ports.

• **NZ Airports** – have a similar variety of ownership circumstances to the main ports, and the degree of consistency and disclosure in public documents is variable, as for the ports. Also, non-aeronautical business and aggregation of data over airports operated by each company complicates data extraction (e.g. AIAL Ltd owns Queenstown Airport). However, the three leading international airports (Auckland, Christchurch, Wellington) are covered by annual disclosure requirements under the Commerce Act to a set template, and data from these submissions could form the basis for at least partial coverage of the airports sector. The disclosure data include revenue, productivity, reliability and activity data.

• **Airways NZ** – the agency responsible for ATM, reports annually against its strategic objectives and KPIs related to safety, capacity, cost-effectiveness, predictability (reliability) and environmental impact

• **Visitor and Domestic Travel Surveys** – Tourism NZ carries out regular surveys of international visitor arrivals and departures, identifying overseas visitors for business, social or tourism purposes, and New Zealanders travelling abroad. The domestic travel survey is of day and overnight inter-regional travel within NZ. These provide some potential indicators of market demand for passenger travel and could help in identifying trends and rates of change.

• **Ministry for Primary Industry** - Statistics of production of the main agricultural and forestry export commodities that are important demand factors for freight movement by road, rail and through the export ports.

• **Ministry for the Environment** – MfE’s environmental indicator programme includes the following for transport: household expenditure on transport as an indicator of consumption; vehicle kilometres of travel by road where more travel and a higher proportion of heavy freight vehicles indicates more adverse impact; and VKT by vehicle age – older being worse.

### 3.4 Review and discussion of potential indicators

#### 3.4.1 Potential pressure indicators common to transport sub-sectors

Below are potential indicators for transport pressure. These are in addition to the generally applicable indicators in Section 2.7.

**Demand pressure indicators**

• **Household travel characteristics** – household vehicle ownership rates in particular affect the pressure on transport infrastructure. This information is available from census data

• **Real expenditure on transport** - percentage of total household expenditure and growth rate in real (inflation adjusted) expenditure on transport, with sub-components of purchase of new vehicles, vehicle operation, domestic passenger (public) transport and international travel, from the Statistics NZ Household Economic Surveys (3 yearly) with an agreed deflator such as CPI. The transport disaggregate data are only available nationally but regional data for Auckland,
Wellington, Canterbury and the rest of the North and South Islands are published which would enable some regional comparison

- *Transport cost movements in comparison to overall consumption costs* – from the CPI (purchase of vehicles SE9071, private transport supplies SE9072 and services, passenger transport services SE9073) as a ratio of CPI (all groups SE9A) index

- *Export and import cargo volumes, nationally and by main port (including airports and air cargo)* – Merchandise Import and Export Volume Indexes (all groups, SIA2I91 and SEA2E91); Overseas cargo loaded and unloaded by port (gross weight tonnes) series OSCA to 2007 since substituted with Infoshare database

### Supply Pressure Indicators

- Retail prices of petrol and diesel fuel (real) and growth from previous year – MBIE publication Energy Data File (annual)

#### 3.4.2 Potential State Indicators - Road Infrastructure

Almost all of the potential indicators pertaining to road infrastructure are gathered directly or collated from local authorities and reported by the NZTA. The organisation of NZTA on a regional basis allows many of the data sets and indicators to be reported on local authority, regional and national level. All of the following are from NZTA except where noted.

**Better use of existing infrastructure**

- *Speed/user time savings, roads* - road traffic delay from congestion is the main negative influence on user welfare and is also closely related to reliability of journey times. The established congestion monitoring surveys measure peak and off-peak travel time (and hence average speed) for selected journeys in the main centres and on some important inter-urban routes. The resulting indicators use established Austroads methodology. NZTA uses the Auckland peak data as an index of severe congestion and includes this in its Statement of Intent for 5 year targets. Faster transport means the implied cost of using transport for other activities is lower and the welfare generated is higher.

- *Speed/user time savings, public transport* - there are apparently no comparable published data on route travel times/speeds, or comparisons between peak and off-peak periods (for congestion monitoring), although we are aware of some steps to do so.

- *Reliability, roads* - The variability of travel times is extracted from the same survey and is reported as part of the MOT transport indicators. This indicator describes reliability under day-to-day traffic variation. A separate indicator is published that describes road outages with a duration of 12 hours or more due to weather and other natural events, long duration road incidents and planned closures. This is reported as part of NZTA’s long term monitoring. There is a gap between day-to-day variation and the longer period closures, for most road incidents such as crashes, spillages and other causes. Higher reliability means
road users need to allocate less ‘buffer’ time when travelling, which reduces the implicit cost of transport and increases welfare.

- **Reliability, public transport** – Auckland Transport reports reliability statistics for urban rail and bus services in terms of punctuality (arrival to schedule) and service performance (completion of routes).

- **User cost savings, roads** - the quality of ride provided by the running surface, measured by roughness is the main road condition factor affecting vehicle operating costs, excluding the more fixed elements such as road geometry that require capital investment to change. NZTA produces indicators of smooth travel exposure on a regional basis for state highways and local roads and maintaining a certain overall proportion of smooth surface is one of NZTA’s long term indicators. Lower vehicle operating costs increase welfare.

- **Provider cost savings** - Rut depth is a measured condition factor indicative of the underlying structural integrity of the road pavement – excessive rutting indicating that the pavement strength is insufficient for the load carried and that more costly intervention will be required. It is part of NZTA’s SOI monitoring indicators. Less rutting increases welfare in the sense that less expenditure will be required to maintain the road.

- **Provider cost savings** - a further quality indicator is surface defects that can normally be treated by routine maintenance and should be kept at a low level to prevent more rapid deterioration of the asset. It therefore provides one indicator of good maintenance management practice and cost minimisation.

- **Capacity utilisation, roads** - in terms of traffic volumes is measured by vehicle-kilometres travelled per network kilometre on public roads. As this indicator aggregates areas where traffic flows have declined, but where an ongoing commitment to retain road access remains, with areas where traffic growth has led to congestion, it should be treated with caution as an increase will not necessarily indicate greater user welfare or better matching of road supply to demand. An indicator that quantifies VKT experiencing severe congestion, measuring where and when capacity is exceeded, would be more relevant.

- **Capacity utilisation, public transport** – an indicator of passenger boardings (patronage) per seat-km of services operated would be indicative of capacity utilisation of PT services; however the seat-km data are not published although should be capable of calculation. The capacity utilisation during the peak period at the peak load point along a sample of routes would be a useful addition to monitor the degree of in-vehicle crowding.

- **Safety** – the three components of road safety are safe roads, safe vehicles and safe drivers. The infrastructure providers (the road controlling authorities – local councils and NZTA) have direct influence over design, traffic control and other operational aspects of the road network. NZTA also oversees driver and vehicle licensing, vehicle roadworthiness and vehicle design rules, while the NZ Police are responsible for traffic enforcement activity. Road safety also involves schools, health and emergency services and the media so requires a high degree of coordination and integration of roles. The primary indicators of road safety overall are road fatalities and injuries expressed per vehicle-kilometre or per
The per kilometre indicator is more closely related to driving exposure, while the per capita measure implicitly incorporates the degree of motorisation, so is arguably more broadly based and reflects changes in motorisation. There are many other indicators that could be considered for aspects of road safety, but one or both of these two system-wide indicators is probably sufficient. The relatively small number of fatalities means that trying to disaggregate this indicator regionally would encounter too much random statistical variation and this could be attempted only by including serious injuries (basically hospitalisations), although this too is complicated by uncertainty in the reporting rate. Greater safety reduces accident costs of transport and increases welfare.

- **Travel mode availability** – private transport availability can be monitored through Census data on vehicle availability to households. The proportion of households with no private motor vehicle available is a basic indicator of lack of access to private transport and is available on a regional basis, indicating regions of relative deprivation. Public transport availability can be gauged from the proportion of urban households within walking distance (typically 500m) of an urban public transport service (bus, rail or ferry) and MOT reports this data for each region. However, it is somewhat imprecise and is not confined to the urban area boundaries so is possibly not very reliable or useful. MOT also has an indicator at concept stage under “social connectivity” for the ability to get to “key locations” by public transport, cycle or walking. Greater availability means more options to use transport services and higher welfare.

- **Cost/Price alignment for road infrastructure** – as yet there is no direct pricing for road use (other than a couple of toll lengths), although the technology that would allow vehicles to be metered for the time and place of their road use essentially exists (basically vehicle positioning detection coupled with a charging regime). Cost recovery for roads is through petrol excise and the road user weight/distance charge for diesel and heavy vehicles (although this is in the process of being simplified). It would be possible to report a ratio indicator of road provision costs, excluding new construction (but possibly including renewals), to road revenues. This would be indicative of the extent to which the existing network operational costs are being met from PAYGO revenue. However, a regional breakdown is not simply done.

- **Productivity for road infrastructure** - we propose productivity be measured as the annual user output supported by roads, which desirably would be as the activities or as a proxy the number of trips facilitated, but more practically as the vehicle-kilometres travelled, as a ratio of the annual recurrent costs of operation and maintenance of the road network. NZTA publishes network VKT and the costs of those inputs that occur on a recurrent basis, such as road maintenance, road operation, road policing, the cost of renewals, in fact almost all costs apart from new construction and a share of NZTA administration costs. NZTA reports the costs of operating and maintaining the road network in cents/VKT for the state highways and for local roads as a whole but also with breakdowns regionally and by local authority available. Once this is corrected to a fixed cost base, using the NZTA’s own index of cost escalation for road maintenance activities, then this will provide a suitable indicator to track overall efficiency.
changes and geographic variation. (In doing such interpretation how the inbuilt
cost differences due to terrain, geology and materials availability in different
parts of the country together with higher or lower traffic densities affect the
productivity indicator will need to be borne in mind). Higher productivity
means more transport activity per dollar of cost, and assuming that is directly
associated with greater welfare (or is caused by lower costs) then higher
productivity is a welfare improvement.

- **Productivity for passenger transport** – an indicator of revenue passenger kilometres
divided by public transport provision costs (estimated as fare-box revenue plus
subsidy) can be provided for each urban centre. There is a price index published
by NZTA to correct for inflation in PT provision costs which can be applied to
put the indicator on a real cost basis to show efficiency changes from year to
year. Again, higher productivity is a welfare improvement if this is associated
with more welfare-generating activity facilitated by transport, or a reduction in
the cost of PT services.

- **Environmental performance** – the direct environmental impact of the road
infrastructure arises mainly from visual impact and land and community
severance effects, together with indirect impacts of resource depletion
(construction materials and land use); and rail is similar. Road and rail traffic are
the main sources of environmental impact through air emissions, noise and
vibration. Emission controls at source through less polluting transport
equipment offer the best opportunity for improvement, but otherwise by
mitigation measures in relation to local adverse effects. Two indicators are
suggested, growth in total CO₂ emissions from road transport and on a per
capita basis, and total emissions of fine particulates (PM₁₀ and possibly PM₂.₅) on
a similar growth and per capita basis. These estimates should be available from
the MOT’s vehicle fleet emissions model which tracks growth, utilisation and
technology change in the NZ road vehicle fleet. Environmental externalities reduce welfare, and so reductions in emissions are a welfare improvement.

**Better allocation of new investment**

- **Use of BCA in investment decisions** – NZTA and its predecessors have used BCA
as part of the decision-making framework for at least 30 years and the valuation
of road user costs and savings is one of the most well-developed areas of cost-
benefit analysis dating back to work in the USA and UK in the 1960s, and by the
World Bank. The analysis is partial-equilibrium (that is it assumes that any one
investment does not significantly affect the costs of supply of goods and
services) and primarily for selection between investment options. Attempts have
been made to widen the analysis for strategic projects, through CGE analysis,
and the wider economic “WEB” benefits being claimed for the Roads of National
Significance (RONS). However, there is some lack of consensus on the validity of
some of the methods and results, particularly where these result in B/C ratios
being greatly increased above a straightforward computation of road user
savings against investment costs. Also there appears to be some inconsistency in
that certain projects have these additional benefits credited whereas others do
not.
Another area that has been the focus of past debate is the inclusion of a willingness-to-pay value for avoiding a statistical fatality which forms part of the analysis of road safety benefits, which has very greatly increased the benefits ascribed to accident reduction over earlier practice which concentrated on the more tangible benefits of lowered medical costs and loss of output. An additional matter was the use for many years of a 10% discount rate, on the advice of Treasury, which had the effect of preferring low capital cost high maintenance cost investment over high capital cost low maintenance cost investment. While this has been relaxed to 7% it is still different from some overseas practice which has reduced the discount rate to 3% (the UK) for long lived strategic infrastructure.

Other issues have been generated traffic benefits, computed using the “rule of half” according to standard consumer surplus theory, particularly in congested networks where there is unmet latent demand, and whether present practice mitigates against the development of compact urban form less reliant on transport to meet activity needs – i.e. that analyses do not take proper account of land use/transport dependencies and long term interactions. While the BCA has long formed a part of decision-making, in recent years it has been reduced from the main factor to one several factors on which project ranking and decisions are made in what is now closer to a multi-criteria evaluation (MCE) and decision process. Exactly which criteria are included and their relative importance is now strongly influenced by the Government Policy Statement (GPS) on transport which is subject to change from time to time and particularly at changes of Government. At present the strategic emphasis of investment is on economic growth, particularly road investment that supports export production (and by inference less emphasis on roads supporting social communications and environmental wellbeing). The framework rates investments on strategic fit (GPS and NIP conformity), effectiveness and efficiency (B/C ratio). The NZTA Board decisions on all large investments are reported online, so the decision process is transparent. Overall, the use of BCA in transport investment decision-making must be rated as strong although less so than in the past, with some areas of uncertainty and with the potential for decisions to be politically influenced, although this is always true of publicly-funded investment.

- **Productivity as Aggregate B/C Ratio for Capital Investment** – As NZTA requires B/C ratios to be computed for all capital investment, it would be possible to compute an indicator such as the aggregate of benefits divided by aggregate of costs over projects funded in each year, with breakdowns by region and by activity class (type of investment). We suggest, for comparability, that the B/C ratios be those before addition of agglomeration or other WEB benefits. NZTA operates a project information and management system PROMAN that might be a suitable data source for such a calculation.

- **Uptake of New Technology** – There are several innovations and new and prospective technologies that could change the form of road infrastructure design and use including: (i) communications substitution for travel (ultra-high speed broad band included); (ii) change from fossil fuel to electric/biofuel vehicles; (iii) autonomous self-guiding cars which have potential to improve safety, increase effective arterial road capacity through reduced headways,
alleviate parking pressure (autonomous drop-off/park/pick-up) and be conducive to sharing/hiring schemes; (iv) intelligent highways - control of speeds and access to avoid overload; (v) innovative road building and structural materials including recycled waste. A key feature of these developing technologies is that they can be retrofitted into the legacy infrastructure. However, to construct some form of innovation index is challenging and there is no suitable existing indicator. It is possible that new project investment could be rated for new technology features and the roading agencies themselves rated for innovative research spending and development.

- **Accuracy of Traffic Forecasts** – new investment decisions are frequently responsive to an existing capacity problem. However, large long term investments do rely on long term growth forecasts. Uncertainties in these forecasts include: (i) the saturation level of car ownership and possible future declines in car ownership; (ii) the forecasting of annual distance travelled per vehicle owned; (iii) the effect of personal/household income and the relative prices of vehicle ownership and operation (including fuel prices) on both car ownership and use; (iv) the effects of communications substitution for travel; (v) the effects of urban migration and compaction in urban land use and increased use of public passenger transport systems on private vehicle travel; and (vi) the effect of changes in the age structure of the population. Total travel (VKT) in NZ has plateaued since 2006 and light vehicle ownership per capita and road travel per capita have both fallen. However, the default regional traffic growth projections in NZTA’s advice on project evaluation lie between 1% and 3% per annum which implies an expectation that the recent trends do not mark a permanent change in the growth path. Even though an arithmetic basis, over the time horizon for investment of 30 years this implies growth of up to 90% on current flows. There appears to be some justification for an indicator of the quality of investment allocation based upon reliance on long term traffic growth. This can be achieved through sensitivity testing within the BCA. The NZTA evaluation procedures do include extensive requirements for sensitivity testing and formal risk analysis for several factors but the extent to which these are followed and their incorporation into the decision-making process is less clear cut. The basics to develop an indicator of susceptibility to traffic forecasting risk therefore exist, but may take some work to implement.

### 3.4.3 Potential State Indicators – Airport Infrastructure

The most useful and consistent data source for indicators is the annual disclosure statement and tables made by the three main airports to the Commerce Commission. Some leading data is reported in the annual reports of the airport operating companies but this can vary from year to year in content and format and is very heavy on financial results and less detailed on operational statistics. The form of investment analysis applied to airport infrastructure is essentially from the financial viewpoint of the airport company and does not have regard to wider social cost benefit analysis that would incorporate the benefits to the airlines and air passengers. There is some commercial tension between the airport operators and the airlines due to the monopolistic position of the main airports, hence the close scrutiny by the Commerce Commission.
Better use of existing infrastructure

- Passenger Travel Time through Airport Terminals – the airport operator has some control over the through-terminal efficiency of emplaning and deplaning passengers, although other actors, such as the air carriers, various government border services and air traffic control, can add extra time and uncertainty, particularly for international travel. Airport operators tend either to advise passengers to build in a conservatively large time buffer to their travel (e.g. 3 hours at Auckland for international travel) or defer to the air operator for such advice. However, Auckland Airport includes “passenger transfer efficiencies” and “processing times” as two of its KPIs, although these do not appear to be published (neither do other sustainability KPIs). Faster travel time reduces the implicit cost of using airports and increases welfare.

- In-Flight Delay – Airways NZ monitors the combined annual minutes of in-flight delay for arrivals to Auckland and Wellington as a performance metric for the airways system. Again, faster travel time increases welfare.

- Airport Terminal Capacity Utilisation – the Commerce Commission disclosure tables include several capacity utilisation indicators: busy hour passenger density indicators for the landside concourse, check-in, airside concourse and departure lounge (including persons/available seat) areas, percentage utilisation of processing capacity for baggage handling, passport control, security with similar indicators for inward passengers. Indicators are given separately for international and domestic terminal facilities. The underlying data on which the indicators are based are also presented and a commentary on interpretation. This provides ample information on which to report performance of the various parts of the airport terminal passenger operation under peak conditions, and it would be possible to amalgamate these separate indicators into some form of composite score which could be tracked from year to year. What is not shown is the peaking characteristic of air passenger flows through the terminals and whether there is any scope or advantage in load levelling by trying to influence airline arrival and departure schedules (probably the airport operators have little influence. Note that there is no variation in the charges made in relation to peak arrival times – i.e. no financial incentive for airlines to time-shift their demand). Higher utilisation corresponds to greater services provided from existing infrastructure and thus higher welfare.

- Airfield Capacity Utilisation – while there are utilisation and capacity considerations for the apron stands and taxiways, the CC disclosure statement requires only a comparison between busy hour aircraft movements and runway busy hour capacity under visual and instrument meteorological conditions. If the demand exceeds runway capacity, then this will result in aircraft either being held at the gate or stacked in the air, and the number of hours per year

that this applies will be a measure of the over-capacity. While this was reported by AIAL, it is not a requirement, only the runway movements during the busy hour (which is only relevant if capacity is never exceeded). However, while it could be improved upon, this does provide a useful indicator of capacity utilisation. As with passenger movements through the terminals, it would be informative to also include a statistic describing the variance in capacity utilisation (describing the “peakiness” of demand. Again, higher utilisation corresponds to higher welfare.

- **Reliability** - the disclosure tables include reliability measures of number and hours per year of interruptions to: runway availability, taxiway availability, airbridges and baggage handling systems. Although the CC requires the airport operator to report on on-time flight departure delay as numbers of such delays, hours of delay and the party responsible, only one of the three airports was able to report this information in 2012 partly due to inability to impose this compliance requirement on the airlines. However, the runway availability is probably the best indicator as does not confuse airline operating reliability shortcomings with those of the airport infrastructure. As with road transport, higher reliability corresponds to higher welfare.

- **Safety** – safety has a higher priority in aviation than in any other transport mode and air accidents at NZ airports are very rare so are not particularly useful as an indicator. Alternative possibilities are recorded lesser incidents on take-off and landing in which the airport infrastructure is a factor or other operational indicators, such as the number of approaches aborted. However a source for such data has not been identified. Another possibility is a comparison of runway dimensions, the take-off length requirements for the aircraft type and weight using the facility and ICAO standards, which would need some investigation. Each airport has a safety management system (SMS) in place and reporting on the compliance with the SMS is a further possible source for safety indicators, although there does not appear to be public reporting on the SMS.

For operation of the ATM system, the main safety indicator is the number of loss of separation incidents recorded (with a target of zero by 2018).

- **Productivity** – total passenger numbers rather than aircraft movements is probably the best output measure to act as a proxy for welfare. The denominator annual cost should be the total operational expenditure plus the regulatory depreciation, both reported in the annual disclosure statements to the CC (schedule 7, lines 20 and 22). The depreciation serves as a proxy for the annual cost provision for renewal of assets. A suitable deflator is needed to bring this indicator to a real cost basis, and this can be decided by analysing the typical expenditure make-up (civil engineering, plant, buildings and services, staff costs etc.) and applying suitable PPI or CPI series indexes.

- **Environmental performance** – apart from during construction or extension, airport infrastructure has limited direct impact on the environment, most effects being from air operations. Noise in the vicinity of airports has historically been an issue but land use controls and greatly reduced aircraft engine noise has reduced this impact over time. Aircraft CO₂ emissions are a significant contributor to NZ transport sector emissions but are influenced by airports only
insofar as delays to take off and landing add to fuel consumption, so are covered by the congestion and in-flight delay indicators suggested above.

**Better allocation of new investment**

- **Productivity** – desirably this indicator would measure the discounted incremental welfare/user benefits created by capital investment in new, upgraded or expanded airport infrastructure divided by the cost of the investment. In practice this information is not available and the nearest substitute is the % return on investment as reported to the Commerce Commission which we understand to exclude non-aeronautical assets (hotels, business park etc). However this is very much a second best indicator and was developed to assist the CC in its price oversight and regulation. For new investment, the change in ROI over time could be used if the extent this was caused by new investment and no other factors was known.

- **Use of B/C analysis in investment decisions** – it would be expected that each airport company’s consideration of new capital investment would include a financial B/C analysis from the company’s viewpoint using the company’s WACC as a minimum rate of return on assets over a suitable time horizon. Such analysis would include a forecast of incremental revenues generated and the investment and recurrent cost implications of each investment, including tax considerations and risk. However such analyses, assuming they are carried out, are generally held confidential and would be difficult to aggregate over the whole airport sector. A more generalised indicator could be formed using the annual passenger growth divided by the total capital investment in new, upgraded or expanded airport facilities, again as reported to the Commerce Commission. This would apply only to the three regulated airports but could possibly be extended to the next tier of airports, given appropriate data is extractable from annual reports. The index might need to be smoothed over a period of years because of inherently lumpy investment, but could probably be back-analysed to include historic data to produce a 5 year moving average.

- **Accuracy of traffic forecasts** – each airport company forms a view on future traffic expectations, and these usually find a place in the airport master plan. Airport master plans are prepared from time to time and forecasts of passengers and aircraft movements are not necessarily reviewed annually, so base dates and the divergence between plan and actual traffic will vary from one airport to another. However, with a little enquiry and effort, it would be possible to assemble data to enable a retrospective analysis of 5 and maybe 10 year actual growth against forecast which could be updated annually. This could be reported as a ratio of actual to forecast to indicate under- or over-prediction.

### 3.4.4 Potential State Indicators – Port Infrastructure

There is no common reporting requirement or format for the main ports that readily allows aggregation and comparison of data as is possible for the main airports. Also there is a greater degree of competition in the port sector; an obvious example being Auckland versus Tauranga, so commercial information tends to be more closely held.
The welfare benefits provided by ports to the freight interests lie in the time between ship arrival and when the goods are available for collection and. For outgoing cargo, the latest acceptance time prior to sailing time. The variation/reliability in the rapidity of port handling is also a significant factor. Reliability of ship arrival times is largely out of the port company’s control, except where there are tidal limitations that can potentially be improved through dredging. The capacity of ports to handle new generation of ships that require longer deeper berths and approach channels can potential affect future competitiveness and ultimately becomes a cost to the freight shipper if cargo has to be transhipped at another port.

Inland ports and freight terminals provide an adjunct to port land, allowing cargo aggregation and storage away from the often congested waterside container stacks, although with an additional rail or road freight link (e.g. Metroport freight terminal feeding Tauranga and Wiri inland port supporting Ports of Auckland, both in South Auckland).

The time to discharge cargo and present it for collection is partly a function of the ship/shore transfer rate; the degree of utilisation of the container stacks and the methods used for moving containers also affects the time to order and present boxes to shipside or to despatch. Other steps in the process, such as a border security and customs, depend on the efficiency of Government agencies.

The efficiency of moving ships through a port contributes to its attractiveness as a point of call and indirectly will influence freight costs. If berth occupancy increases much over 70% then the frequency of ship delays becomes excessive. The vessel turnaround time and berth occupancy are both potentially useful and readily measurable indicators.

**Better use of existing infrastructure**

- *Port Operational Efficiency/Port Transit Times* – most container ports report the crane rate in TEUs/h to the Australasian Waterline Standard, which gives some assurance of comparability between ports. MoT summarises this data on an annual for NZ ports.

  The average vessel time in port (days/hours) is a further potential indicator. While this is not published, MoT also reports rates for container transfer between ship and shore, a rate of ship working by all cranes, which goes some way to an indicator of port length of stay. This does not cover break-bulk and bulk cargo movements however, which are important at several ports. Greater efficiency corresponds to lower freight costs for any given amount of freight handled, and therefore higher welfare.

  The reporting of time taken for road and rail transfers is less consistent or likely to be published across ports. For example Auckland reports the time to turn around trucks delivering or collecting cargo in three time brackets, with most

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falling into the <30 minutes category which is a possible operational efficiency indicator.

The World Bank publishes the Logistics Performance Index\(^\text{22}\) for a number of countries including New Zealand. ‘Lead time to import’ refers to the days from port of discharge to arrival at the consignee. The data is not updated annually.

- **Capacity Utilisation** – Berth occupancy is an often used measure of ship-handling capacity utilisation and is the ratio of time the berth is occupied to the total time available. A possible measure of wharf utilisation is the annual container throughput per ground container slot, possibly divided into empty and full containers (as empties can be higher stacked). Where the port handles significant bulk and break-bulk cargo, then a wharf utilisation measure of cargo tonnes per square metre of storage area can be used either instead of or in parallel with container stack utilisation. Increasing the utilisation rate of wharf land, like the berthing, is only desirable up to the point where the handling equipment can efficiently move the goods.

- **Reliability** – is probably most practically measured as the proportion of time that berth occupancy and storage occupancy exceeds the efficient handling capacity, such as to induce significant delays. The proportion of time that truck turnaround exceeds a certain limit (see the Auckland example of 30 mins) is a further indicator of reliability. Reliability of sailing times is another possibility but would include ship operator as well as port reliability factors

- **Safety** – ports generally report occupational safety as numbers of injuries and/or time lost due to injuries. One or other of these could be used as an indicator, possibly reporting the number of fatalities and serious injuries and the lost time as a proportion of the total hours worked (note – the numbers in the workforce is variable and should include private stevedore labour as well as port company employees so this precludes an indicator based on total workforce numbers).

- **Productivity** – this can be expressed as annual cargo tonnage throughput divided by the annual operating costs inclusive of depreciation, amortization and impairment. To be consistent across ports, a position needs to be taken on whether operating expenses relate solely to the provision, operation and maintenance of the wharves and berths, or whether the costs of services that may be provided by the port company but also can be provided by others (stevedoring, pilotage etc) should also be included. It may be necessary to differentiate between container wharves, where equipment is more frequently owned and operated by the port company, and general cargo wharves where separate stevedores are more likely to be engaged.

- **Environmental Performance** – the main environmental impacts of ports and port operations are shoreline and hydrology modification by reclamations for port extensions and maintenance dredging of berths and channels, including disposal of materials. Visual impact, noise and emissions are also factors for those ports

situated in downtown areas. An semi-quantitative index of environmental impact could possibly be developed for a comparison of the main ports but this would not change significantly from year to year so may be of limited use.

**Better allocation of new investment**

- **Productivity** – as with airports, a suitable measure of the incremental change in productivity of new investment is a benefit/cost analysis from a national economic viewpoint or failing that from the port company financial viewpoint, where the benefits are the additional welfare created by the port expansion or upgrading arising through avoided congestion delays, faster throughput or a more cost-efficient combination of technology, labour and capital. This information is not provided in company financial statements and there is no reporting requirement to a regulator or oversight agency as for airports that would provide a second best substitute. So access would be required to any return on investment (ROI) analysis that each port company might have made on its development projects, such as for wharf extensions, additional container cranes and berth or channel deepening. In some cases, such analyses would necessarily be done on a wider transport network basis as the effects might change the pattern of trade at neighbouring ports and potentially on the road and rail network.

- **Use of B/C analysis in investment decisions** – to rate each port’s assessment process would require access to the same data as noted above. Similar considerations apply to investment decisions in cruise ship facilities, although the welfare benefits to NZ lie in the additional spending retained in NZ from cruise visitors and the surplus earned by services to cruise vessels.

- **Accuracy of traffic forecasts** – each port company forms a view on future traffic expectations, and these usually find a place in its forward long term strategy or master plan. Such strategies or plans are prepared from time to time and the forecasts of freight volumes and ship calls are not necessarily reviewed annually, so base dates and the divergence between plan and actual traffic will vary from one port to another. However, with a little enquiry and effort, it would be possible to assemble data to enable a retrospective analysis of 5 and maybe 10 year actual growth against forecast which could be updated annually. This could be reported as a ratio of actual to forecast to indicate under- or over-prediction.

**3.4.5 Potential State Indicators – Rail Freight Infrastructure**

The rail network and operation is all part of KiwiRail, so the analysis and reporting published by KiwiRail or available from the SOE by Treasury request should be available to support a series of indicators. KiwiRail has produced quite detailed and open annual reports of its operations and finances since it was formed (in contrast to the lack of public information when it was under private ownership).

With the exception of the Auckland and Wellington suburban rail systems, considered as part of public passenger transport and discussed under road infrastructure, the rail
infrastructure is predominantly designed and operated to serve freight needs (long distance passenger rail being now largely oriented to tourist sightseeing).

There are issues when considering new investment (or disinvestment) in freight rail of the effect on the road network, and a joint corridor investment approach is often more useful than considering rail alone.

**Better use of existing infrastructure**

- *Freight transit times and reliability* – much rail freight is bulk low value materials (coal, logs etc.) which are not time sensitive, and savings in transit time will often just result in more time in storage at one or other end of the trip. In markets such as container freight on overnight services and on links such as Auckland to Port of Tauranga, prompt delivery is more important, although it is reliability that is more important than speed of transit. KiwiRail reports as one of its KPIs the percentage of premium freight consignments that are within 30 minutes of the schedule time and this could be adopted as an indicator of user benefit.

- *Capacity utilisation* – the capacity of a rail line depends on factors such as whether it is single or double tracked and if single tracked the number of crossing loops; also the weight and horizontal geometry of the trackwork, the gradients and the signalling all affect the maximum train weights and speed and hence the effective capacity. Capacities of individual lines can be estimated but this is not generally available information. Gauge limits such as tunnel and bridge widths and heights also affect what can be carried. Some lines are very limited by international standards due to NZ’s narrow gauge, steep gradient sections (1:50 is not uncommon) and limited tunnel height. Only part of the network is electrified. As with other modes, the indicators of capacity utilisation can only be at system average level and will not necessarily be informative of how close to capacity parts of the network are. Possible indicators are net tonne-kilometres of freight expressed as an index or as a ratio of track-kilometres (although this changes only slowly). As changes in track kilometres occur at the margin, where there has been an increase or reduction in track coverage, the incremental/decremental net t-km per km length of track could be informative (e.g. for situations such as the East Coast and Northland).

- *Safety* – KiwiRail includes Lost Time Injury Frequency Rate (LTIFR) and Medical Treatment Injury Frequency Rate (MTIFR) both expressed per million man-hours. These are suitable indicators for occupational H&S. However, public injuries occurring at pedestrian and vehicle rail crossings and where members of the public have crossed the track illegally are also important, as at-grade rail/road crossings have a particularly high accident and injury rate (expressed in terms of road vehicle kilometres of exposure). The NZTA Crash Analysis System (CAS) records rail crossing accidents and these can be reported either as a ratio of train-km or as a ratio of road VKT. The number of fatal and reported serious injuries per train-km or per 100 million VKT are appropriate measures. KiwiRail also records accidents from pedestrian incursions into the
rail corridor away from road and pedestrian crossings, which are not captured by the CAS system and these could be reported separately.

KiwiRail maintains a priority list of level crossings requiring treatment (such as by adding barrier arms, lights and bells, or grade separation). Progress in applying safety upgrades to crossings could also form part of a safety indicator set (numbers completed per year)

- **Productivity** – KiwiRail reports freight operating expenditure as a proportion of freight revenue and total labour costs as a percentage of revenue, both as productivity measures. To be consistent with the treatment of other modes, we propose a productivity indicator of net freight tonne-km per dollar of freight operating cost, which can be calculated readily from KiwiRail’s annual reporting.

- **Environmental Performance** – KiwiRail monitors its annual carbon emissions in CO2 equivalents which would be a suitable indicator of environmental performance. Various technical efficiency improvements and substitution for diesel (electrification, biofuels) contribute to improved performance as well as to lowering operating costs.

**Better allocation of new investment**

- **Productivity** – as with other modes, new capital investment (as opposed to maintenance and renewals) should be justified through an economic BCA or, if from the KiwiRail viewpoint a financial BCA. The vast majority of KiwiRail infrastructure spend appears to be on remedial maintenance and renewals, so productivity of new investment in freight rail may be limited. Productivity of investment in passenger rail is probably more significant, particularly in Auckland rail station upgrades, double tracking and electrification, although most of this investment is now either completed or in progress.

- **Use of B/C Analysis in Investment Decisions** - similar considerations apply as in other modes. As an SOE, it is expected that business case justification has made for new investment following Treasury guidelines although details of the process and decision-making are unclear and are not in the public domain.

- **Traffic Forecasts** – Rail competes for a relatively small portion of the surface transport market, so general growth in GDP and freight demand cannot be automatically translated into rail traffic growth which will depend on rail’s competitive position and will be limited to certain contestable markets. However KiwiRail in its Statement of Corporate Intent does set targets for outyears up to 3 years ahead including for freight net tonne-km (and for all of its KPIs) which can be retrospectively compared with actual out turn. A back analysis to the 2010-2012 SOI can also be made.

### 3.4.6 Potential Response Indicators

Potential responses to pressures acting on the existing state of the transport infrastructure include:
• Expenditure (i) on upgrading, expansion or new infrastructure to meet anticipated or actual demand including on new and innovative technologies (ii) on maintenance and operation to improve the technical efficiency and effective capacity of existing infrastructure

• Regulatory responses by Government: (i) either through regulatory oversight and intervention to correct market imperfections where the infrastructure is owned and/or operated by an SOE (KiwiRail) or mixed model corporate entity (port and airport companies); (ii) direct policy direction to Government agencies, that is NZTA, including through various Government Policy Statements (GPS).

Response indicators - road

• Public investment in road infrastructure and passenger transport – NZTA recorded data on annual real (inflation adjusted using NZTA’s cost deflators) change in expenditure for construction, renewals and maintenance for the state highway network and for local roads. Data are also recorded for passenger transport. The indicator could be expressed on per capita basis (since the user base for roads is essentially the whole community) to be compatible with other sectors where investment is expressed on a per user basis. A further indicator of maintenance and operational expenditure as a ratio of total expenditure would indicate shifts between capital development and maintenance of the existing network. As well as being reported by NZTA, most of the required data is summarised in the MOT transport indicator set for investment. 23

• Government policy and regulatory responses - the government updates the GPS on land transport funding on an annual basis, so changes in the investment emphasis can be identified from one GPS to the next. As the GPS sets out expected funding levels for different classes of expenditure over a forward view of 10 years, it is possible to compare the anticipated expenditure with actual outturn in each of the 14 activity classes. Specific initiatives, such as the Roads of National Significance (RONS) can be monitored individually.

Response indicators – air

• Investment in airports – Investment in the three regulated airports is available through Commerce Commission disclosure tables identify value of newly commissioned infrastructure assets, asset management and operations and asset maintenance (schedule 1, line 78, schedule 2, lines 22 and 23). An indicator set could show total investment, annual change, proportions of capital versus O&M, and investment on a per passenger throughput basis. It would be desirable to include other NZ airports that support regular passenger transport services in the indicator set, maybe as a single aggregate, but data assembly from each airport’s financial and operating statements would be required.

- Government policy and regulatory responses – decisions and directives made by the Commerce Commission provide the basis for an indicator of policy and regulatory response. The number of interventions and their nature can be recorded or include a more qualitative summary of their significance.

Response indicators - sea

- Investment in ports – investment in main port infrastructure capital works, maintenance and operations, on a port basis or national aggregate, as total expenditure, rate of change and on a freight tonnage throughput basis (dedicated container wharf/terminal operations can be separated and be on a TEU throughput basis if desired). Construction of the indicators will require collating data from individual port financial statements and operating data reports, with the problem of variation in definitions and degree of disclosure.

- Government policy and regulatory responses – ports are not a regulated industry under the Commerce Commission. The current Government Policy Statement “Connecting New Zealand” focuses on port productivity, and the freight network has recently been the subject of a report by the Productivity Commission. Government intervenes less in the port sector than other transport modes where it either the owner or applies some regulatory oversight. If this position should change, then a role for a monitoring indicator might emerge.

Response indicators – rail

- Investment in rail infrastructure – KiwiRail’s annual reporting provides physical performance measures of infrastructure and rolling stock renewals, but investment in capital works, operations and maintenance are not specified in the financial statements where costs are classified on an input rather than output basis. As an SOE, Government could request data in the necessary form but some consultation would be required. Once obtained, the investment costs could be shown as real totals, annual growth and normalised on a per freight-tonne-km or freight revenue basis.

- Government policy and regulatory responses – Government’s primary intervention is financial support to the KiwiRail “Turnaround” Plan, aimed at improving the performance of the rail freight network through infrastructure renewals and new rolling stock. The financial support is separate from the GPS on Land Transport Funding and National Land Transport Programme. The amounts are disclosed as grant income in the KiwiRail financial statements and can be tracked as Government commitment to supporting the reinvigoration of the rail system. A possible indicator would be grant income as a percentage of total income and the annual change in (real) grant income.
4 Telecommunications

Telecommunications infrastructure in New Zealand is largely owned by the private sector, although government involvement in infrastructure funding is increasing with the ultra-fast broadband (UFB) programme and rural broadband initiative (RBI). Demand for telecommunications services comes from households that use these services directly, and businesses that use telecommunications as an input to provide other goods and services.

The main components of New Zealand’s telecommunications infrastructure are:

- International submarine cables and satellite systems connecting New Zealand with the rest of the world;
- The copper network used to provide telephone services (POTS), and data services (ADSL) to most homes and businesses;
- Fibre networks connecting some homes and businesses, and used for regional and national backhaul;
- TV and radio broadcast networks, which are currently transitioning from analogue to digital technology; and
- Mobile networks that provide voice and data services in most of the populated areas of the country.

4.1 Key characteristics of the sector

Referring back to the general characteristics of infrastructure discussed in section 2.4, telecommunications infrastructure has the following features:

Asset lives: Telecommunications is a technology-driven sector, with new technologies driving cycles of investment and uptake by end-users. This means that some assets (e.g. mobile network radio equipment) have relatively short lives, while some assets that can be re-used for different technologies have relatively long lives (e.g. underground ducts).

Payback periods: Investment is generally tied to technology cycles, and payback periods in many cases are correspondingly short, although some investments that involve high levels of capacity (e.g. fibre) have longer payback periods.

Lumpy capacity: Capacity is generally very lumpy, particularly relative to the size of the New Zealand market.

Economies of scale & scope: These economies are strong, given the lumpiness of capacity and the level of demand in New Zealand. Once investment has occurred, telecommunications costs are largely fixed, with costs mostly depending on the number of users connected and not the volume of traffic.

Network structure: Telecommunications exhibits classic characteristics of networks, with traffic aggregated from relatively low capacity distribution networks (e.g. the
copper network) to higher capacity transmission networks (e.g. fibre networks). The nature of data traffic means it is feasible to aggregate traffic across a broad geographic area – almost all international data traffic flows through the Southern Cross Cable submarine system.

**Outputs are inputs:** Some telecommunications outputs are inputs into production of other things, and some outputs are consumed directly.

**Externalities:** New telecommunications services sometimes exhibit positive externalities, where the value of the service increases with the number of people that uses it. This can also happen with services that use telecommunications as an input, e.g. TradeMe is more valuable when more buyers and sellers use it. Thus demand for telecommunications services can grow rapidly once sufficient scale is achieved, but there is also a risk that new services will fail to achieve critical mass.

**Efficiency/equity trade-offs:** The cost of providing telecommunications services to end users is higher for users in remote or geographically challenging locations. Furthermore, access to basic telecommunications services is considered essential for everyone to have. As a result, equity-based policies such as the telecommunications service obligation (TSO) framework, and infrastructure development programmes such as the Rural Broadband Initiative, fill market gaps to enable the widespread availability of basic telecommunications services.\(^{24}\)

**Demand volatility:** Demand for telecommunications services exhibits peaks and troughs based on time of day and day of the week. Geographic demand patterns (particularly on mobile networks) are also created by commuting patterns, holidays, and special events.

**Demand for reliability:** Consumers generally demand high reliability of telecommunications services. Service providers invest in route diversity and other infrastructure resilience capabilities to assure high levels of service reliability.

**Imperfect markets:** Due to economies of scale and scope and the relatively small size of the New Zealand market, there is limited competition in some telecommunications markets. Some wholesale markets are subject to access and price regulation as a result.

**Place matters:** Local infrastructure must be in place to handle demand at that location. However compared to other infrastructure sectors, in telecommunications there is more ability to aggregate volumes across regions and nationally.

\(^{24}\) The TSO and other subsidy schemes such as the RBI are funded by the Telecommunications Development Levy (TDL).
4.2 Relationship to welfare

Welfare from telecommunications is generated by a mix of:

- Direct consumption of telecommunications services, e.g. households making phone calls and using internet services;
- Production of other services that use telecommunications as a complementary input, e.g. web-based businesses such as TradeMe, sales and marketing, providing customer service, and so on.
- Facilitating the development of social capital through human communication, and as technology develops further, facilitating the accumulation of human capital (through e-learning) and health capital (through tele-medicine).

As households obtain welfare directly from use of telecommunications services, the quantity of use is potentially a valid measure of welfare – if households use more telecommunications services then it can be assumed this gives them higher welfare.

However, the definition of services in the calculation of usage presents some difficulties given that different telecommunications services can be substitutes. For example, data and voice calls can be substitutes if Skype or other VOIP technologies are used to provide call services. In principle it would be possible to calculate an aggregate household telecommunications usage indicator by converting voice and other services to equivalent volumes of data, but in practice this is difficult as the volume of data usage itself is unknown.

The quality of services is also important – if calls drop or broadband is slow then the welfare derived will be less. Where telecommunications is used as an input by businesses, quality is important.

4.3 Existing data sets and indicators

A key challenge in developing telecommunications infrastructure indicators is availability of data, given the high degree of involvement of private businesses in the sector. This means some indicators are commercially sensitive. Furthermore, some of the key businesses, such as Vodafone, do not publish detailed annual reports on their New Zealand operations. The most reliable indicators are therefore those collected and reported by the Commerce Commission, which aggregate data from across the sector. Some indicators are also available from international organisations such as the OECD.

The following data sources are available:

- Commerce Commission – The Commission publishes an annual telecommunications sector monitoring report that includes information on investment, competition, prices, traffic volumes, and summarises significant developments in the sector.
- Statistics New Zealand – Publishes statistics on business use of information technology, productivity in the sector, and household take-up on services. The
latter are published only in Census years and therefore less useful than other sources of information about household take-up.

- OECD – The OECD’s “broadband portal” contains basic indicators of broadband take-up across different countries including New Zealand. Household and business internet usage statistics, and broadband coverage are also reported but these indicators are not updated regularly.

4.4 Review and discussion of potential indicators

With the above characteristics of telecommunications infrastructure in mind and the relationship to welfare as discussed above, the following are recommended potential indicators for telecommunications infrastructure performance.

4.4.1 Potential pressure indicators

Demand pressure indicators

- Population, economic activity - pressure on telecommunications infrastructure is generated by overall economic activity, and population.

National economic activity and population, including future population projections, will determine pressure on national-level infrastructure such as international submarine cables.

Local and regional population and activity will determine pressure on other infrastructure such as local exchanges, mobile networks and fibre backhaul. Changes in total employment can proxy for changes in economic activity in each region.

These population, economic activity and employment indicators are generally applicable across most infrastructure sectors and are outlined in Section 2.7

Supply pressure indicators

Telecommunications costs - a significant component of telecommunications costs relates to labour, for which cost indexes are available (Statistics NZ Labour Cost Index Series SG51J9 “Information, Media and Communications”). Capital costs are also important, however prices for telecommunications equipment are difficult to observe and are often negotiated individually between suppliers and buyers.
4.4.2 Potential state indicators

Better use of existing infrastructure

We propose indicators of use of existing telecommunications infrastructure that measure rates of take-up, quality of service, intensity of competition, and prices as discussed below:

- **Service quality - broadband market penetration** - Standardised measures of fixed and wireless broadband penetration are available from the OECD’s Broadband Portal. These give the number of fixed and wireless broadband subscriptions per 100 inhabitants according to an internationally comparable methodology, with the latest data available for June 2012 (the illustrations for this section are in an attached appendix to this document). Assuming that increased penetration reflects greater usage of telecommunications infrastructure and greater welfare, increases in penetration are an improvement.

- **Service quality - broadband speeds** - are important for the quality of broadband services. Average download speeds are monitored and reported by the Commerce Commission on an annual basis. Everything else equal, higher speeds indicate greater welfare from telecommunications infrastructure. Changes in the overall average speed are influenced by the transition from dial-up to broadband technology, and improvements in broadband speeds. The latter is influenced by a range of factors including local access speeds and technology, backhaul capacity, the use of local caching and content distribution networks, and international bandwidth prices.

The Commerce Commission also reports average web download speeds by region. These benchmarks are based on downloads from a New Zealand reference website, and reflect capacity and constraints in domestic transmission and local access networks. For any given region, an increase in speed is an improvement, provided this does not come at the cost of reduced speed elsewhere.

- **Retail market price competition** - competition in retail markets is important to deliver the full benefits of existing infrastructure. The Commerce Commission publishes measures of supplier concentration in retail voice, broadband and mobile markets. These are calculated as the Hirschman-Herfindahl index (HHI), which is the sum of the squared market shares of all suppliers. A monopoly market has an HHI of 10,000 and lower values of the HHI indicate greater potential competition, leading in theory to lower prices and increased product quality. A reduction in the HHI is thus interpreted as an improvement.

- **Productivity** - of the “information media and telecommunications” sector is measured and reported annually by Statistics New Zealand. This includes capital, labour and multifactor (all factors combined) productivity. Capital productivity in the sector has remained relatively constant over time, while

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labour productivity has increased dramatically. This is presumably due to labour-saving technological change that has required greater capital investment, offset by savings in labour costs and greater labour productivity.

Given the degree of substitution between capital and labour in the telecommunications sector, in our view the multifactor productivity is the most useful indicator of infrastructure productivity, and an increase in this indicator is an improvement, everything else equal.

• **Service coverage** - The availability of telecommunications services in different regions is another important indicator of the welfare created by telecommunications infrastructure. While fixed-line voice services are generally available, mobile and broadband coverage does not include all of the population. While we have not been able to obtain public indicators of coverage, in principle mobile and broadband coverage can be calculated from the national broadband map[^26].

• **Price benchmarking** - Finally, the Commerce Commission reports price benchmarks for fixed-line, broadband and mobile services. In general price benchmarking is difficult in telecommunications due to the common practice of bundling different services together for a single price, and the fact that multiple bundles targeted at different customer segments are offered in the market. The Commerce Commission has attempted to resolve this issue by defining representative usage patterns and assuming that customer choose the best package that meets their usage.

  However over time the bundles and usage patterns change and it is difficult to compare prices over a long period of time. For this reason, we recommend that telecommunications price benchmarks be used cautiously. It can be difficult to interpret a price change as an improvement or a worsening, as the change in price may be associated with different services being provided and/or different usage levels.

**Better allocation of new investment**

• **Quality of investment allocation/adoption of new technology** - to some extent, the indicators listed above will also reflect better allocation of new investment, in particular improvements in fixed and mobile broadband penetration, coverage and speeds. However in general it is difficult to measure the allocation of new investment in telecommunications infrastructure directly, partly because it is driven by private sector investment, and partly because it is driven by technological change which is difficult to measure quantitatively. We therefore recommend the use of expert judgement to assess whether the New Zealand telecommunications sector is keeping pace with international trends and investment in new technologies.

• **Quality and stability of regulation** - Furthermore, the industry is heavily regulated, and so regulation (and regulatory risk) plays an important role in determining the level and types of investment. There is regulation specific to the telecommunications sector in New Zealand and this regulation impacts on the investment by commercial telecommunications providers.

In many cases, providing telecommunications services to end-users requires combining the infrastructure provided by several private firms, and thus coordination between these firms is also important to achieve efficient investment. Thus it would be useful to have indicators of the quality and stability of regulation under the Telecommunications Act. While difficult to measure directly, an independent assessment could be informed by the timeliness and consistency of Commerce Commission decisions and the overall stability of the regulatory regime.

• **Data capacity growth** - if the telecommunications industry is driving technology change and introducing new capabilities then this is likely to provide more welfare from the infrastructure. This is difficult to measure quantitatively, and data capacity growth may be difficult to ascertain.

### 4.4.3 Response Indicators

• **Investment in provision of infrastructure** - the most visible response indicator in telecommunications is investment in infrastructure. The Commerce Commission publishes data on total investment and investment by type. It is not clear whether these figures also include government-funded investment; if not, that could be added to the private investment. To form an indicator with some prospect of international comparison, investment can be expressed on a per capita basis over the national population.

• **Regulatory actions** - the other main responses are regulatory in nature. This includes changes to the Telecommunications Act, the directives given to the Commerce Commission, the decisions made by the Commerce Commission, and direct government initiatives such as the ultra-fast broadband programme and rural broadband initiative. While difficult to measure as a standardised indicator, these responses can be noted and tracked over time as they occur.
5 Energy

The NIP divides the energy sector into electricity, oil and gas sub-sectors. Energy infrastructure is largely provided by a combination of state-owned enterprises and private businesses. The main components of energy infrastructure are:

- Oil and gas extraction facilities in Taranaki
- The Marsden Point oil refinery
- Oil and gas transmission pipelines, storage facilities, port transfer terminals, and gas reticulation networks
- Electricity generation plants, including hydro, thermal, geothermal and wind
- High voltage electricity transmission and lower voltage distribution networks

The oil and gas sub-sectors also depend heavily on international and domestic transport for importing crude oil and distribution of final products.

5.1 Key characteristics of the sector

5.1.1 Electricity Supply Network

Electricity supply networks such as New Zealand are conventionally split into generation, transmission, distribution and retail:

- Generation: converts energy such as gas, coal, oil, wind, hydro, solar into electrical energy;
- Transmission: takes the electrical energy from the generators and transmits it in bulk to large industrial users and distributors;
- Distribution: operates a reticulation “wires” network to consumers.
- Retail: sell power to consumers over the reticulation network

The transmission and distribution components are natural monopolies whilst generation and retail elements operate in a competitive market. Even though retail consumers are supplied by their respective distribution company, they typically have a choice of retailers and these retailers act competitively to increase revenue and profitability.

In general, the output of generators cannot be stored and therefore supply and demand must be matched in real time. In simplistic terms the output of generators is controlled minute by minute by the market operator\(^\text{27}\) based on forecast demands for the day ahead and price of power bid into the market by the generation companies.

\(^{27}\)The physical wholesale market is managed by Transpower in its role as System Operator.
5.1.2 Oil and gas supply

Resources and Exploration

The energy supply and economic importance of natural gas and has grown rapidly since the first commercial discovery at Kapuni in 1959. This discovery led to increased exploration activity and further major gas finds. LPG and gas liquids are also produced in small quantities but so far there has been relatively little economically recoverable oil. New Zealand currently produces all natural gas consumed within the country and exports gas-based products, the most notable of which is methanol.

The approach to oil and gas in future appears to be in attracting exploration and production in oil and gas facilities to NZ in the first place. The number and quality of exploration permits tendered will determine the future interest of the international companies to invest.

NZ has more than adequate reserves for its domestic and energy use but it is important to focus on the exportability of product whether in the form of crude oil as in the Maari field or as Methanol as produced by Methanex. Another future draw card will be the possibility of finding a suitable source of gas to develop an LNG plant for the export of LNG. This is a real possibility with existing blocks being explored in the Canterbury Basin (Anadarko) and the Great South Basin (Shell/OMV).

Oil and gas exploration permits and (at a later stage when resources are proved) mining permits are issued to local and overseas companies by the government agency New Zealand Petroleum and Minerals (NZPM).

Production facilities

Existing major production facilities are:

- Maui and Kapuni – Operator : Shell Todd Oil Services (Natural Gas, LPG)
- Maari – Operator : OMV (Oil)
- Pohokura – Operator : Shell Exploration New Zealand Ltd. (Natural Gas)
- McKee Mangahewa - Operator : Todd Energy (Natural Gas, LPG)
- Kupe : Operator – Origin Energy (Natural Gas, LPG, Condensate)

Oil Refining

While some oil is produced from NZ wells the country is substantially reliant on imported crude. The NZ Refining Company operates the country’s sole refinery at Marsden Point, supplying all of NZ aviation fuel demands, 80% of diesel and around 50% of petrol demand. The remainder is made up of refined product imports. The refinery is owned by the big four “downstream” petroleum companies in NZ: Z Energy, BP, Chevron (Caltex) and Exxon Mobil.
The refinery is some 50 years old but has been upgraded to meet recent international environmental standards for sulphur content in diesel and benzene in petrol. The refinery has also recently approved a further project to increase capacity.

**Bulk Oil and Gas Transmission and Distribution**

A single oil products pipeline between Marsden Point and Wiri in South Auckland is used for bulk distribution to the Auckland region from where it is distributed by road to retail outlets and users with their own tank storage. Products are pumped along the line in separated batches and the pipeline is approaching capacity. Apart from any resilience risk if the pipeline were damaged, if capacity is exceeded then either a second line would be required (a major investment) or product transported south by road or rail. Oil products are also distributed to other parts of NZ by coastal shipping.

The North Island has a network of natural gas transmission pipelines operated by Vector Limited, a monopoly with operational guidelines established through legislation. The most important is the bulk gas pipeline which runs from Taranaki to South Auckland, again a single direct line with associated disruption implications if damaged or otherwise unserviceable.

A number of energy companies (Contact, Meridian, Genesis etc.) operate the urban gas reticulation networks in the larger centres in North Island. These energy companies also distribute and sell electricity. The gas transmission network servicing the Auckland region also has a capacity constraint which would need to be considered under any future gas supply expansion in the region needs to take account of these factors.

**Gas Users**

The major gas users are:

- **Power generators** – for example the Genesis Huntly E3P gas fired station. The gas-fired stations are used for covering electrical power demand peaks and at times when hydro flows need to be conserved.

- **Petrochemical Plants:**

  *Methanol* - Methanex NZ is the largest gas user in New Zealand and provides impetus for further exploration and development of gas fields at present. Methanol is exported to China and South East Asia from New Plymouth and methanol price/demand directly affects production rates.

  *Urea manufacture* - The Ballance facility converts natural gas to ammonia and urea fertiliser. All production is for local consumption.

- **General industrial and domestic consumption** – in those centres where there is existing gas reticulation. These are centres to which it was found economic to construct bulk natural gas pipelines, at the time when natural gas was substituted for the older coal gas technology.
5.1.3 The statutory framework for energy supply and pricing

**Electricity**

The regulation of the electricity market in New Zealand is the responsibility of the Electricity Authority (formerly the Electricity Commission) whilst the electricity lines businesses, including Transpower and the distribution lines companies, are regulated by the Commerce Commission.

The statutory framework has been evolving since 1987 and the current legislation is the Electricity Reform Act 1998 which splits the industry into distinct separate parts namely generation, transmission, distribution, retail, consumers and regulation.

Overall the New Zealand Electricity Authority is responsible for the management of the electricity industry, while Transpower as System Operator manages the electricity system in real time to ensure generation matches demand. Policy and governance is managed by the New Zealand Government and several Crown entities, including the Ministry of Economic Development (now the Ministry of Business, Innovation and Employment), the Commerce Commission, and the Energy Efficiency and Conservation Authority.

Prior to regulatory reforms of 2009 the Electricity Commission (EC) issued a bi-annual Statement of Opportunities (SOO) pursuant to part F of the Electricity Governance Rules 2003 (Rules). The SOO looked at a far greater time horizon (30 years) than Transpower’s Annual Planning Report (10 years). The last SOO was issued in 2010 and under regulatory reforms the Ministry of Economic Development (now MBIE) took over responsibility and replaced the SOO with a new document, Electricity Demand and Generation Scenarios (EDGS). The draft EDGS 2012 has yet to be formally published.

**Gas**

The Gas Industry Company (GIC) was established in 2004 under Part 4A of the Gas Act 1992 as the gas industry’s approved co-regulatory body. The GIC works with Government and industry to develop recommendations on industry arrangements that meet the objectives of the Act and the April 2008 Government Policy Statement on Gas Governance, which forms part of the Government’s wider New Zealand Energy Strategy.

The GIC is owned by industry shareholders and is funded by a levy on industry participants. It is incorporated as a company under the Companies Act 1993 and is governed by a Board comprising a majority of Independent Directors as well as Industry-Associated Directors. Its regulatory oversight encompasses the natural gas wholesale and retail markets, processing facilities, and the transmission and distribution sectors of the industry. It does not have regulatory involvement in the upstream gas exploration and production sector, although a number of producers are also wholesale market participants. It also has not been required to extend such arrangements to the LPG sector.

The GIC works with other regulatory bodies with gas industry responsibilities:
Ministry of Economic Development (now MBIE)

- The safe supply and use of gas (Energy Safety Service)
- Monitoring and overseeing the co-regulatory model of gas governance
- Consumer protection (Ministry of Consumer Affairs)

Commerce Commission

- Enforcing competition, fair trading and consumer credit legislation
- Implementing a price-quality regime for gas pipeline (transmission and distribution) services and the associated information disclosure regime

In recognition that they share common interests in the gas industry, on 5 August 2011 The GIC and the Commerce Commission entered into a Memorandum of Understanding setting out how they will coordinate their respective roles under the Gas Act 1992 and the Commerce Act 1996. Liaison is also maintained with the electricity regulator, the Electricity Authority, in areas of mutual interest.

5.1.4 Factors influencing energy supply and demand

Unlike other infrastructure sectors, oil and gas production and consumption is strongly influenced by international price and supply factors and also by electrical energy supply with which oil and gas compete in the domestic energy market. There are a number of other factors related to the configuration of the energy production and supply network that result in regional variation in availability and future growth constraints.

These factors include:

- *The gas price relative to electricity* - at present prices gas is a cheaper option for some domestic uses, e.g. present gas costs for heating are $0.08/kwh versus $0.22/kwh for electricity\(^{28}\).

- *Gas transmission constraints* - the northern section of the bulk gas pipeline, owned and operated by Vector, has a capacity constraint for customers in the Auckland/Hamilton and Whangarei regions which affects future market growth.

- *Demand for methanol as an automotive fuel* – modern cars are able to run on petrol/methanol (and petrol/ethanol) blends. Car manufacturers are responding to growing demand in some countries, in particular China. This holds the possibility of greatly increasing the export market for methanol and potentially in NZ as the vehicle fleet becomes compatible. In turn this could increase the uses and competition for NZ natural gas.

- **Gas firing for power generation** - this is mainly for serving peak demand in NZ, particularly in dry years.

- **World crude oil prices** - influence the cost of petrol and diesel and have a flow on effect on vehicle usage. Currently standing at around $100/bbl, the range of $150 to $200/bbl is recognised as the price range at which wide scale substitution by other energy forms will become viable.

- **Gas extraction technology and price impacts** - horizontal drilling and pressurised fracturing (“fracking”) technology in gas bearing strata has greatly increased the gas available at low cost (e.g. $4/GJ for shale gas in the USA in comparison to current LNG prices of $15/GJ). This will have a significant influence on the gas exploration and development appetite of major international players.

- **Availability of local oil and gas reserves** - the attractiveness of NZ in relation to exploration and development relative to other countries is an important factor. NZ is a remote destination and thus needs proactive support from government for exploration activities. The need for constant opening up of new exploration permits is important to retain interest of international companies in NZ. As well as conventional drilling, potential for viable gas supplies onshore using horizontal drilling and fracturing are changing the picture of NZ gas and oil exploration.

- **Domestic markets for cheaper gas** - Gas as a resource is not a “must have” for a country. However, cheap gas availability opens doors to cheaper manufacturing solutions and industries such as petrochemical production which in New Zealand’s case forms an important part of GDP as well as export earnings.

### 5.1.5 Energy Demand and Supply Management

The generation of electricity is governed by available energy resources (such as coal, gas, oil, wind, hydro, tide, solar and geothermal) and the total capacity, that is the number and rating of power stations to convert the energy source into electricity.

Electrical energy cannot be stored in bulk in any economical way using commercially available technologies and therefore supply and demand must be balanced in real time. This means that there must be sufficient capacity (the number and rating of power stations) plus an adequate margin to cover plant failure and maintenance to cover demand at any instant in time.

Apart from a few special exceptions power stations cannot start instantaneously from cold and therefore there must always be an adequate margin of idle spinning reserve (hot standby) to cover for sudden loss of generators on the system and sudden increases in load e.g. “TV pickup” during major events.

The total available installed capacity must therefore meet the maximum demand plus adequate reserves and likewise energy must be available at the power stations to be able to meet the maximum demand.
On the demand side the load profile, that is the total demand at any instant in time, varies considerably on a daily, seasonal and geographic basis.

Typically daily demand peaks occur in the morning as people arrive at work and in the afternoon. Seasonal peaks can be either summer or winter depending upon whether the load is predominantly heating or air conditioning. In recent years summer peaks have become more prevalent due to the increase in uptake of air conditioning.

During the night time, demand is typically considerably lower than the daytime and this disparity in the peak and minimum demand causes inefficiency due to the generating plant being idle much of the time and some plant only earning revenue for very short windows.

This inefficiency can be a substantial barrier to investment in new plant that may be required as demand increases over time and various strategies have been attempted such as tariff structure and off peak heating to reduce peaks and flatten out the demand profile such that generating plant is run efficiently and earning revenue for as much of its life as possible.

All these factors influence the price that generating companies bid into the market. The System Operator chooses the lowest prices bid that will satisfy the demand and the costs then flow through via the retailers of electricity and eventually to the consumers.

There is now increasing focus on smarter and more efficient ways of using the available generation, transmission and generation capacity to match the demand profile, which involves optimising the use of the assets without a loss in service performance.

Examples of the initiatives in place are dynamic rating of transmission lines to increase transmission capacity when environmental conditions permit, demand management strategies to flatten out peaks in demand, use of latent embedded generation capacity within large commercial and industrial consumers and domestic solar generation.

While there are feed-in tariffs available for those with on-site generation, a particular trend is the use by large-site consumers to use on-site generation during peak period to reduce the load from the distribution network, for which the consumer is then reimbursed.

The traditional differential charging for peak versus off-peak power continues in some areas however the greater potential in demand levelling may be in smart metering.

One result of demand and supply management strategies is to increase the unit of GDP achieved per unit of electrical energy supplied.

5.2 Relationship to welfare

As noted above, welfare generated by energy infrastructure is entirely indirect, as energy is used to facilitate other activities. This includes the production of goods and
services, as well as accumulation of other types of capital. Negative externalities are also a relatively significant consideration.

5.2.1 Better use of existing infrastructure

Given that energy is primarily an input to other processes, welfare from energy infrastructure will increase if it is produced in a lower cost, more efficient manner, and is more reliable. Indicators of better use of existing infrastructure could include:

- Reliability and/or failure rates
- Energy costs per unit
- Price/cost alignment
- Energy production productivity measures
- Utilisation rates of energy assets

5.2.2 Better allocation of new investment

Indicators of the allocation of new energy investment could include:

- Return on capital
- Rate of adoption of new technologies
- Impact of new investments on reliability or resilience of energy infrastructure
- Efficiency of investment and regulatory processes
- Extent of barriers to uptake of new energy sources and resources
- Energy demand forecast accuracy

5.3 Existing Data Sets and Indicators

5.3.1 Electricity

Operational data, particularly pricing and efficiency measures are important to stakeholders. Planning data is required to provide accurate, transparent signals to stakeholders, providers and users alike, to underpin investment plans.

- **Lines Company Asset Management Plan** - all 28 distribution companies (also known as lines companies) are natural monopolies and are regulated in lieu of natural competition. Amongst the requirements placed upon the lines companies is an obligation to publish an annual asset management plan\(^\text{29}\) which

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\(^{29}\) The purpose of the AMP is to comply with requirement 7 of the Commerce Commission's Electricity Distribution (Information Disclosure) Requirements 2008.
is a comprehensive document including 10 year forecast of capital expenditure to meet expected demand.

- **Lines Companies Reliability Reporting** - are also required to maintain and publish reliability information, including internationally recognised measures:
  - SAIDI (System Average Interruption Duration Index): the length of time in minutes that the average customer spends without supply over a year; and
  - SAIFI (System Average Interruption Frequency Index): the number of sustained supply interruptions which the average customer experiences over a year.

The data exclude low voltage, transmission and generation related events and are measures of efficiency in the context of operation of the network and indicators of where assets require renewal/reinforcement/maintenance.

- **Transpower Annual Planning Report** - Transpower Ltd, as owner, operator and planner of the national transmission grid, plays a pivotal role in the New Zealand power supply and since 2006 has issued an Annual Planning Report\(^{30}\) (APR) which provides comprehensive information including demand and generation forecasts for the next 10 to 15 years. The APR is not a regulatory requirement upon Transpower\(^{31}\) but nonetheless provides a comprehensive source of data to help interested parties come to decisions such as when to retire generation or when and where to invest in new generation or new industries.

The UK equivalent of the APP is the “Electricity Ten Year Statement” (ETYS) and the National Grid (NG) in the UK has a mandatory duty to produce the ETYS to a specific format. In order to provide consistent and dependable performance indicators in the New Zealand power sector consideration should be given to agreeing with Transpower to publish the APR in a defined format and an obligation for electricity market participants to supply information in a defined format.

- **Ministry of Business Innovation and Employment** – MBIE’s Energy Data File publishes generation and consumption data on a quarterly basis which identifies generation by different types of generation, and consumption by different categories of consumer.

- **Generators’ Annual Reports** – each generator publishes annual reports which detail the amount of electricity produced and costs and margins in producing

\(^{30}\) [https://www.transpower.co.nz](https://www.transpower.co.nz), Transpower Annual Planning Report

\(^{31}\) Unlike the United Kingdom where there is a licence obligation upon the Grid Operator to publish a 10 year plan based on prescribed mandatory inputs from electricity participants.
this. Energy costs per unit can be derived from gross production divided by gross costs. A measure of the productivity of energy generation assets can come from ROI figures.

- **Lines Companies Annual Reports** – information on financial performance.
- **Commerce Commission** – data on industry financial performance.

### 5.3.2 Oil & Gas

Oil and Gas players are all public or private companies many of which are controlled by overseas interests. Generic data is available but in many cases data such as cost of production is confidential due to the competitive nature of the market.

The following are key sources of information for the Oil and Gas industry.

- **The Gas Industry Company** - provides information regarding latest legislation governing the gas industry as a whole.
- **NZ Petroleum & Minerals** – data on oil and gas exploration permits and information on oil and gas production permits.
- **Ministry of Business Innovation and Employment** – MBIE’s Energy Data File publishes information on oil and gas production, gas and petroleum product consumption data on a quarterly basis MBIE Energy Data File
- **Statistics NZ** – publishes Energy Use Surveys for different sectors.
- **Refining New Zealand Annual Report** – This report together with regular news updates provides data relating to the refining industry in New Zealand and usage of the Refinery to Auckland Pipeline
- **International Comparative Data** – e.g. BP Statistical Review of World Energy – There is international data available provided by oil and gas companies, service companies, accounting firms and various petroleum interest groups.
- **Petroleum Exploration and Production Association (PEPANZ)** - is an incorporated society, operating as a trade association, which promotes the interests of petroleum producers and explorers in New Zealand.

### 5.4 Review and Discussion of Potential Indicators

#### 5.4.1 Pressure Indicators

Apart from the general pressure indicators applying to infrastructure, the following are specific to the energy sector:

*Demand pressure indicators*

- **Energy retail prices and change** - in real terms for gas, petrol, diesel and electricity using the CPI all groups as a deflator – as a demand indicator for retail energy
and as an indicator of cost efficiency of energy retail supply (desirably energy prices should not rise above the general rate of inflation)

- **NZ gas price relative to electricity** – either wholesale or retail price ratio in $/GJ to indicate the propensity for switching between gas and electrical energy for domestic and industrial use.

- **International oil and gas price relativity** – ratio of a recognised price of crude oil (Brent, West Texas or, more relevant to NZ supply, Tapis crude) to international LNG price, as an indicator of the propensity for energy switching by users (such as vehicle fleets)

- **International demand/price for methanol** – affecting demand for natural gas use in the Methanex plant

- **Percentage breakdown in demand for oil products** - (avgas, avtur, regular and premium automotive gasoline, automotive and marine diesel oil, light, medium and heavy fuel oils) – as an indicator of changing energy demand mix and potential need for changes to refinery configuration and balance of imported versus locally refined products

- **Rate of uptake of new technologies** – conversion rate of the NZ vehicle fleet to electric, hybrid and methanol powering, expressed as growth rates of numbers of licensed vehicles by motive power the percentage of the fleet total; as an indicator of changing form of energy end use in the road transport sector

- **Changes in gas and electrical energy demands** - by industrial sector (or a selection of key sectors) particularly the Bluff Aluminium Smelter

- **Changes in energy demand per head and per household** – indicating the changing efficiency of energy utilisation in the residential sector

**Supply pressure indicators**

- **Oil and gas upstream permits and exploration** (somewhat related to permit availability and the international market for deploying rigs)

- **New generation** - (including geothermal) that displaces current serviceable generation

### 5.4.2 State Indicators - Electricity

**Better use of existing infrastructure**

- **Service levels and reliability** – SAIDI and SAIFI indexes and the extent to which infrastructure delivers service and reliability against targets set by the Electricity Authority. Greater reliability corresponds to greater welfare as there will be fewer periods when service is unavailable.

- **Utilisation rates** - of energy assets (higher utilisation corresponds to higher welfare from existing infrastructure, everything else equal):
  - generation plant capacity versus peak demand (assuming a suitable reserve capacity to deal with incidents and drop-outs).
Hydro storage levels – sufficient storage (greater than minimum) gives flexibility in the use of generation plant and transmission infrastructure.

Transmission capacity versus peak demand at bottlenecks.

- **Energy cost/unit** – generation cost/unit; transmission cost/unit; distribution/retail company costs;
- **Price/cost alignment** – relationship between the average cost per unit sold related to average cost per unit produced by generators. Alternately this could also include costs for transmission.
- **Residual life of assets** – age of major assets since first construction or major rehabilitation compared to the expected design life for that asset type. In general where an asset has exceeded its relevant design life this reduces welfare through higher likelihoods of failure and investment required.
- **Resilience** - (e.g. Cook Strait DC Link) degree of interconnectedness / redundancy. While the principle of avoiding failure in key links is understood, it is difficult to define a quantitative indicator that well represents resilience.
- **Productivity of energy assets** – Total amount of electricity produced divided by the total cost (including return on capital and generation operating expenditure).
- **ROI** - for generators, transmission and distribution lines companies. The Crown Ownership Monitoring Unit collects this information for generators.
- **Environmental performance** - CO2 emitted per unit of energy generated; breaches of environmental consent conditions (e.g. max/min river flows and lake levels; run-off from geothermal.); medical and lost time injuries within transmission sector.

**Better allocation of new investment**

- **Energy demand forecasting accuracy** - as reported by Transpower in APRs
- **Trend in ROI** (albeit influenced by dividend requirement and commerce commission)
- **Trend in system reliability** - SAIFI, SAIDI indicators

### 5.4.3 State Indicators - Oil and Gas

**Better use of existing infrastructure**

- **Utilisation rates of energy assets** - Volume versus capacity for infrastructure network: oil refinery, oil and gas transmission pipelines.
- **Cost of energy/unit** – oil and gas (includes capital and operating costs)
- **Price/cost alignment** – relationship between the average cost per unit sold related to average cost per unit produced by refinery.
- **Productivity of energy assets** – Output of refinery versus costs; output of gas network versus costs.
• ROI - for refinery, Vector.

• Residual life of assets – age of major assets since first construction or major rehabilitation compared to the expected design life for that asset type. In general where an asset has exceeded its relevant design life this reduces welfare through higher likelihoods of failure and investment required.

• Environmental performance – major environmental breaches (land or marine).

**Better allocation of new investment**

• Exploration - amount of confirmed oil and gas prospects.

• Trends in reliability - of oil and gas transmission / distribution network

• Trend in ROI - for Refining NZ, Vector (gas network)

• Forecasting accuracy - of energy demand

### 5.4.4 Response Indicators

**Infrastructure investment - Electricity**

• Annual capital expenditure per unit supplied on:
  - Power generation (Generation companies annual reports)
  - The national grid (Transpower annual report)
  - Distribution lines (lines companies annual reports)

• Measures from the Commerce Commission regarding an acceptable ROI

**Infrastructure investment – Oil and Gas**

• Capital expenditure on:
  - gas transmission (Vector Gas financials)
  - gas Distribution (financial statements made under the *Gas Regulations* 1997)
  - oil refinery and product pipeline to Wiri

• Measures from the GIC; reporting against key regulatory projects.

• Government licencing for prospecting / extraction; exploration grants given / fields explored (MBIE Energy Data File)

**Government regulatory intervention**

• Government financial incentives (including taxation effects)

• Government regulatory intervention (including effects of RMA changes)
6 Water

6.1 Key characteristics of the sector

In New Zealand, urban water infrastructure is largely owned by the communities served by them, and operated and administered through their respective local authority. The urban water infrastructure includes drinking water supply, wastewater and stormwater services supporting business, industrial and residential needs. Much of the existing water supply and wastewater infrastructure was installed in the 1960s-1980s with subsidies provided by central government. With the exception of limited funding that is currently being provided by central government for deprived communities for the upgrading of community water supplies and sewerage, no other subsidies are available for capital development.

Productive water infrastructure includes infrastructure required for productive activities including irrigation, hydro-generation, agro-processing, rural domestic supply and stock water. This infrastructure is in mixed ownership including Central Government (SOEs), Local Government, individual, community and company ownership. In this section we concentrate on urban water (water supply, wastewater and storm water) and rural water for agricultural use (excluding water to rural households and ancillary uses). Water used as a resource for hydro power is covered under Energy Infrastructure.

6.1.1 Urban Water Supply Infrastructure

Ownership and administration

Local authorities (regional, unitary, city and district) have responsibilities for urban water services. Regional council responsibilities for water include:

- Sustainable regional well-being
- Managing the effects of using freshwater, land, air and coastal waters, by developing regional policy statements and the issuing of consents
- Managing rivers, mitigating soil erosion and flood control
- Harbour navigation and safety, oil spills and other marine pollution.

The Wellington region is a special case with the Greater Wellington Regional Council having responsibility for harvesting, treating and delivering drinking-water to the four City Councils for distribution via their networks (a wholesaler/retailer-type split). Auckland is also a special case with the Council-controlled Organisation Watercare Services Ltd providing all water and wastewater services (but not stormwater).

Territorial Authorities (city and district and councils) responsibilities for water include:

- Sustainable district well-being
• The provision of local infrastructure, including water, wastewater and stormwater services
• Environmental safety and health, building control, public health inspections and other environmental health matters
• Controlling the effects of land use, noise and the effects of activities on the surface of lakes and rivers.

Six of the territorial authorities – Auckland Council, Nelson City Council, Gisborne, Marlborough, Tasman District and the Chatham Islands are unitary councils, which mean they also have the powers of a regional council in respect of the RMA.

**Asset Management Plans**

Investment and expenditure by the various Councils is covered by the provisions of the *Local Government Act 2002* (LGA). Councils are required to prepare Asset Management Plans (AMPs) for all assets including water, wastewater and stormwater, 10 year Long Term Plans (LTPs) and Annual Plans (APs). Prior to adopting LTPs and APs the councils are required to submit their plans to the Office of the Auditor General for an audit opinion, consult with their communities, invite and consider submissions and then amend the plans if necessary to reflect the communities’ feedback.

The AMPs summarise:

• The age, condition and value of council assets
• Plans to maintain and renew them as they wear
• Levels (quality) of service council expect the assets to deliver e.g. water quality and effluent discharge quality.

The AMPs include a defined methodology for planned maintenance and asset replacement as well as a forecast of the expected costs to maintain and replace the assets. Any potential changes in the external environment such as population growth or changes in legislation that may impact on the services in the future are also considered. The documents are reviewed cyclically (typically at least every three years) to ensure they remain relevant.

The AMPs are used extensively to prepare the LTPs and APs. The LTP, which prior to 2012 was called the Long Term Council Community Plan (LTCCP), sets out a council’s priorities, activities and funding over a 10 year period. AMPs provide information on the council’s budget and plans for the year, and explain any variations from the LTP; the APs must be adopted before the commencement of the year in which they operate.

It is in this context that the urban water supply infrastructure must compete against all other council activities for funding.

**Key infrastructure components**

The key components of urban water infrastructure are:
• The water gathering and abstraction system - water sources, including dams, groundwater wells, or river intakes (often with pumping stations)
• Treatment plants to make the water suitable for drinking (potable)
• Water distribution networks of reservoirs and pipes (often with pumping stations) connecting households and businesses
• Wastewater networks, treatment plants, and disposal systems
• Stormwater collection and disposal systems.

Note that there are a number of rural water suppliers owned by Councils which supply stock and domestic water only (not water for irrigation).

6.1.2 Productive (Agriculture) Water Infrastructure

With the exception of infrastructure that is held in public ownership by central Government (e.g. SOEs) or Local Government, and that must comply with the associated regulatory requirements (e.g. the LGA), there is little visibility of the water infrastructure serving the agricultural sector, much of which is privately owned and operated. This includes information on asset funding, condition, operation, and maintenance.

The scale, complexity and capital requirements of regional scale irrigation and rural water infrastructure proposals require third party investment and often multiple investors. High standards of commercial governance are required. Return on investment needs to accrue to both infrastructure investors and the irrigating farmers.

The key components of productive (agricultural) water infrastructure are:
• The water gathering and abstraction system - for example dams, groundwater wells, or river intakes (often with pumping stations)
• Treatment plants (these are often absent or very rudimentary)
• Water distribution networks of reservoirs and pipes (often with pumping stations) providing water to the farm gate
• On-farm irrigation infrastructure including tanks, border dyke systems, flood, or piped systems (e.g. spray, dripper etc.) and micro irrigation.

6.2 Relationship to welfare

As noted above, water infrastructure provides a mix of direct welfare and indirect facilitation of other activities. The quality of water and wastewater treatment can be measured and is relevant as well as the quantity consumed.
6.2.1 Better use of existing infrastructure

Indicators of better use of existing infrastructure could include:

- The cost of water and wastewater services
- Reliability of services, including interruptions, wastewater overflows
- Productivity measures in water services

6.2.2 Better allocation of new investment

Indicators of better allocation of new water infrastructure investment could include:

- Coverage and availability of water and wastewater services relative to demand
- Changes in quality of potable water and wastewater treatment
- Rate of adoption of new water and wastewater treatment technology
- Water demand forecast accuracy

6.3 Existing Data Sets and Indicators

6.3.1 Water – Urban

Satisfying Selection Criteria

With the multiplicity of asset owners of water infrastructure, as well as the lack of a comprehensive regulatory framework in the water sector, there are no easy ways of satisfying the primary selection criteria for indicators of:

- Data availability and quality, and
- Cost effectiveness

Nor to the secondary criterion of:

- Comparable across jurisdictions and sectors

Two Government Initiatives

There are two government initiatives that could in time provide a basis for the development of suitable indicators. The first of these initiatives is the Local Government (Financial Reporting) Regulations 2011, which arose out the amendments to the Local Government Act in 2010. These regulations are intended to provide a consistent basis for financial reporting by Councils, thereby potentially allowing for the development of some financial performance indicators.

The Schedule to the Regulations provides the form for reporting in long-term plans, annual plans and annual reports. Forms are provided for reporting both “whole of
“Council” and “group of activities”. Potential line items that could be used in the development of performance indicators are:

- Sources of operating funding: Fees, charges, and targeted rates for water supply
- Sources of operating funding: Total operating funding (for each activity – water, wastewater, and stormwater)
- Applications of capital funding: Capital expenditure (for each activity – water, wastewater, and stormwater): (i) to meet additional demand; (ii) to improve the level of service; and (iii) to replace existing assets.

The second government initiative is the development of mandatory non-financial performance measures for five local government services – water supply, sewerage, stormwater, flood protection and roads/footpaths. These are due for implementation in the 2015 Long Term Plans. A draft of the indicators has been prepared by the Department of Internal Affairs (DIA) and has just completed consultation.

In September 2012 Beca provided input to an earlier draft of the performance measures. In relation to the performance measures for water supply and sewerage, we advocated the use of as many of the measures as possible from the National Water Commission in Australia. Our view was that by using as many of these measures as possible, it would overcome one of the significant disadvantages of developing performance measures from scratch; i.e., that they may be open to a wide range of interpretations that does not become clear until they start to be used. The other advantage of using the NWC measures is that it will enable the public to compare its Council with a much larger pool of Councils/Water Authorities across the Tasman.

A brief check has been made of the current DIA drafts for water supply and sewerage and it appears at least some of the indicators that are finally developed should be able to be used as NIP performance indicators, either directly or combined with other readily available data.

**Other Data Sources**

As part of its normal asset management and financial reporting, Councils undertake periodic valuations of their infrastructural assets by asset type. If this information was combined with the capital expenditure data, and perhaps also with population or household numbers, an indicator could be developed that showed the efficiency of use of the infrastructure, and whether the level of ongoing capital investment was sufficient.

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33 The NWC publishes the National Performance Framework: Urban performance reporting indicators and definitions handbook. These measures are widely used in Australia, and the document is “revised every year to ensure definitions, calculations and examples of indicators are consistently interpreted and applied”. 

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6.3.2 Water – Productive (Agriculture) Rural

For water provided to the productive (agriculture) sector, the diversity of ownership and the absence of a regulatory framework (as for the urban sector) means there is a lack of data available. The diversity of ownership also means that the data is held in many places and any data that is available is unlikely to be homogeneous.

Some data is available from the Statistics NZ Water Physical Stock Account as part of its environmental accounts for several natural resources. The data covers drinking water by livestock type (dairy cattle, beef cattle, sheep and etc.) and also for dairy shed water requirements. This data is produced from livestock numbers (from Statistics NZ Agricultural Production Survey for MPI) and an industry consensus on reasonable usage/head/day. The data does not therefore present actual use.

For the water used in irrigation, only allocations are known, not actual use. The 2010 amendment to the RMA requires all water users to meter their abstractions, with a phased introduction between 2012 and 2016. In time, this data could be used as the basis of a performance indicator.

The Statistics NZ Agricultural Production Survey collects and reports extensive data on production by crop and animal type.

The importance of rainfall in NZ agriculture means that any indicator that links irrigation water use to crop or animal production needs to take account of actual rainfall during the reporting year.

6.4 Review and Discussion of Potential Indicators

6.4.1 Water - Urban

Potential Pressure Indicators

Below are potential indicators for pressure on water infrastructure. These are in addition to the generally applicable indicators in Section 2.7.

Pressure indicators for water need to reflect the importance of place, that each supply and wastewater system is a separate network supporting a particular area. The fact that there are over 2000 individual community water supplies, and approximately 336 municipal wastewater treatment plants in New Zealand, means that any pressure indicator must consider the pressures on each specific system. Indicators could then be summarised as national means with range, top percentile and/or standard deviation to show the variation in demand pressure across the country.

34 Source: Drinking Water for NZ: http://www.drinkingwater.esr.cri.nz/
35 Source: NZ Wastewater Information for New Zealand Database (WINFO), http://www.winfo.org.nz
The following has been written in relation to water supply, but similar considerations apply to wastewater, which is generally funded from property rates but in some cases is charged on a line and volume charge basis as a fixed proportion of the drinking water consumed (e.g. Watercare, Auckland)

*Demand pressure indicators – water supply and wastewater*

- **Growth rate in population (for each system, or for a representative sample of systems)** - with the large number of water supplies and dispersed information on the populations served and rates of growth it is difficult to get a good picture on the demand side pressures. The data that is held is managed by ESR for the Ministry of Health and it is for regulation rather than planning purposes. To accurately quantify the water population catchments requires analysis at census mesh block level. The limited coherent information on demand across urban water supplies was a driver for the Audit Office’s interest in the sector. It would be desirable to either require information from TLAs on basic demand characteristics of their supply areas, including residential population, households and commercial and industrial users.

- **Changes in water intensive industry (wet-industry) activity** – available water supply can act as a constraint on water-intensive industry establishing in a particular area; likewise the closure of a wet industry can have a significant effect on demand on existing resources. Knowledge of the development needs and intentions of these industries, particularly if sited in smaller urban areas would be useful for planning purposes. There is doubt that this information is publicly available.

- **Changes in technology** – water supply is a mature technology and there is limited scope for new innovations or major improvements in appliance efficiency. However, changes in utilisation are more likely to be driven by water metering. Auckland (as served by Watercare Services Ltd) has universal metering, serving a population of 1.3 million. Outside Auckland there are about ten Councils who have adopted universal metering and volumetric charging in whole or in part of their jurisdictions. The number of people served by these universal metered supplies outside of Auckland totals about 250,000. This means that about 40% of the population served by community water supplies in New Zealand are metered. So an indicator of the progress of introduction of metering and payment on a connection and volumetric basis rather than as a flat rating charge would be a possible indicator.

- **Changes in water use by residential and industrial consumers** – per capita consumption of water does not change markedly over time, and population is usually a sufficient indicator of future demand. Again, the introduction of metering is the most likely driver of change in consumption of mains supplies.

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36 Fraser K M, 2012. “Urban Metering – The quest to measure how much water is being used, and also being lost” Water, No. 176, September 2012.
• **Cost/pricing sensitivity** - as a minority of consumers are metered, water for the majority is effectively a free good apart from the flat rating charge. In times of supply shortage, operators go straight to supply restrictions such as sprinkler or hosing bans. However, for metered supplies, it would be useful to better understand the demand response to price increases for planning purposes. Data on cost per unit versus consumption is available from the metered systems to allow such an analysis, but as meters are only read quarterly or 6 monthly this data does not pick up demand peaks at an individual consumer level.

**Demand pressure indicators - stormwater**

• **Urban stormwater disposal** – the main demand drivers are rainfall intensity, and area of impermeable surface where run-off is directed to the stormwater system rather than to ground soakage. Increase in the urban land area connected to the stormwater system is a potential indicator (so that a greenfield expansion adds to demand whereas urban intensification has less demand effect)

**Supply pressure indicators**

• **Reservoir storage capacity, and river abstraction or groundwater capacity** – natural water is either collected from rainfall run-off in water supply dams or extracted from natural waterways or groundwater prior to treatment and distribution. The degree of water allocation from surface water catchments and groundwater systems is a potential indicator, and could be categorised, say, into less than fully allocated, fully allocated, over-allocated and heavily over-allocated. This would highlight where there are likely to be difficulties in meeting increased demand.

**Potential State Indicators**

**Better use of existing infrastructure**

The non-financial mandatory indicators that are being developed by DIA, together with other data as appropriate, could form the basis of performance indicators such as:

• Water supply:
  o **Quality** - Compliance with NZ drinking-water standards; the data are available from MoH on national basis. A national indicator of percentage of the population receiving urban drinking water supplies that achieve the standard.
  o **Efficiency** - Extent of water losses as being developed by DIA
  o **Reliability** - response time for faults in the system. The standard could involve the number of reported faults, the time to first response and the time to reinstate the supply. At present there are differences in how this performance data is treated between local authorities. The DIA is attempting to standardise reporting. A difficult is that the size of impact may not be included in the indicator so a small fault may be given the same weight as one with more widespread effect
- **Productivity** - cost/litre of supply would be an appropriate indicator. The DIA is proposing an indicator for average consumption of water per person per day, which together with the metrics in *Financial Reporting Regulations 2011* could be used as basis of an indicator. To be consistent with other sectors, cost should include operating costs and annualised capital costs.

- **Cost/Price Alignment** – similar observations apply, although the actual costs of supply are available, for many supplies there is no pricing basis as water supply is included within the general rate. However for metered supplies this could be a useful indicator, and as more supplies convert to a universally metered system (e.g. Kapiti Coast District and Central Otago District are currently proceeding to implement universal metering).

- **Capacity Utilisation** – a suitable indicator would be years of demand growth available by supply (the “headroom”) and then aggregate this data across all supplies to give a median and proportion with limited headroom. Such an indicator could be developed but would require some analytical work.

**Wastewater:**

- **Reliability/environmental** – the number of sewage overflow events is an indicator being developed by DIA

- **Quality of service/environmental** - compliance with resource consents measured as the number and type of non-permitted discharges (which may be in relation to volume, location and period). These are often triggered by complaints and self-monitoring is expected in many cases, so the robustness of this indicator may be queried. It would need to be qualified with data on monitoring effectiveness.

- **Reliability/user service quality** - Response time for faults, similar observation apply as for water supply

**Stormwater**

- **Quality** – the number of flooding events each year to habitable floors, measured as the number per 1000 properties in the catchment served. The DIA is developing such an indicator

- **Quality** - compliance with resource consents for discharge from a municipal stormwater system. Carries similar considerations as for wastewater and is an aspirational indicator as many discharges are not consented as they are made under general authorisations that predate the RMA.

- **Reliability** - Response time for faults in the system. Similar considerations apply as for water supply and wastewater.
Better allocation of new investment

- Quality of decision process/use of BCA - completion of a benefit cost analysis or a financial business case for local authority water infrastructure is believed to be the exception rather than the rule. The lack of a national mechanism or process model for developing and approving capital expenditure on water infrastructure contrasts, say, with the roads sub-sector. Schemes can be promoted by TLAs without clear regard to community support, particularly of the funding implications.

The following indicators are suggested as possible surrogates for a BCA but would need to be developed:

- Capital funding for additional demand compared with population and wet industry growth (each activity)
- Capital funding to improve level of service compared with customer satisfaction/level of compliance (each activity)
- Capital funding for additional demand and improved level of service compared with value of assets and population served (each activity)

- Accuracy of forecasting – there is probably insufficient data to construct an indicator, and forecasting accuracy was a matter identified in the Auditor General’s Report on the sector. The headroom data mentioned above, if generally assembled over all TLAs, compared against previous growth forecasts could form a basis for assessing forecasting accuracy

Potential Response Indicators

To produce performance indicators that gave a measure of financial efficiency and performance, the financial statement figures from local government in these categories:

- Sources of operating funding
- Applications of capital funding,

These could be combined in various ways with readily available data on:

- total amount of water produced/supplied (m$^3$) in a year (water supply only) *
- population receiving the service (water, wastewater and stormwater)*
- number of households receiving the service (water, wastewater and stormwater)
- land area (km$^2$) receiving the service (stormwater only*)
- asset management data on age, condition and value.- state indicator – difficult to get into common form for lot of systems; there is a National Asset Management Manual for preparing Asset Management Plans but not reporting format – but is caught up in LTP process in theory

Pricing policy may also be a useful response indicator, for example the proportion of metered households or the proportion facing volumetric charges.
6.4.2 Water, Rural (Agriculture)

Note these exclude rural household / stock water supplies as noted in the introduction to this sector.

Potential Pressure Indicators

Demand pressure indicators

Because of the importance of the agricultural sector to export production, as well as to supplying NZ domestic demand, pressure indicators need to reflect the growth in main agricultural commodities, recognising their water intensity.

- *Agricultural outlook* - MPI forecasts of price and production of main commodities, particularly water intensive uses such as horticulture and in the “high pressure” areas of water shortage.

- *Promoted irrigation schemes* – the larger schemes are backed with business cases and detailed data; the number and extent of these major proposals and the volumes of water involved could form the basis of an indicator. The data would need to be considered regionally and/or by catchment.

- *Irrigation prospects* – the number of irrigation schemes in progress and their size. A drawback is that quite sizeable developments by single farmers will not be caught by this, only those with multiple participants that are publicly known. The number and/or volume of water allocations applied for could be a supplementary indicator.

- *Agricultural land prices* – are highly relevant as a demand indicator, and land becomes more valuable with irrigation potential. Land price could form the basis of an indicator.

- *Changes in growing or processing technology* – for example a change from outdoor to indoor dairying would potentially have a large impact. However it is difficult to devise a general indicator.

Supply pressure indicators

- *External pressures on availability of water resources (over-allocation)* – similarly to water supply. The general regions of water pressure are Canterbury, Tasman, and parts of Hawkes Bay.

- *Environmental constraints* – seasonal and year-by-year climate volatility is the most important variable rather than incremental temperature rise, but systematic increase in extreme events by duration, severity or frequency could form the basis of a longer term indicator.

Potential State Indicators

Better use of existing infrastructure

- Once water metering data is available nationally, and if this can be linked to different crop and animal production, a suite of state indicators could be
developed that linked water inputs to actual production (similar to carbon footprinting). For example, x litres of water to produce 1 L of milk.

**Better allocation of new investment**

- **Quality of decision process/use of BCA** - a possible indicator of investment decision quality could be the number and/or percentage of irrigation schemes supported by a formal business case specifying ROI, particularly if supported by independent review or audit. For each scheme, the ROI itself could also form the basis of an indicator, if rolled up to present a national picture.

**Potential Response Indicators**

**Infrastructure investment**

- **Expenditure** – capital expenditure on productive rural (agriculture) water supply schemes.

**Government regulatory intervention**

- The number of water abstraction requests approved and average quantity of water take, together with the resource consent conditions applied to schemes.
7 Summary of proposed indicators

7.1 Indicator Dimensions

The indicators proposed from the foregoing discussion have been summarised in Table 3.

The choice of recommended indicators has been based on our assessment of providing consistency between sectors and covering the breadth of contributors to national infrastructure performance.

The indicators have been classified into 21 categories (see Table 2). While this has the benefit of both introducing a degree of consistency in indicators between sectors it also shows clearly where indicators are currently aspirational in a sector due to a lack of available or relevant data.

Table 2 – Summary of the Indicator Dimensions Identified

<table>
<thead>
<tr>
<th>Indicator Dimension</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pressure indicators:</strong></td>
<td></td>
</tr>
<tr>
<td>1. Population Growth</td>
<td>Population growth and changes in population demographics are primary influences on demand for infrastructure. This can be measured nationally and regionally.</td>
</tr>
<tr>
<td>2. Economic Activity Growth</td>
<td>Economic activity (per capita) will affect the need to use infrastructure services and the value that people put on these services. Economic activity can be measured directly at the national level and regional proxies such as employment are available.</td>
</tr>
<tr>
<td>3. Activity/Demand Growth</td>
<td>Total activity or the volume of demand can reflect demand pressures, and also supply pressures (e.g. costs). A change in total activity thus can indicate a change in pressure, but must be interpreted in light of other factors.</td>
</tr>
<tr>
<td>4. Input Cost Growth</td>
<td>Input costs (e.g. fuel, labour) will affect the costs of providing services using infrastructure and the welfare that can be generated from the use of infrastructure. Lower costs translate to higher welfare, everything else equal.</td>
</tr>
<tr>
<td>5. Macro-Economic Effects</td>
<td>Other macroeconomic effects (aside from economic activity) can be important in some sectors. For example, prices of imported equipment depend on exchange rates. In addition, exchange rates and economic conditions in New Zealand’s trading partners can affect volumes of exports and imports, which are pressures for some types of infrastructure.</td>
</tr>
</tbody>
</table>
6. **Changes in Technology**

Technology has wide ranging effects on the types of infrastructure services that can be supplied and the cost of building and operating infrastructure. Generic indicators of technology are difficult to define, but at any given point in time the rate of uptake of any particular new technology can be measured in principle.

### State indicators:

7. **Level of Competition (HHI)**

The intensity of competition (in sectors such as electricity and telecommunications where infrastructure services are provided in markets) affects the prices that users face relative to costs and thus the efficiency of use of existing infrastructure.

8. **Safety**

Accidents and safety incidents are costs of using infrastructure. If safety can be improved such that these costs reduce, the welfare generated by infrastructure use will be higher, everything else equal.

9. **Productivity**

Productivity (ideally measured as total factor productivity reflecting the value of all inputs) reflects the output produced per unit of input. Greater productivity translates to greater welfare, as fewer scarce resources are used and can be put to alternative use.

10. **ROI**

Return on investment is an alternative measure of (capital) productivity that is easier to calculate in some cases as it does not require valuing all inputs. Greater return on investment should reflect higher productivity and welfare, provided it is not associated with excessive margins between prices for infrastructure services and costs of provision.

11. **Price / Cost alignment**

If the price of using infrastructure reflects its cost then people will make efficient decisions about using it – they will use it when their benefit exceeds the cost. Closer alignment between prices and costs will therefore increase welfare generated by existing infrastructure.

12. **Asset Condition**

Asset condition generally reflects the need to make future investments in maintenance and renewals. Better asset condition therefore is associated with greater welfare, to the extent this translates to future cost savings.

13. **Quality / Reliability of Service**

Quality and reliability of services provided using infrastructure are attributes that are generally valued by infrastructure users. Improvements in these dimensions will increase welfare, everything else equal.
14. Environmental Performance | Negative environmental effects associated with infrastructure can reduce welfare either through effects on human health or people’s intrinsic value of the environment. To the extent these are not offset by policies such as the Emissions Trading Scheme, an improvement in environmental performance increases welfare, everything else equal.

15. Capacity Utilisation | Where fixed costs are significant, an increase in capacity utilisation means that more output is being produced by the same infrastructure, increasing welfare to the extent people value the extra output.

16. Service Availability | Broader service availability (both across space and time) increases the options to use infrastructure services. Greater options are generally valued by infrastructure users.

17. Network Resilience | Higher resilience means infrastructure is able to adequately survive adverse external events. This is a feature that is likely to be valued by infrastructure users.

18. Investment evaluation processes | Higher quality investment evaluation processes will lead to better investment decisions and therefore greater welfare generated by new investment.

19. Accuracy of forecasts | Forecasts are crucial for investment decisions involving long-lived assets. Forecasts can be improved by reducing error, and most importantly by eliminating systematic biases.

20. ROI Trend | To the extent that changes in ROI over time can be attributed to new investments, these changes can be used to measure the marginal contribution of new investments to return on investment in an infrastructure sector.

21. Reliability Trend | To the extent that changes in reliability can be attributed to new investments, these changes can be used to measure the marginal contribution of new investments to reliability, which is valued by infrastructure users.

### 7.2 Response Indicators

Investigation shows that it is difficult to easily quantify response indicators. In many infrastructure sectors, key government responses are regulatory. Such responses are difficult to summarise as indicators due to their varying nature. In some instances added regulation increases welfare, in others it will reduce welfare. RMA changes may alter welfare in ways that are subjective to different audiences. The number of regulatory changes could be tracked in principle, but this is not a useful indicator as it ignores the scope of each regulation. Instead we suggest that regulatory responses for
each sector could be recorded as an annual summary list. This cannot be interpreted easily but would provide useful context for analysing future changes in infrastructure performance.

### 7.3 Geographical / Regional Breakdowns

Place is important in infrastructure provision and issues with infrastructure performance can be regional rather than national. In our commentary on data availability across sectors, there are some indicators where information can be reported regionally. We examined whether the providing a consistent regional breakdown in performance indicators would be a useful function of our recommended indicators.

The challenge is that there is little or no consistency in the indicator dimensions between sectors which provide regional data. Our recommendation is that geographical / regional reporting of infrastructure performance is looked at on a case-by-case basis where required for more in-depth evaluation of particular sector issues.
Table 3 – Summary of Proposed Infrastructure Indicators; Additional recommended indicators; Indicators considered but not recommended

<table>
<thead>
<tr>
<th>(1) Transport Sector - Road</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimension</strong></td>
</tr>
<tr>
<td>1. Population Growth</td>
</tr>
<tr>
<td>2. Economic Activity Growth</td>
</tr>
<tr>
<td>3. Activity/Demand Growth</td>
</tr>
<tr>
<td>4. Input Cost Growth</td>
</tr>
<tr>
<td>5. Macro-Economic Effects</td>
</tr>
<tr>
<td>6. Changes in Technology</td>
</tr>
<tr>
<td>7. Level of Competition (HHI)</td>
</tr>
<tr>
<td>8. Safety</td>
</tr>
<tr>
<td>9. Productivity</td>
</tr>
<tr>
<td>10. ROI</td>
</tr>
<tr>
<td>11. Price / Cost alignment</td>
</tr>
<tr>
<td>12. Asset Condition</td>
</tr>
<tr>
<td>13. Quality / Reliability of Service</td>
</tr>
<tr>
<td>14. Environmental Performance</td>
</tr>
<tr>
<td>15. Capacity Utilisation</td>
</tr>
<tr>
<td>16. Service Availability</td>
</tr>
<tr>
<td>17. Network Resilience</td>
</tr>
<tr>
<td>18. Investment evaluation processes</td>
</tr>
<tr>
<td>19. Accuracy of forecasts</td>
</tr>
<tr>
<td>20. ROI Trend</td>
</tr>
<tr>
<td>21. Reliability Trend</td>
</tr>
</tbody>
</table>
## (1) Transport Sector - Sea

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Indicator</th>
<th>Data Source</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Population Growth</td>
<td>Changes in population / household demographics</td>
<td>Statistics NZ population estimates / projections</td>
<td>A primary influence in demand for infrastructure</td>
</tr>
<tr>
<td>2. Economic Activity Growth</td>
<td>Changes in national /regional economic activity – GDP / person</td>
<td>Treasury fiscal and economic statements</td>
<td>Influences spending per person which changes demand for infrastructure</td>
</tr>
<tr>
<td>3. Activity/Demand Growth</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Proxy may be import/export activity from Statistics New Zealand</td>
</tr>
<tr>
<td>4. Input Cost Growth</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Typically this is commercially sensitive information</td>
</tr>
<tr>
<td>5. Macro-Economic Effects</td>
<td>Commodity import / export trade growth</td>
<td>Statistics New Zealand</td>
<td>SIA2B91, SEA2E91</td>
</tr>
<tr>
<td>6. Changes in Technology</td>
<td>Ports able to be serviced by larger vessels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Level of Competition (HHI)</td>
<td>Number of container ports</td>
<td></td>
<td>Will reflect any consolidation of activities, but may need refinement.</td>
</tr>
<tr>
<td>8. Safety</td>
<td>Lost time injuries as a proportion of hours worked</td>
<td>Port Companies</td>
<td>This may not include private contractors carrying out port work</td>
</tr>
<tr>
<td>9. Productivity</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Could be annual cargo tonnage / port costs</td>
</tr>
<tr>
<td>10. ROI</td>
<td>ROI</td>
<td>Port Companies</td>
<td></td>
</tr>
<tr>
<td>11. Price / Cost alignment</td>
<td>Aspirational Indicator</td>
<td></td>
<td>This would rely on typically commercially sensitive information</td>
</tr>
<tr>
<td>12. Asset Condition</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Quality / Reliability of Service</td>
<td>Port Operational Efficiency – TEU/hr</td>
<td>MoT</td>
<td></td>
</tr>
<tr>
<td>14. Environmental Performance</td>
<td>Breach of resource consent conditions, Groundings</td>
<td>Regional Councils, Maritime NZ</td>
<td></td>
</tr>
<tr>
<td>15. Capacity Utilisation</td>
<td>Berth / Container space occupancy ratio</td>
<td>Reported by some ports</td>
<td></td>
</tr>
<tr>
<td>16. Service Availability</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Network Resilience</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Investment evaluation processes</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Accuracy of forecasts</td>
<td>Actual tonnage versus commodity I/E growth projections</td>
<td>Port and Statistics NZ data</td>
<td></td>
</tr>
<tr>
<td>20. ROI Trend</td>
<td>Reported ROI trend</td>
<td>Port Companies</td>
<td></td>
</tr>
<tr>
<td>21. Reliability Trend</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## (1) Transport Sector - Air

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Indicator</th>
<th>Data Source</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Population Growth</td>
<td>Changes in population / household demographics</td>
<td>Statistics NZ population estimates / projections</td>
<td>A primary influence in demand for infrastructure</td>
</tr>
<tr>
<td>2. Economic Activity Growth</td>
<td>Changes in national /regional economic activity – GDP / person</td>
<td>Treasury fiscal and economic statements</td>
<td>Influences spending per person which changes demand for infrastructure</td>
</tr>
<tr>
<td>3. Activity/Demand Growth</td>
<td>Forecast growth in air passengers / air cargo</td>
<td>Statistics New Zealand</td>
<td></td>
</tr>
<tr>
<td>4. Input Cost Growth</td>
<td><em>Aspirational Indicator</em></td>
<td></td>
<td>This is typically commercially sensitive information</td>
</tr>
<tr>
<td>5. Macro-Economic Effects</td>
<td>Forecast growth in air passengers / air cargo</td>
<td>Statistics New Zealand</td>
<td></td>
</tr>
<tr>
<td>6. Changes in Technology</td>
<td><em>Aspirational Indicator</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Level of Competition (HHI)</td>
<td>Number of carriers servicing domestic / international</td>
<td></td>
<td>Could be assessed regionally / major overseas hubs</td>
</tr>
<tr>
<td>8. Safety</td>
<td>Loss of separation incidents reported</td>
<td>Airways NZ</td>
<td></td>
</tr>
<tr>
<td>9. Productivity</td>
<td><em>Aspirational Indicator</em></td>
<td></td>
<td>Alternate could be passenger numbers / annual cost</td>
</tr>
<tr>
<td>10. ROI</td>
<td>ROI of airport companies</td>
<td>Airport companies</td>
<td></td>
</tr>
<tr>
<td>11. Price / Cost alignment</td>
<td><em>Aspirational Indicator</em></td>
<td></td>
<td>This is typically commercially sensitive information</td>
</tr>
<tr>
<td>12. Asset Condition</td>
<td><em>Aspirational Indicator</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Quality / Reliability of Service</td>
<td>Inflight Delay</td>
<td>Airways NZ</td>
<td>Shows effect of technology / air control processes</td>
</tr>
<tr>
<td>14. Environmental Performance</td>
<td>Breach of resource consents</td>
<td>Regional Councils</td>
<td></td>
</tr>
<tr>
<td>15. Capacity Utilisation</td>
<td>Busy hour movements / capacity</td>
<td>Commerce Commission, Auckland Airport</td>
<td></td>
</tr>
<tr>
<td>16. Service Availability</td>
<td>Runway length for single-aisle (national) / widebody (international)</td>
<td>Airways NZ</td>
<td>Runway length defines aircraft / routes servicing a region</td>
</tr>
<tr>
<td>17. Network Resilience</td>
<td><em>Aspirational Indicator</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Investment evaluation processes</td>
<td><em>Aspirational Indicator</em></td>
<td></td>
<td>Difficult with commercial ownership / sensitivity</td>
</tr>
<tr>
<td>19. Accuracy of forecasts</td>
<td><em>Aspirational Indicator</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. ROI Trend</td>
<td>ROI of airport companies</td>
<td>Airport companies</td>
<td></td>
</tr>
<tr>
<td>21. Reliability Trend</td>
<td>Runway availability</td>
<td>Commerce Commission</td>
<td></td>
</tr>
</tbody>
</table>
## (1) Transport Sector - Rail

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Indicator</th>
<th>Data Source</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Population Growth</td>
<td>Changes in population / household demographics</td>
<td>Statistics NZ population estimates / projections</td>
<td>A primary influence in demand for infrastructure</td>
</tr>
<tr>
<td>2. Economic Activity Growth</td>
<td>Changes in national / regional economic activity – GDP / person</td>
<td>Treasury fiscal and economic statements</td>
<td>Influences spending per person which changes demand for infrastructure</td>
</tr>
<tr>
<td>3. Activity/Demand Growth</td>
<td>Forecast rail tonnage growth</td>
<td>KiwiRail</td>
<td></td>
</tr>
<tr>
<td>4. Input Cost Growth</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Macro-Economic Effects</td>
<td>Commodity import / export trade growth</td>
<td>Statistics New Zealand</td>
<td>SIA2F91, SEA2E91</td>
</tr>
<tr>
<td>6. Changes in Technology</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Level of Competition (HHI)</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Competition is from road and maritime sectors</td>
</tr>
<tr>
<td>8. Safety</td>
<td>LTIFT, MTIFR per million-hours worked; Fatal/Serious Injuries</td>
<td>KiwiRail; NZTA</td>
<td>KiwiRail H&amp;S; Road User / Pedestrian injuries</td>
</tr>
<tr>
<td>9. Productivity</td>
<td>Net freight tonne-km / freight operating expenditure</td>
<td>KiwiRail annual reporting</td>
<td></td>
</tr>
<tr>
<td>10. ROI</td>
<td>ROI</td>
<td>KiwiRail annual reporting</td>
<td></td>
</tr>
<tr>
<td>11. Price / Cost alignment</td>
<td>Aspirational Indicator</td>
<td></td>
<td>May become available from corporate reporting</td>
</tr>
<tr>
<td>12. Asset Condition</td>
<td>Aspirational Indicator</td>
<td>KiwiRail turnaround plan may inform this</td>
<td></td>
</tr>
<tr>
<td>13. Quality / Reliability of Service</td>
<td>Freight transit time and reliability (Premium Freight)</td>
<td>KiwiRail KPI</td>
<td></td>
</tr>
<tr>
<td>14. Environmental Performance</td>
<td>Emissions from rail activity</td>
<td>KiwiRail annual reporting</td>
<td>Will show the effect of electrification</td>
</tr>
<tr>
<td>15. Capacity Utilisation</td>
<td>Tonne-km per km track</td>
<td>KiwiRail annual reporting</td>
<td>Will show the effect of closures &amp; extensions</td>
</tr>
<tr>
<td>16. Service Availability</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Relates to penetration of rail services geographically / to areas of GDP activity</td>
</tr>
<tr>
<td>17. Network Resilience</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Relates to vulnerability/ performance of key links/bottlenecks in network</td>
</tr>
<tr>
<td>18. Investment evaluation processes</td>
<td>Use of national quantitative Benefit Cost appraisal</td>
<td>KiwiRail turnaround plan may inform this</td>
<td></td>
</tr>
<tr>
<td>19. Accuracy of forecasts</td>
<td>Net freight tonne-km versus forecasts</td>
<td>KiwiRail Statement of Corporate Intent</td>
<td>Will require back-analysis</td>
</tr>
<tr>
<td>20. ROI Trend</td>
<td>ROI trend</td>
<td>KiwiRail annual reporting</td>
<td></td>
</tr>
<tr>
<td>21. Reliability Trend</td>
<td>Freight transit time reliability trend (Premium Freight)</td>
<td>KiwiRail KPI</td>
<td></td>
</tr>
</tbody>
</table>
## (2) Telecommunications Sector

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Indicator</th>
<th>Data Source</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Population Growth</td>
<td>Changes in population / household demographics</td>
<td>Statistics NZ population estimates / projections</td>
<td>A primary influence in demand for infrastructure</td>
</tr>
<tr>
<td>2. Economic Activity Growth</td>
<td>Changes in national / regional economic activity – GDP / person</td>
<td>Treasury fiscal / economic statements</td>
<td>Influences spending per person which changes demand for infrastructure</td>
</tr>
<tr>
<td>3. Activity/Demand Growth</td>
<td>Aspirational indicator</td>
<td></td>
<td>In principle total domestic and international data traffic volumes could be measured but this information may be commercially sensitive</td>
</tr>
<tr>
<td>4. Input Cost Growth</td>
<td>Labour cost index for telecommunications</td>
<td>Statistics New Zealand SG51J9</td>
<td>Labour is a key cost input for telecommunications; capital costs are also important but not measured in a systematic way</td>
</tr>
<tr>
<td>6. Changes in Technology</td>
<td>Aspirational indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Level of Competition (HHI)</td>
<td>HHIs for retail voice, broadband and mobile</td>
<td>Commerce Commission</td>
<td>Reflects intensity of competition and hence efficiency of use of existing infrastructure</td>
</tr>
<tr>
<td>8. Safety</td>
<td>Aspirational indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Productivity</td>
<td>Total factor productivity index</td>
<td>Statistics New Zealand</td>
<td>Reflects overall productivity of capital and labour in the sector</td>
</tr>
<tr>
<td>10. ROI</td>
<td>Aspirational indicator</td>
<td></td>
<td>ROI information will be known by private firms but likely to be highly commercially sensitive</td>
</tr>
<tr>
<td>11. Price / Cost alignment</td>
<td>Aspirational indicator</td>
<td></td>
<td>Prices are typically for bundles of services and many costs are common to multiple services, so it is difficult to measure the difference between prices and cost. To some extent the HHI indicator will be a proxy for this.</td>
</tr>
<tr>
<td>12. Asset Condition</td>
<td>Aspirational indicator</td>
<td></td>
<td>Information about condition and age of most assets will be held by the private sector</td>
</tr>
<tr>
<td>13. Quality / Reliability of Service</td>
<td>Aspirational indicator</td>
<td></td>
<td>Information about service reliability will be held by the private sector; only major outages will be publically reported</td>
</tr>
<tr>
<td>14. Environmental Performance</td>
<td>Aspirational indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Capacity Utilisation</td>
<td>Aspirational indicator</td>
<td></td>
<td>Total capacity will be known by the private sector but will be commercially sensitive</td>
</tr>
<tr>
<td>16. Service Availability</td>
<td>Aspirational indicator</td>
<td></td>
<td>Publically available (in the National Broadband Map) but an indicator of availability needs to be calculated</td>
</tr>
<tr>
<td>17. Network Resilience</td>
<td>Aspirational indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Investment evaluation processes</td>
<td>Aspirational indicator</td>
<td></td>
<td>Most investment is undertaken by the private sector</td>
</tr>
<tr>
<td>19. Accuracy of forecasts</td>
<td>Aspirational indicator</td>
<td></td>
<td>Most forecasts are developed by the private sector</td>
</tr>
<tr>
<td>20. ROI Trend</td>
<td>Aspirational indicator</td>
<td></td>
<td>ROI information will be commercially sensitive</td>
</tr>
<tr>
<td>21. Reliability Trend</td>
<td>Aspirational indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimension</td>
<td>Indicator</td>
<td>Data Source</td>
<td>Commentary</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>1. Population Growth</td>
<td>Changes in population / household demographics</td>
<td>Statistics NZ population estimates / projections</td>
<td>A primary influence in demand for infrastructure</td>
</tr>
<tr>
<td>2. Economic Activity Growth</td>
<td>Changes in national /regional economic activity – GDP / person</td>
<td>Treasury fiscal and economic statements</td>
<td>Influences spending per person which changes demand for infrastructure</td>
</tr>
<tr>
<td>3. Activity/Demand Growth</td>
<td>Changes in energy demand by sector</td>
<td>MBIE Energy Data file</td>
<td></td>
</tr>
<tr>
<td>4. Input Cost Growth</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Macro-Economic Effects</td>
<td>World Crude Oil / LNG Prices</td>
<td>Tapis Crude, International LNG pricing</td>
<td>Relates to likely substitution away from electricity and vice versa</td>
</tr>
<tr>
<td>6. Changes in Technology</td>
<td>Rate of uptake of electric vehicles in NZ fleet</td>
<td>NZTA</td>
<td>Effects pressure on network</td>
</tr>
<tr>
<td>7. Level of Competition (HHI)</td>
<td>Number of Electricity Generators / Retailers</td>
<td>Transpower</td>
<td></td>
</tr>
<tr>
<td>8. Safety</td>
<td>Lost time injuries per unit of electricity generated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Productivity</td>
<td>Productivity of energy assets</td>
<td>Shareholder reports, Transpower reporting</td>
<td>Will require some collation; Transpower annual reporting is very detailed</td>
</tr>
<tr>
<td>10. ROI</td>
<td>ROI of energy assets</td>
<td>Shareholder reports, COMU for Generators</td>
<td>Will consider new generation that replaces current serviceable generation</td>
</tr>
<tr>
<td>11. Price / Cost alignment</td>
<td>Cost per unit generated / cost per unit retailed</td>
<td>Various</td>
<td>May require aggregation of costs over multiple companies</td>
</tr>
<tr>
<td>12. Asset Condition</td>
<td>Residual life of key assets</td>
<td>Asset Management Plans</td>
<td>Age of assets versus expected design lives</td>
</tr>
<tr>
<td>13. Quality / Reliability of Service</td>
<td>Meeting SAIDI and SAIFI targets</td>
<td>Lines companies’ reporting</td>
<td></td>
</tr>
<tr>
<td>14. Environmental Performance</td>
<td>CO₂ emitted per unit of energy generated; breaches of consents</td>
<td>Transpower, MBIE</td>
<td>Will consider the amount of new generation that is non-thermal</td>
</tr>
<tr>
<td>15. Capacity Utilisation</td>
<td>Generation / Transmission capacity versus peak demand &amp; reserve</td>
<td>MBIE Energy Data File / Transpower reporting</td>
<td>May show effects of Demand Management / Dynamic Rating of Transmission</td>
</tr>
<tr>
<td>16. Service Availability</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Network Resilience</td>
<td>Resilience of Transmission network connectors (Cook Strait DC)</td>
<td></td>
<td>Challenge to measure redundancy-provision quantifiably</td>
</tr>
<tr>
<td>18. Investment evaluation processes</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Likely information available on transmission network, not others.</td>
</tr>
<tr>
<td>19. Accuracy of forecasts</td>
<td>Accuracy of demand forecasts versus actual demand</td>
<td>Transpower annual reporting</td>
<td></td>
</tr>
<tr>
<td>20. ROI Trend</td>
<td>Trend in ROI of energy assets</td>
<td>Shareholder reports, COMU for Generators</td>
<td></td>
</tr>
<tr>
<td>21. Reliability Trend</td>
<td>SAIDI and SAIFI trends</td>
<td>Lines companies’ reporting</td>
<td>Reflects investment in transmission / distribution</td>
</tr>
<tr>
<td>Dimension</td>
<td>Indicator</td>
<td>Data Source</td>
<td>Commentary</td>
</tr>
<tr>
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<td>----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1. Population Growth</td>
<td>Changes in population / household demographics</td>
<td>Statistics NZ population estimates / projections</td>
<td>A primary influence in demand for infrastructure</td>
</tr>
<tr>
<td>2. Economic Activity Growth</td>
<td>Changes in national /regional economic activity – GDP / person</td>
<td>Treasury fiscal and economic statements</td>
<td>Influences spending per person which changes demand for infrastructure</td>
</tr>
<tr>
<td>3. Activity/Demand Growth</td>
<td>Energy demand forecasts</td>
<td>GIC, NZP&amp;M, MBIE</td>
<td></td>
</tr>
<tr>
<td>4. Input Cost Growth</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Macro-Economic Effects</td>
<td>World Crude Oil / LNG Prices</td>
<td>Tapis Crude, International LNG pricing</td>
<td></td>
</tr>
<tr>
<td>6. Changes in Technology</td>
<td>International demand for methanol as alternative vehicle fuel</td>
<td></td>
<td>Demand for methanol could create export market for national gas</td>
</tr>
<tr>
<td>7. Level of Competition (HHI)</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Could be the number of domestic oil/gas fields in production</td>
</tr>
<tr>
<td>8. Safety</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Could be H&amp;S information related across major sector employers</td>
</tr>
<tr>
<td>9. Productivity</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. ROI</td>
<td>ROI for Refining NZ and Vector</td>
<td>RNZ, Vector Annual Reports</td>
<td></td>
</tr>
<tr>
<td>11. Price / Cost alignment</td>
<td>Price / Cost for Oil and Gas</td>
<td>MBEI M&amp;S Trends, RNZ, NZP&amp;M, GIC</td>
<td></td>
</tr>
<tr>
<td>12. Asset Condition</td>
<td>Residual life of major assets and pipelines</td>
<td>RNZ, Vector</td>
<td></td>
</tr>
<tr>
<td>13. Quality / Reliability of Service</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Environmental Performance</td>
<td>Breaches of resource consents from infrastructure / extraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Capacity Utilisation</td>
<td>Volume / Capacity for infrastructure network (refinery, pipelines)</td>
<td>Refining NZ, GIC, Vector</td>
<td>Potentially a description of regional availability of gas / gas products</td>
</tr>
<tr>
<td>16. Service Availability</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Network Resilience</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Will relate to key links in gas and refinery pipelines</td>
</tr>
<tr>
<td>18. Investment evaluation processes</td>
<td>Known recoverable reserves</td>
<td>MBIE Energy Data File, NZP&amp;M reporting</td>
<td>Proxy for effectiveness of investment in prospecting (but not infrastructure)</td>
</tr>
<tr>
<td>19. Accuracy of forecasts</td>
<td>Accuracy of energy demand forecasts</td>
<td>GIC, NZP&amp;M, MBIE</td>
<td>Shows investment in efficiency</td>
</tr>
<tr>
<td>20. ROI Trend</td>
<td>Trend in ROI for Refining NZ and Vector</td>
<td>RNZ, Vector Annual Reports</td>
<td></td>
</tr>
<tr>
<td>21. Reliability Trend</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
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<tr>
<td>1. Population Growth</td>
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<td>Treasury fiscal and economic statements</td>
<td>Influences spending per person which changes demand for infrastructure</td>
</tr>
<tr>
<td>3. Activity/Demand Growth</td>
<td>Annual rate of change in serviced water consumption in m$^3$/head</td>
<td>LTPs and AMPs</td>
<td>Total amount of drinking water supplied</td>
</tr>
<tr>
<td>4. Input Cost Growth</td>
<td>Aspirational Indicator</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td>5. Macro-Economic Effects</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Changes in Technology</td>
<td>Metering of consumers' supply</td>
<td></td>
<td>Sensitivity in demand response to charging</td>
</tr>
<tr>
<td>7. Level of Competition (HHI)</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Typically only monopoly suppliers</td>
</tr>
<tr>
<td>8. Safety</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Productivity</td>
<td>Cost per litre supplied</td>
<td>Financial Reporting Regulations (2011)</td>
<td>In development by the DIA</td>
</tr>
<tr>
<td>10. ROI</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Price / Cost alignment</td>
<td>Aspirational Indicator</td>
<td></td>
<td>Likely that information is only available for Auckland (Watercare)</td>
</tr>
<tr>
<td>13. Quality / Reliability of Service</td>
<td>Compliance with NZ drinking water standards</td>
<td>MoH</td>
<td></td>
</tr>
<tr>
<td>14. Environmental Performance</td>
<td>Consent breaches and flooding events to habitable floors</td>
<td>Regional Councils / DIA developing</td>
<td></td>
</tr>
<tr>
<td>15. Capacity Utilisation</td>
<td>Demand growth available in systems (‘headroom’)</td>
<td>Council Long Term / Asset Management Plans</td>
<td>May be too difficult to calculate and aspirational.</td>
</tr>
<tr>
<td>16. Service Availability</td>
<td>Proportion of Urban Population with supply system meeting NZ Drinking Water Standards</td>
<td>MoH</td>
<td></td>
</tr>
<tr>
<td>17. Network Resilience</td>
<td>Reservoir Storage (mean and minimum days of supply)</td>
<td>District or Unitary Councils, Greater Wellington Regional Council, Watercare</td>
<td>Potential alternate is investment per population size</td>
</tr>
<tr>
<td>18. Investment evaluation processes</td>
<td>Use of quantitative BC Appraisals</td>
<td>Regional Council, Watercare</td>
<td></td>
</tr>
<tr>
<td>19. Accuracy of forecasts</td>
<td>Aspirational Indicator</td>
<td></td>
<td>This matter was identified in the Auditor General’s report on the sector</td>
</tr>
<tr>
<td>20. ROI Trend</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Reliability Trend</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## (4) Water Sector - Rural

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Indicator</th>
<th>Data Source</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Population Growth</td>
<td>Changes in population / household demographics</td>
<td>Statistics NZ population estimates / projections</td>
<td>A primary influence in demand for infrastructure</td>
</tr>
<tr>
<td>2. Economic Activity Growth</td>
<td>Changes in national /regional economic activity – GDP / person</td>
<td>Treasury fiscal and economic statements</td>
<td>Influences spending per person which changes demand for infrastructure</td>
</tr>
<tr>
<td>3. Activity/Demand Growth</td>
<td>Over-allocation of water resources</td>
<td>Regional Councils</td>
<td>Actual use will be reported from 2016</td>
</tr>
<tr>
<td>4. Input Cost Growth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Macro-Economic Effects</td>
<td>Agricultural Outlook</td>
<td>Ministry of Primary Industry</td>
<td></td>
</tr>
<tr>
<td>6. Changes in Technology</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Level of Competition (HHI)</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Safety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Productivity</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. ROI</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Price / Cost alignment</td>
<td>Aspirational Indicator</td>
<td>Alternate could be the level of metering of river take for irrigation</td>
<td>Alternate could be the level of metering of river take for irrigation</td>
</tr>
<tr>
<td>12. Asset Condition</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Quality / Reliability of Service</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Environmental Performance</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Capacity Utilisation</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Service Availability</td>
<td>Irrigation Schemes (in size by region)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Network Resilience</td>
<td>Irrigation Prospects (in size by region)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Investment evaluation processes</td>
<td>Number of schemes supported by formal business case with ROI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Accuracy of forecasts</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. ROI Trend</td>
<td>Aspirational Indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Reliability Trend</td>
<td>Aspirational Indicator</td>
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</table>
### (5) Additional Recommended Indicators Outside of 21 Dimensions

<table>
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<tr>
<th>Dimension</th>
<th>Indicator</th>
<th>Data Source</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electricity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Hydro storage above ‘minimum’ operating level</td>
<td>Various</td>
<td>Hydro storage availability affects system flexibility</td>
</tr>
<tr>
<td>Other</td>
<td>Amount of new generation consented by thermal / non thermal</td>
<td>Transpower</td>
<td>Determines whether investment is moving towards less emissions</td>
</tr>
</tbody>
</table>

### (6) Indicators Considered but not Recommended

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Indicator</th>
<th>Data Source</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shared across all sectors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic Activity Growth</td>
<td>Employment participation rate</td>
<td>Statistics New Zealand</td>
<td>Influences spending which changes demand for infrastructure</td>
</tr>
<tr>
<td></td>
<td>Changes in regional economic activity</td>
<td>Statistics New Zealand Labour Force Survey</td>
<td>Employment is good proxy for regional to economic activity</td>
</tr>
<tr>
<td></td>
<td>Outlook for key commodities (wood, dairy, etc.)</td>
<td>Commodity Price Index, Ministry of Primary Industry</td>
<td>Influences trade which changes demand for infrastructure</td>
</tr>
<tr>
<td></td>
<td>Exchange rate</td>
<td>Statistics New Zealand</td>
<td>Influences trade which changes demand for infrastructure</td>
</tr>
<tr>
<td><strong>Input Cost Growth</strong></td>
<td>Limitation of key input resources; e.g. water, construction aggregates</td>
<td>Statistics New Zealand Producer Price Index (SQUEE1200); NZTA, Regional Councils</td>
<td>Influences supply costs and investment decisions</td>
</tr>
<tr>
<td>Macro-economic effects</td>
<td>Environmental / climate change; extreme weather / seismic events</td>
<td>NIWA, GNS, International Sources</td>
<td>Will affect design standards and resilience</td>
</tr>
<tr>
<td>Other</td>
<td>Key skill shortages</td>
<td>Difficult to measure</td>
<td>Will affect investment / operations costs</td>
</tr>
<tr>
<td><strong>Shared across all Transport Sectors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity/Demand Growth</td>
<td>Household travel characteristics (household vehicle ownership, household size, etc.)</td>
<td>Statistics NZ from Census data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Household travel expenditure on travel (vehicle costs, operational costs, PT travel, etc)</td>
<td>Statistics NZ from Household economic survey</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Household travel expenditure as proportion of consumer price index</td>
<td>Statistics NZ from Household economic survey</td>
<td></td>
</tr>
<tr>
<td>Activity / Demand Growth</td>
<td>Merchandise import and export volumes</td>
<td>Statistics NZ (SIA2191, SEA2E91)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Retail price of petrol and diesel (real)</td>
<td>MBIE Energy Data File</td>
<td>Fuel prices affect demand for travel, substitution of telecommunications etc.</td>
</tr>
<tr>
<td>Input Cost Growth</td>
<td>Transport cost movements in comparison to overall consumption</td>
<td>Statistics NZ (SE9071/9072/9073)</td>
<td></td>
</tr>
<tr>
<td><strong>Transport: Roads</strong></td>
<td></td>
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<tr>
<td>---</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quality / Reliability of Service</strong></td>
<td>Travel Times and reliability by Public Transport</td>
<td>Aspirational</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technology advances (e.g. HOP card) may allow this to be collected. Results may depend on operator performance more than infrastructure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Capacity Utilisation</strong></td>
<td>Public Transport Capacity Utilisation (PT boardings per seat-km)</td>
<td>Aspirational</td>
<td></td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>Efficiency: GPD ratio to vehicle-km of travel</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Service Availability</strong></td>
<td>Proportion of households with no access to vehicle; access to travel modes within 500 metres</td>
<td>MoT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>May be too imprecise to be a proxy for availability</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Price / Cost Alignment</strong></td>
<td>Public Transport revenue versus cost of provision</td>
<td>MoT / NZTA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Affected by things other than infrastructure provision</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Productivity</strong></td>
<td>Public Transport revenue passenger-km versus cost of provision</td>
<td>MoT / NZTA</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Transport: Rail (None)</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transport: Sea</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Quality / Reliability of Service</strong></td>
<td>Reliability (port access, ships, shipping delays)</td>
</tr>
<tr>
<td></td>
<td>Potentially could use World Bank Logistics Performance Index (Imports)</td>
</tr>
<tr>
<td><strong>Transport: Air</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Quality / Reliability of Service</strong></td>
<td>Passenger travel time through airport terminals</td>
</tr>
<tr>
<td></td>
<td>While Auckland is largest airport, still not a national indicator</td>
</tr>
<tr>
<td><strong>Capacity Utilisation</strong></td>
<td>Airport Terminal Capacity Utilisation (busy hour pax movements / processing capacity)</td>
</tr>
<tr>
<td><strong>Productivity</strong></td>
<td>Passenger Numbers / annual costs in sector</td>
</tr>
<tr>
<td></td>
<td>Aspirational</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Telecommunications</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity / Demand Growth</strong></td>
<td>Fixed-line and wireless broadband penetration rates</td>
</tr>
<tr>
<td></td>
<td>Annually, nationally</td>
</tr>
<tr>
<td><strong>Changes in Technology</strong></td>
<td>Data Capacity Growth</td>
</tr>
<tr>
<td><strong>Quality / Reliability of Service</strong></td>
<td>Average download speed nationally &amp; by region</td>
</tr>
<tr>
<td><strong>Service Availability</strong></td>
<td>Mobile &amp; Broadband population coverage</td>
</tr>
<tr>
<td></td>
<td>Not currently available but could be calculated with GIS</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th><strong>Electricity</strong></th>
<th></th>
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<tbody>
<tr>
<td><strong>Activity / Demand Growth</strong></td>
<td>Changes in energy demand per head and per household</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>Electricity retail prices in real terms</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>Relative prices of Gas and Electricity</td>
</tr>
<tr>
<td></td>
<td>Affects substitution of one energy source the other</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>New generation that displaces current serviceable generation</td>
</tr>
</tbody>
</table>

| **Oil and Gas** |  |
### Activity / Demand Growth
- Changes in energy demand per head and per household
  - MBBE Energy Data File

### Input Cost Growth
- Key Skill shortages in Oil and Gas sector
  - PEPANZ
- Cost of Exploration
  - Qualitative as exact impact difficult to quantify
  - Barrier to entry/exploitation

### Water: Urban

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Source(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Growth</td>
<td>Population growth rate (for each system or sample of systems)</td>
<td>ESR (MoH), LTPs and AMPs</td>
</tr>
<tr>
<td>Network Resilience</td>
<td>Availability of water resources (including effects of over-allocation)</td>
<td>Aspirational</td>
</tr>
<tr>
<td>Other</td>
<td>Urban Stormwater disposal</td>
<td>District or Unitary Councils, Urban land area connected to systems</td>
</tr>
<tr>
<td>Network Resilience</td>
<td>River abstraction capability</td>
<td>Regional Councils</td>
</tr>
<tr>
<td>Price / Cost alignment</td>
<td>Charge for water versus cost of producing per unit</td>
<td>District or Unitary Councils, Greater Wellington Regional Council, Watercare</td>
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<td>Asset Condition</td>
<td>Extent of water losses in network</td>
<td>DIA</td>
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<tr>
<td>Water: Rural</td>
<td>Agricultural Land Prices</td>
<td>Statistics New Zealand</td>
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<tr>
<td>ROI &amp; ROI Trend</td>
<td>Agricultural Land Prices</td>
<td>Statistics New Zealand</td>
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<td>Macro-Economic Effects</td>
<td>Environmental Volatility</td>
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