SPATIAL INFORMATION SYSTEMS

STAGES 1 & 2

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STAGE 2 APPENDICES

EXECUTIVE SUMMARY

1. INTRODUCTION

Spatial Information Systems (SIS) have been developed to a stage (in 1994) where they are of significant value as a management tool to organisations that administer geographically distributed assets, such as roads.

Transit New Zealand administers the New Zealand state highway network which, being geographically distributed, is referenced by a form of spatial index.

For these reasons, opportunities may exist through the use of SIS for improving the efficiency and effectiveness of Transit New Zealand's management of the network, and for better facilitation of its existing information systems, such as Road Assessment and Maintenance Management (RAMM).

Therefore a study of the usefulness to Transit New Zealand of SIS as a management tool was undertaken, in two phases. Stage 1 undertaken in 1992 investigated the applicability of, and identified, SIS appropriate to Transit New Zealand.

Stage 2 undertaken in 1993-94 advanced the investigation by clarifying how Transit New Zealand may benefit from applying SIS to management of the state highway asset. This was achieved by visiting two transportation authorities in Australia that use SIS.

2. OBJECTIVES

Stage 1 objectives were to:

- Review Transit New Zealand use of data and the applicability of SIS.
- Develop concepts for appropriate SIS in Transit New Zealand, and evaluate them.
- Provide Transit New Zealand with an assessment of the costs and benefits of the most appropriate SIS.

Stage 2 objectives were to:

- Clarify how Transit New Zealand may benefit by applying SIS to its functions of:
  - Strategic management of the state highway asset,
  - Policy development and, where applicable, providing advice to Central Government.

3. STRUCTURE OF REPORT

The two stages (1 and 2) of the research are reported as two separate parts of this report, each with its own Appendices.

4. STAGE 1 RESEARCH

4.1 Approach to Research

The research procedure included:

- interviews with Transit New Zealand staff,
- development of concepts for SIS,
- workshops to assess benefits from such systems,
- survey of SIS vendors for information about their products,
- assessment of cost estimates, and cost-benefit analysis of the SIS concepts.

4.2 Concepts for Spatial Information Systems

Three SIS concepts, which would be appropriate to Transit New Zealand's needs and which could be implemented independently or as a progression, were identified. The concepts, in advancing order of sophistication, are:

Concept 1 - Spatial Information Indexing System
This concept is primarily a geographical index to information relating to sections of the state highway network. It would be a catalogue to the various systems already established in Transit New Zealand that collect, store, maintain and distribute spatially related information.

It could be either a complete solution, or an initial step towards a more complex system which might incorporate more direct links to existing and future databases.

Concept 2 - Spatially Linked Information Indexing System
This concept provides for greater spatial analysis capability and includes online access to existing and future databases.

It allows the introduction of more advanced spatial analysis capabilities. Thus it would allow for analysis and interpretation of multiple pieces of information relating to the same or similar sections of the state highway network. (This is the major advance of this concept over Concept 1).

Concept 3 - Spatially Integrated Highway Management System
This concept incorporates all the information relating to the state highway network which is required by Transit New Zealand to effectively and efficiently manage that network.

The development of this concept would be a major strategic investment by Transit New Zealand. It would involve the integration of existing information systems as one system using the spatial relationships between information as the common index.

4.3 Technology and Costs

Vendors of SIS were approached for information about the suitability of their products to an organisation, like Transit New Zealand (which has responsibility for administering a road network), and for the costs of establishing such a system(s).

Table 1 shows the costs (in NZ$ 1992) associated with Concepts 1 and 2 only. Costs for Concept 3 are not reported because the vendors were unable, with the information supplied, to accurately determine the system requirements and hence costs.

Table 1. Establishment and annual costs (rounded to nearest $100) for Concepts 1 and 2.

Concept	Establishment Costs	Annual Costs
Concept 1	$203,000	$33,800
Concept 2	$1,070,100	$144,300

These costs were extrapolated over five years and adjusted by +2% per year to take account of inflaation.

4.4 Benefit Assessment

Transit New Zealand staff, from both Head Office and Auckland regional office, were asked to assess the value of benefits likely to accrue from implementing SIS based on each of the three identified concepts. Most benefits identified by them were based around time savings.

The benefit estimates shown in Table 2 are considered to be conservative, and not representative of the potential impact that SIS could have on Transit New Zealand's operations.

Table 2. Annual benefit values (rounded to nearest $100), at three different hourly charge rates, for Concepts 1, 2 and 3.

Concept	Annual Benefits		
	$20/hour	$25/hour	$50/hour
Concept 1	$19,000	$23,800	$47,500
Concept 2	$161,600	$183,000	$288,300
Concept 3	$237,500	$260,500	$375,800

The benefits were extrapolated over five years and adjusted by +2% per year to take account of inflation.

4.5 Cost-Benefit Analysis

Two comparisons of the costs and benefits of Concepts 1 and 2 were completed. The first (Table 3) used annual operating costs with annual benefits, after the initial establishment costs had been incurred. Based on this analysis, Concept 2 would appear to be justified from an operational point of view.

Table 3. Annual costs versus annual benefits (rounded to nearest $100) for the first year of operation at full annual cost, for Concepts 1 and 2, at three different hourly charge rates.

Concept	$20/hour	$25/hour	$50/hour
Concept 1			
Benefits	$19,000	$23,800	$47,500
Costs	$33,800	$33,800	$33,800
Outcome	**-$14,800**	**-$10,000**	**+$13,700**
Concept 2			
Benefits	$161,600	$183,000	$288,300
Costs	$144,300	$144,300	$144,300
Outcome	**+$17,300**	**+$38,700**	**+$144,000**

The second comparison (Table 4), totalling the first year establishment costs with the annual costs and analysing accumulated costs against accumulated benefits over five years, presents a different picture. Comparing the overall costs with the accumulated benefits highlights that neither Concept 1 nor 2 are justified financially.

Table 4. Total accumulated costs (establishment plus annual) versus total accumulated benefits (rounded to nearest $100) over 5 years, for Concepts 1 and 2, at three different hourly charge rates.

Concept	$20/hour	$25/hour	$50/hour
Concept 1			
Benefits	$78,400	$98,000	$196,000
Costs	$374,200	$374,200	$374,200
Outcome	**-$295,800**	**-$276,200**	**-$178,200**
Concept 2			
Benefits	$666,000	$754,400	$1,188,300
Costs	$1,791,000	$1,791,000	$1,791,000
Outcome	**-$1,125,000**	**-$1,036,600**	**-$602,700**

4.6 Conclusions

Many opportunities exist for achieving operational improvements within Transit New Zealand through the implementation of SIS. However, the assessments of the financial benefit (from two of the three SIS concepts identified) that would accrue from these improvements failed to fully account for all the opportunities. Thus the cost-benefit analysis does not justify the implementation of SIS into Transit New Zealand.

This conclusion is nevertheless at odds with transportation authorities in Australia and elsewhere in the world, who consider benefits are to be gained in using SIS and who, in consequence, are developing and implementing such systems.

4.7 Recommendations

Further investigation is needed to clearly determine the areas where SIS would provide the greatest benefits to Transit New Zealand. Some steps to achieve such clarification should include:

(a) *Appoint an appropriate person*, and allocate sufficient resources to perform further investigations to complete the research into SIS to an appropriate standard.

(b) *Liaise with overseas transportation authorities* which have developed SIS for road network management.

(c) *Increase staff comprehension* of SIS specifically and of information systems in general.

(d) *Assess all regional offices* to determine where the greatest benefits from SIS are likely to accrue, and identify other opportunities.

(e) *Prepare requirements specifications* which meet most of the information systems needs of Transit New Zealand, and distribute to all offices for comment.

(f) *Prepare more rigorous benefit assessments* to ensure more accurate estimates of the financial value of establishing SIS.

(g) *Seek vendor submissions* based on more comprehensive and detailed specifications.

(h) *Prepare detailed cost-benefit analysis* to provide a more reliable financial statement for the justification of investing in SIS.

5. STAGE 2 RESEARCH

5.1 Approach to Research

To advance its investigation into SIS, a study team from Transit New Zealand visited, in June 1993, two Australian Authorities, Roads and Traffic Authority of New South Wales (RTA) in Sydney and Roads Corporation of Victoria (VIC ROADS) in Melbourne. These Authorities are responsible for the management of the principal road networks in their respective states, and also have a number of similarities in their functions with Transit New Zealand.

The objective was to clarify the benefits that Transit New Zealand could obtain from SIS for its strategic management of the state highway asset, and for policy development including, where applicable, provision of advice to central government.

5.2 Use of Spatial Information Systems by RTA and VIC ROADS

The study team found that neither RTA nor VIC ROADS had established a standard framework within which SIS could be developed, as both organisations had approached SIS development on an application by application basis.

RTA originally implemented five different SIS that had little co-ordination between projects. It has now embarked upon a project to rationalise the types of systems, the data held, and the applications being developed.

VIC ROADS had established from the outset a Geographic Information Service group which had responsibility for all SIS projects. This group developed policies and procedures for the development of SIS, and established a strategy for its development. VIC ROADS had also linked SIS to its corporate databases and is able to present information in a spatial format.

However, RTA and VIC ROADS are now undertaking a study to integrate their referencing systems and to establish standards for them. The establishment of, and adherence to, such standards for SIS is paramount to produce useful and reliable information.

5.3 Concepts for Spatial Information Systems

All the concepts applied by RTA and VIC ROADS, and the three concepts for SIS identified for Transit New Zealand, rely on the development of a consistent digital map database for the whole area and on the acceptance of a standard location referencing system suitable for all applications. This integrated approach to data and its indexing used by SIS makes them powerful analysis tools.

5.4 Use of Spatial Information Systems by Transit New Zealand

Transit New Zealand could benefit significantly from the application of SIS to realise the full potential for its strategic management of the state highway asset.

The use of SIS by Transit New Zealand would also facilitate the development of policy and advice presented to Government and other decision makers in an integrated form.

The greatest potential for benefiting from SIS within Transit New Zealand lies in the areas of:

- Strategic Planning,
- Road Use Analysis,
- State Highway Asset Management.

5.5 Recommendations

Future Research
Nine steps in three phases are recommended to advance Transit New Zealand's research into SIS.

Phase I

1. Maintain communication with RTA and VIC ROADS in Australia to learn the outcomes of their respective road referencing system projects.

2. Describe in more detail the functions performed by Transit New Zealand in the areas of strategic planning, road use analysis, and state highway asset management, and document the existing resources, systems and data used.

Phase II

3. Either in parallel with Phase I or before proceeding to Phase III, Transit New Zealand, in its current review of its Strategic Information Systems Plan (SISP), must examine whether the strategic decision-making applications and benefits identified justify further attention and what priority this activity should have.

Phase III

4. Confirm which of the three identified SIS concepts best meets Transit New Zealand's requirements and develop an overall view defining how to integrate SIS with Transit New Zealand's existing and future information systems.

5. Prepare a specification for the development of a corporate database of road and road-related information defining Transit New Zealand's future requirements for strategic and road use information.

6. Define in more detail the applications and data likely to be required by Transit New Zealand.

7. Elaborate on the likely benefits which will accrue to Transit New Zealand from implementing the preferred concept and identified applications.

8. Re-assess the potential cost of implementing and operating the preferred concept.

9. Review the results of Phases I, II and III and undertake such further work as may be required to prepare recommendations for Transit New Zealand to consider whether it should adopt SIS.

Phase IV

If a decision is taken in favour of implementing an SIS, three further steps need to be taken.

10. Define a suitable approach to acquire the system.

11. Acquire suitable digital base maps.

12. Implement the system and load the data.

Costs of Future Research

• Costs associated with completing Phase I, Step 1 are considered to be nominal and part of Transit New Zealand's continual contact with Australian transportation authorities.

• Costs likely to be incurred in completing Phase I, Step 2 include:

- Preparatory work involving Transit New Zealand staff in determining SIS applications

- Assistance in determining the processes and information used in SIS applications

- Five weeks consulting assistance to compile descriptions of these SIS applications (estimated cost of $30,000 plus travel and accommodation costs)

- Involvement of Transit New Zealand staff from both Head Office and regional offices in interviews and reviews during the consulting assignment

• Costs incurred in completing Phase II will be incurred as part of Transit New Zealand's already planned review of the Strategic Information Systems Plan.

ABSTRACT

Spatial Information Systems (SIS) have been developed to a stage (in 1994) where they are of significant value as a management tool to organisations that administer geographically distributed assets, such as roads.

This study reports on the possible opportunities provided by SIS for improving efficiency and effectiveness of Transit New Zealand's management of New Zealand's state highway network, and for better facilitation of its existing systems, such as Road Assessment and Maintenance Management (RAMM).

Stage 1 undertaken in 1992 investigated the applicability of, and identified, SIS appropriate for Transit New Zealand's perceived needs. Three concepts of SIS were identified, evaluated and are described.

Stage 2 undertaken in 1993-94 clarified how Transit New Zealand may benefit by applying SIS to management of the state highway asset. A study team visited two transportation authorities in Australia (Roads and Traffic Authority of New South Wales, and Roads Corporation of Victoria in Melbourne) that use SIS, and have similarities in their functions with those of Transit New Zealand. The approaches and the concepts applied by these Australian Authorities to SIS are described and comparisons drawn with Transit New Zealand.

The greatest potential for applying these systems within Transit New Zealand lies in the areas of:

- Strategic planning,
- Road use analysis,
- State Highway asset management.

SPATIAL INFORMATION SYSTEMS

STAGE 1

1. INTRODUCTION

Spatial Information Systems (SIS) have been developed to a stage (in 1994) where they are of significant value as a management tool to organisations that administer geographically distributed assets, such as roads.

This report presents the results of a study undertaken in 1992 into the usefulness of spatial information systems (SIS) to Transit New Zealand and into the opportunities to utilise currently available SIS within Transit New Zealand operations.

The applicability of SIS as a management tool that would better facilitate the utilisation of the systems being used now, such as Road Assessment and Maintenance Management (RAMM), was investigated as well.

The objectives were to:

(a) Review the uses of information by Transit New Zealand, and determine Transit New Zealand's data and application requirements for spatial analysis,

(b) Develop concepts on how to apply spatial analysis capabilities within Transit New Zealand so as to provide the greatest benefit,

(c) Identify the available technology appropriate to Transit New Zealand's perceived needs,

(d) Analyse and assess the costs and benefits associated with the SIS concept(s) identified.

SIS[1], which encompass textual and graphical systems that manage data having geographic references, were the focus of the research. Where references are made in this report to Geographic Information Systems (GIS)[2], this term is, for the purposes of this study, to be considered the generic term for computer-based mapping systems.

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1 SIS - generic term for techniques for collecting, storing and retrieving spatial data collected from the real world.

2 GIS - a set of integrated techniques for collecting, storing, retrieving, transforming and displaying spatial data collected from the real world, that can be interrogated for analysis.

2. BACKGROUND

In January 1989 Transit New Zealand commissioned the Spatial Information Research Centre of University of Otago to undertake a research project into the feasibility of adding graphics capability to RAMM. This Otago report was delivered in February 1991 and the results indicated that some modifications to RAMM would be required before an acceptable interface could be achieved.

Now many of the local authorities (District Councils) which use RAMM to manage their road networks are investigating or acquiring GIS. This situation provides an opportunity for Transit New Zealand and other roading authorities to maximise the benefits of this technology by integrating RAMM with GIS.

Transit New Zealand therefore wishes to identify its requirements for spatial analysis capabilities and to investigate how such a system, if implemented, would affect its operations.

3. RESEARCH STUDY APPROACH

This study was undertaken as four separate tasks in accordance with the project brief (Reference: Transit New Zealand PR3-0083). The research study personnel are listed in Stage 1 Appendix 1. The activities involved in each task are set out below.

Task 1
Identify Transit New Zealand's spatial information needs by:

- a review of available documentation relating to existing systems used by Transit New Zealand that hold spatial information,
- interviews with nominated Transit New Zealand staff, in both Head Office and Auckland Regional Office,
- preparation of an SIS inventory,
- identification of concepts for SIS applicable to Transit New Zealand's needs.

Task 2
Identify appropriate SIS technology and evaluate the options which are available for each of the SIS concepts identified in Task 1 by:

- reviews of available SIS to identify those matching the current and perceived future requirements for spatial information analysis within Transit New Zealand,
- a survey of a limited number of SIS vendors to ascertain relevant products and costings to suit a major transportation organisation such as Transit New Zealand,
- a limited evaluation of these systems to determine the most appropriate technology for the identified concepts.

Task 3
Provide Transit New Zealand with an assessment of the costs and benefits of systems for each of the identified concepts by:

- benefit analysis workshops in both Transit New Zealand Head Office and Auckland Regional Office, to assist staff in procedures for completing benefit assessment forms;
- an estimate of the costs associated with each concept,
- an assessment of the benefits likely to accrue from each concept,
- an outline cost-benefit analysis for each concept.

Task 4
Produce a report encompassing the findings of the previous three tasks covering the following topics:

- spatial information needs for Transit New Zealand,
- systems available to meet the needs of Transit New Zealand,
- cost-benefit analysis for each concept.

4. TRANSIT NEW ZEALAND FUNCTIONS RELATING TO SPATIAL INFORMATION SYSTEMS

To more fully understand the functions of Transit New Zealand, as well as its relationships with government and transport related organisations, Figures 4.1 and 4.2 were developed. An inventory (Table 5.1) was also made of Transit New Zealand's existing use of systems, both computerised and manual, that either contain spatial data or refer to them, to show when and where they are utilised.

The inventory and diagrams show that Transit New Zealand uses a wide range of systems that contain information relating to a particular location on the state highway network. Thus the best starting place for determining Transit New Zealand's needs for spatial information is by considering its use of these existing systems.

For example, Figure 4.1 represents the principal functions performed by Transit New Zealand and the interactions between these functions. The activities performed within each functional area are listed in Stage 1 Appendix 2, which is not exhaustive as it lists only the activities that use spatial information.

Figure 4.2 identifies the interfaces and relationships between Transit New Zealand and other organisations involved in transportation in New Zealand.

Two significant functions performed by Transit New Zealand which require up-to-date, reliable and easily accessed information are:

- the development of strategies relating to the state highway network,
- the provision of advice to Government.

Both functions require support systems which can gather disparate pieces of information relating to the matter in question and provide an overall view of the pertinent issues. The SIS concepts presented in this report address these needs, each at a different level of sophistication.

Interviews with Transit New Zealand staff focused on their use of spatial information and related systems, manual and computerised, and of those containing spatially related information. Stage 1 Appendix 3 presents these systems and also the researchers' understanding of the activities that utilise the different systems.

Stage 1 Appendix 4 shows where each of the systems are used, whether they are manual or automated, and who is responsible for the data. The information in this table was obtained from interviews with Transit New Zealand Head Office and Auckland Regional Office staff.

Figure 4.1 Principle functions performed by Transit New Zealand, and their interactions.

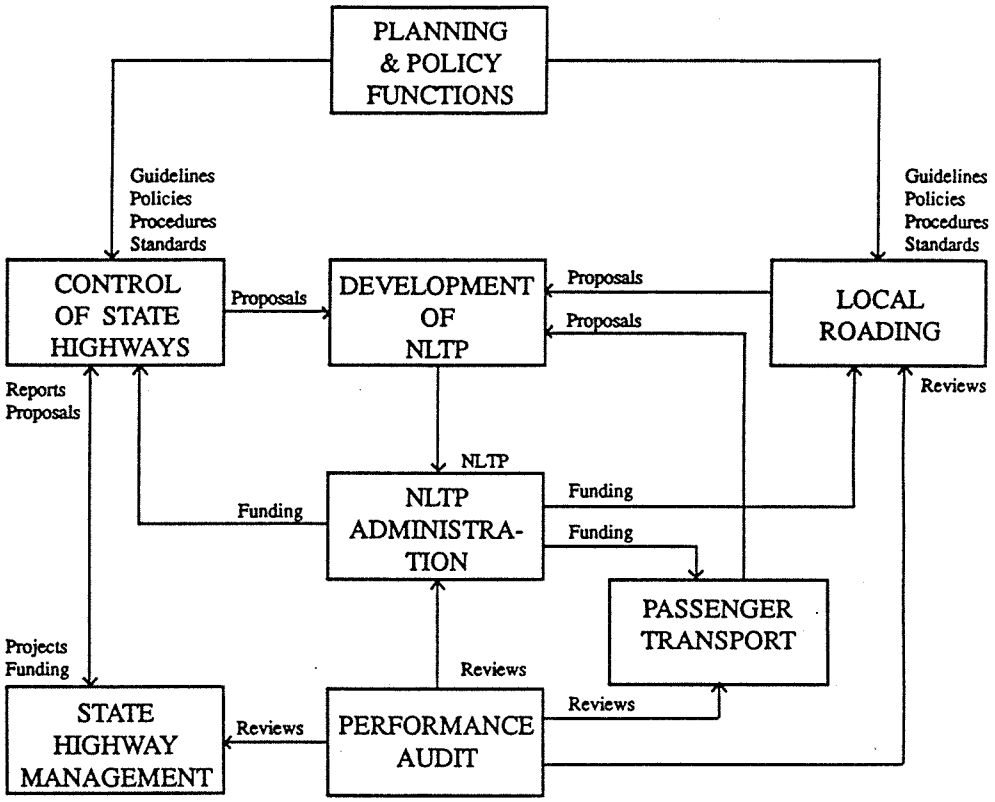
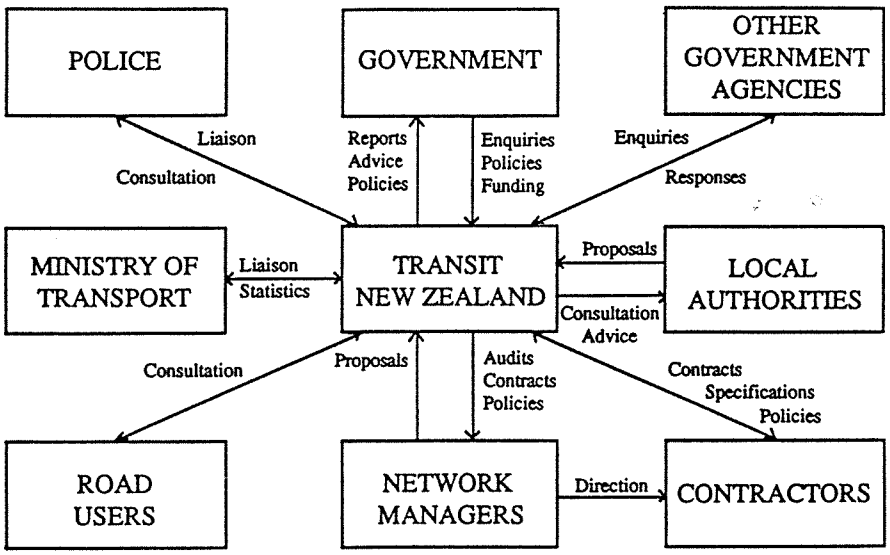


Figure 4.2 Transit New Zealand and its interfaces with other organisations.



5. CONCEPTUAL SOLUTIONS

The areas identified for applying an SIS to support Transit New Zealand operations are presented in Table 5.1.

From the information gathered during Task One of this project, three potential SIS concepts were identified which could be implemented independently or as a progression:

Concept 1: Spatial Information Indexing System,

Concept 2: Spatially Linked Information Indexing System,

Concept 3: Spatially Integrated Highway Management System.

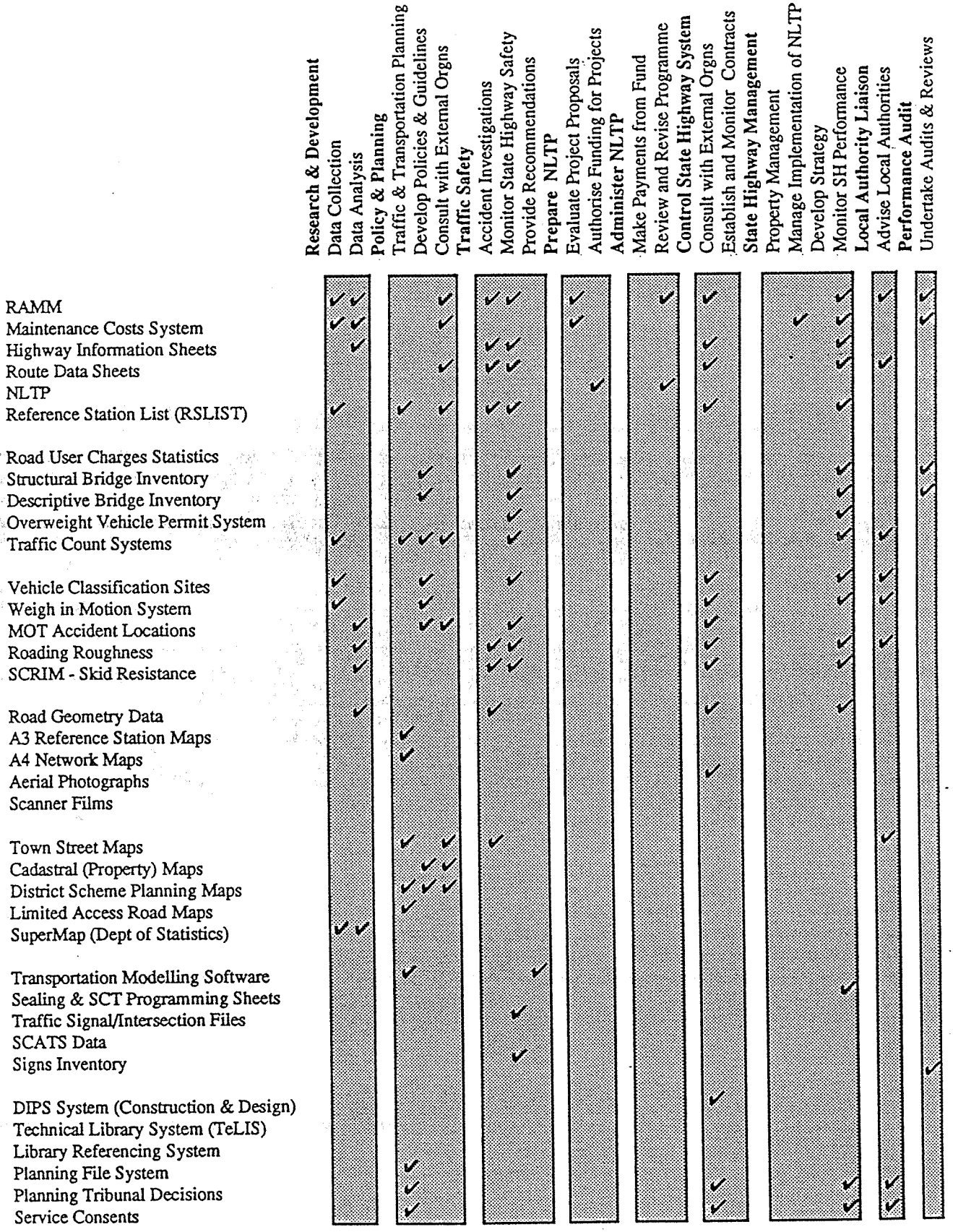
A significant influence on the development of these concepts is the degree to which the management and control of the stage highway network has been devolved to network management consultants and highway maintenance contractors.

The implication of this devolution is that many of the benefits normally obtained from SIS will accrue to Transit New Zealand consultants and contractors. As more Transit New Zealand functions are contracted out under competitive pricing policies, fewer operational management benefits from SIS will accrue directly to Transit New Zealand.

However, with a growing amount of information about the state of the road network being provided, Transit New Zealand needs to hold at least a subset of these data for its own needs as well as to reduce its reliance on consultants and contractors for information and for reference. Transit New Zealand also needs these data when it has to determine priorities.

The SIS concepts presented in this report have been developed with Transit New Zealand's principal role of controlling the network managers and contractors as the primary focus. The detail of the three SIS concepts is contained in Stage 1 Sections 8, 9 and 10.

Table 5.1 Areas identified where Transit New Zealand might apply spatial information systems.



6. BENEFIT ASSESSMENT

A limited number of Transit New Zealand staff were asked to determine the value of the benefits that would accrue from the implementation of an SIS. They had to identify and review their activities that would be likely to benefit from SIS and to estimate the potential impact the system would have on their jobs and/or Transit New Zealand operations.

The researchers provided Transit New Zealand staff with guidelines for completing the benefit assessment forms, to enable them to determine appropriate benefit values. Stage 1 Appendix 5 is a copy of these guidelines.

Most of the benefits were associated with time savings and, to value these, an hourly charge rate was requested from Transit New Zealand. It was agreed that a range of rates would be used to establish the sensitivity of the cost-benefit analysis to changes in the hourly charge rate. The three rates used are:

$50 per hour
$25 per hour
$20 per hour

Each benefit value was assigned a level of confidence reflecting the estimates made by Transit New Zealand staff of the probability of achieving the identified benefit. This was then used to discount the benefit values by the following factors:

Level of Confidence	Discount Factor
High	80%
Medium	50%
Low	20%

An example of a completed Benefit Assessment Form for Concept 1 is presented in Stage 1 Appendix 6.

To determine the basis for extrapolating the benefits estimated by Transit New Zealand Auckland Regional Office staff across the other Transit New Zealand regional offices, the State Highway Funding figures from the 1991/92 and 1992/93 National Land Transport Programmes (NLTP) were used. The regional office allocation of funds for each of the two NLTP years were totalled, and then averaged (Table 6.1). These averages were used for the extrapolation.

This approach was adopted in the absence of any agreed formula. It is accepted that some functions which are performed in the Auckland Regional Office are not replicated in other regional offices. The percentages calculated are considered only as a guideline and as being appropriate for this research study.

Table 6.1 Allocation of funds ($1000 units) for State Highways to Transit New Zealand regional offices, from National Land Transport Programmes (1991-92 and 1992-93).

Region	1991/92	1992/93	Average	%
Auckland	51,201	65,342	58,272	22
Hamilton	56,189	59,063	57,626	22
Napier	26,974	21,297	24,135	9
Wanganui	28,441	22,813	25,627	10
Wellington	29,301	29,035	29,168	11
Christchurch	43,426	35,840	39,633	15
Dunedin	31,826	25,536	28,681	11

The estimates of benefit are considered to be conservative because:

- limited consideration is given to the improvement of Transit New Zealand management information,
- the annual volumes are estimates only,
- they focus primarily on staff time savings associated with each activity,
- they do not include the potential benefit of avoiding further investments in capital and/or staff resources,
- staff are not intimately acquainted with, or in some cases have not been exposed to, the functions and capabilities of SIS,
- benefits accruing to the tax-payer and/or rate-payer, or the community as a whole, are not included,
- they were extensively modified through assignment of low or medium confidence levels,
- no allowance was made for potential revenues being raised through providing the public and/or other organisations with required information within desired time scales,
- not all staff originally interviewed were able to complete benefit assessment forms, which narrowed the range of activities for analysis.

While the predominant tangible benefit identified was saving time, other substantial but unquantifiable intangible benefits were considered. However, valuing such intangible benefits is difficult until more details are available on the functions that an SIS would perform. For this to be achieved, a more detailed investigation into Transit New Zealand's needs for, and use of, SIS will have to be undertaken.

The intangible benefits referred to above include:

- improved access by Transit New Zealand Head Office and regional offices to information collectively held by Transit New Zealand,
- reduced duplication of data throughout Transit New Zealand regional offices,
- standardisation of information being retained, both with the spatial and textual components,
- the ability to make better informed decisions knowing that all data relating to the issues in question have been considered.

Benefit assessment for each of the three SIS concepts is further discussed in Stage 1 Sections 8, 9 and 10.

7. COST ESTIMATIONS

Four vendors of SIS were asked for information about their products and for indicative costs of establishing a system based on the conceptual solutions described in Section 5. They were both low and high cost system suppliers.

The vendors and their products were:

Vendor	**Product**
Critchlow Associates	MapInfo
Eagle Technology	ARC/INFO ARC/VIEW
Intergraph	MicroStation (MGE)
Wang NZ	Genasys

Each vendor was asked for indicative prices covering:

- hardware and software,
- system customisation to suit the stated needs of Transit New Zealand,
- training and system implementation requirements,
- on-going system support and maintenance costs,
- any other costs expected to be incurred in the establishment of the proposed systems.

The indicative costs provided by the vendors were subject to a considerable number of caveats concerning their accuracy. This was primarily related to the vendor having only a generalised specification of system requirements to price against.

The cost schedules are subject to the following specific comments:

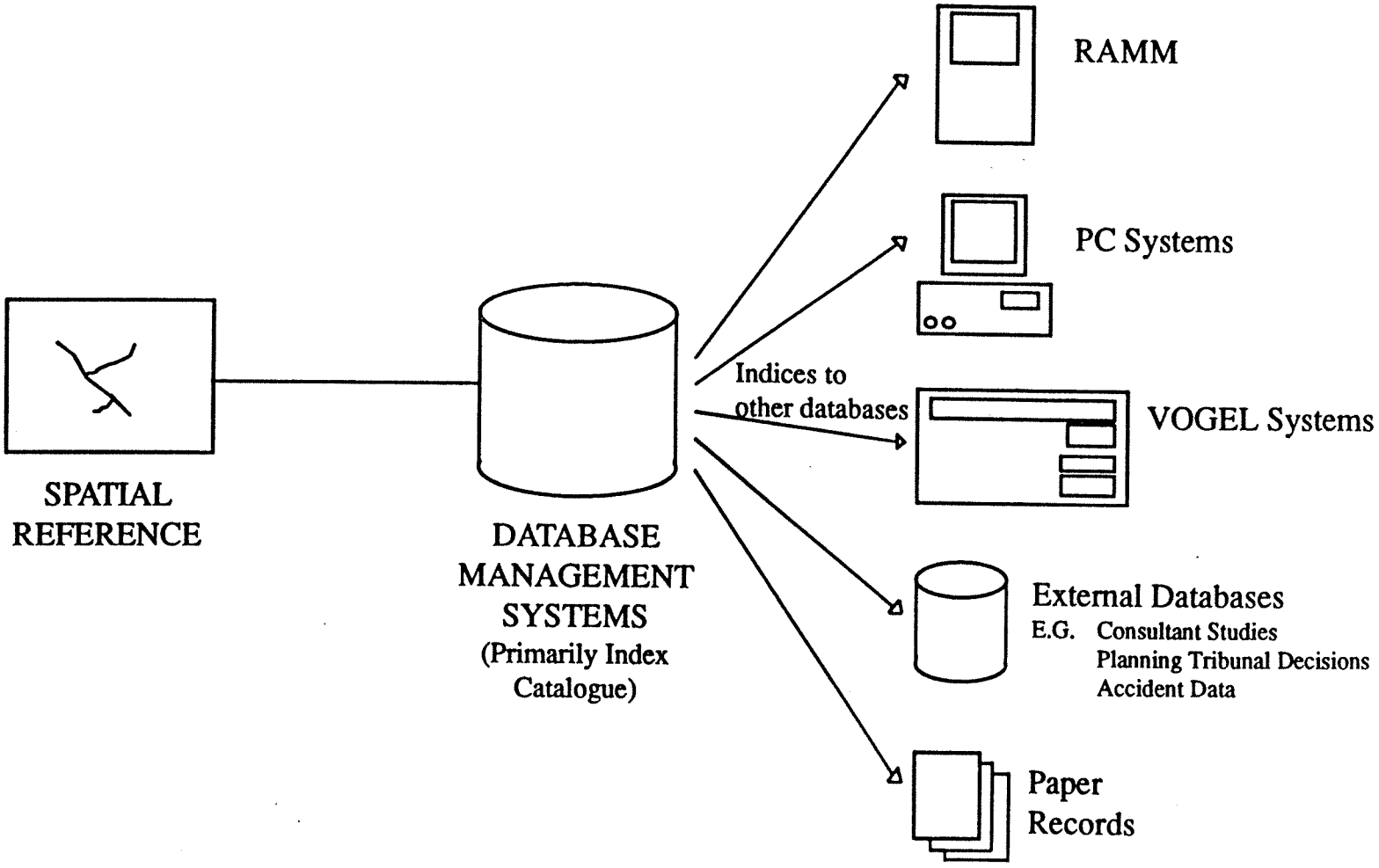
- vendors had only limited information upon which to estimate costs and have therefore priced conservatively,
- costs are based on retail price lists and some discounting would normally be expected in a competitive selection process,
- the exact system sizing and application requirements have not been determined which makes the system customisation difficult to estimate,
- the project estimates include only direct external costs and no estimate has been made of the amount of time that Transit New Zealand staff would have to commit to the project.

Because of the limited scope of the research study it was not possible to estimate the costs of converting existing Transit New Zealand data into the appropriate format.

Cost estimates for each of the three SIS concepts are further discussed in Stage 1 Sections 8, 9 and 10.

Figure 8.1 Concept 1 - Spatial information index system.

CONCEPT DIAGRAM



8. CONCEPT 1 - SPATIAL INFORMATION INDEXING SYSTEM

8.1 Introduction

Concept 1 provides for the establishment of an SIS which would reference in spatial terms the large amount of information that Transit New Zealand collects, stores, maintains and distributes. It would in effect be a catalogue to the different systems already existing in Transit New Zealand. Enquiries about a location shown on a map of the road network would result in the display and/or printing of a list of the available information related to the section of network selected.

Figure 8.1 presents this concept in diagrammatic form. The textual database linked to the computer network would hold references to information (construction drawings, safety reports, project proposals, accident reports, etc.) relating to sections of the state highway network. The textual database would require regular maintenance to remain useful, as it incorporates the identification of the particular part of the network the information relates to and the entry of the appropriate reference and/or index to the information.

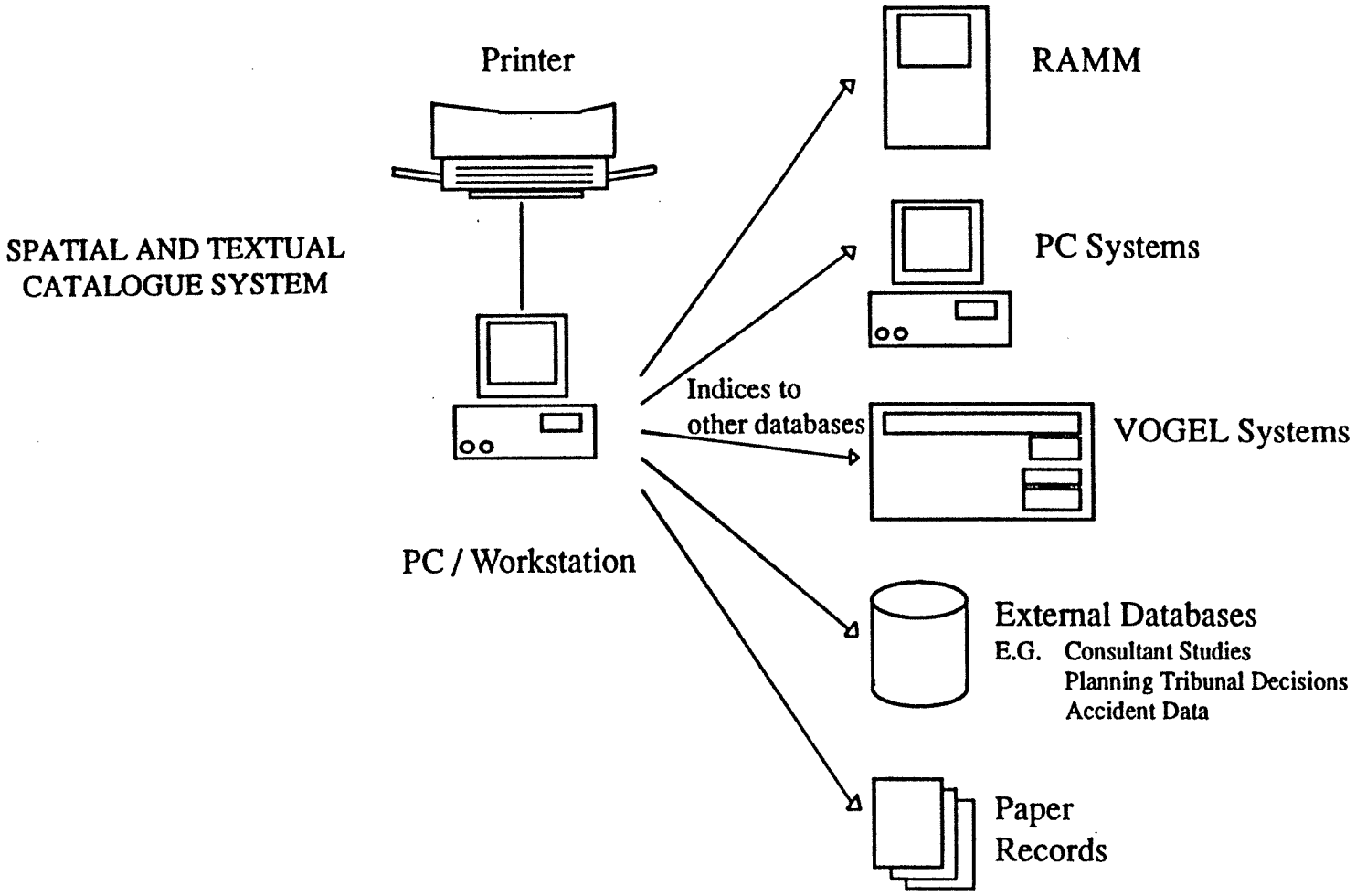
The characteristics of this concept are as follows:

- schematic diagrams of roading network to be the primary spatial reference,
- information access to be based on standard location reference,
- geographic representations and databases to be developed to support specific projects,
- Transit New Zealand regional office systems to operate autonomously,
- Transit New Zealand Head Office system to consolidate its regional office data,
- systems are likely to be PC-based,
- systems to be relatively simple and low cost,
- systems to have minimal impact on existing systems and organisation.

This concept could be considered as a complete solution, or it could be used as an initial step towards a more complex system which might incorporate more direct links to existing and future databases.

Figure 8.2 Concept 1 - Spatial information index system.

POTENTIAL HEAD OFFICE AND REGIONAL OFFICE CONFIGURATION



8.2 Suitable Technology

A suitable technology for Concept 1 is represented in Figure 8.2. Concept 1 can be considered as a text-based records management system with the spatial component as an extension. This concept recognises that most of the information relating to the state highway network held by Transit New Zealand is paper-based and identifies two technologies that are potentially suitable:

- textual records management systems,
- combination of spatial and textual systems.

8.2.1 Textual Records Management System

A records management system is a comprehensive indexing and retrieval system, used to manage the filing of all documents in a large organisation.

Access keys to information held in the system would be textual, i.e. street or road section name, or reference station code. A textual records management system appropriate for Concept 1 could possibly include:

- PC or workstation hardware,
- DOS or UNIX operating systems,
- textual spatial references (e.g. reference station codes),
- selection of information by predefined categories,
- integration with a project management system,
- a complaints register,
- potential extension into document imaging.

Products available for records management systems include:

- Computer Aided Records Management System (CARMS),
- The Under Secretary Records Management System,
- Recall Plus,
- File Track (Transit New Zealand document tracking system).

8.2.2 Combination of Spatial and Textual Systems

The introduction of the spatial component provides a graphics display of the road network to identify and locate the textual information associated with the particular section of road.

Characteristics of SIS suitable for this concept could include:

- PC or workstation hardware,
- DOS or UNIX operating systems,
- PC or workstation designed spatial software applications or a subset of software originally designed for more powerful computers,
- limited spatial analysis capabilities,
- schematic representation of the state highway network,
- textual and spatial indices,
- the potential extensions to the textual database listed under the textual records management system.

Two types of graphical presentation software could potentially meet the needs of Concept 1. These are:

- *Computer Aided Draughting-based GIS* - primarily technical design graphics with limited attribute file support. Examples of packages include:
  - Autocad
  - Versacad

- *Desktop GIS* - graphics capability with database functionality for analysis. Examples of packages include:
  - PC ARC/INFO
  - ARC/VIEW
  - MapInfo
  - GS Map
  - MapGrafix

8.3 Benefit Assessment

The net (discounted) financial benefits for Concept 1 for Transit New Zealand's Head and regional offices are shown in Table 8.1.

Table 8.1 Concept 1 - Annual financial benefits
(based on three different hourly charge rates).

Region	**$ per Annum (rounded to $100) Hourly charge rates**		
	$20	**$25**	**$50**
Auckland	1,000	1,300	2,600
Hamilton	1,000	1,300	2,500
Napier	400	500	1,100
Wanganui	500	600	1,100
Wellington	500	600	1,300
Christchurch	700	900	1,700
Dunedin	500	600	1,300
Head Office	14,400	18,000	35,900
Total	**19,000**	**23,800**	**47,500**

Assessments of activity benefits for Concept 1 are provided in Stage 1 Appendix 7. While some of the activities receive no benefits from Concept 1 they have been included to provide a comparison with these same activities in Concepts 2 and 3.

The benefit values were extended over five years to provide an insight into the financial worth of the project over this period. It has been assumed that no benefits would accrue during the first year as it is estimated that the system would take at least twelve months to establish across all eight Transit New Zealand offices.

The estimates of benefit provided by Transit New Zealand staff were adjusted for inflation at a rate of +2.0% per year, which is the current average of inflation projections for 1992 - 1996. These estimated net monetary benefits are presented in Table 8.2 and were used in the analysis of the cost-benefit ratio for Concept 1.

Table 8.2 Concept 1 - Estimated net monetary benefits.

Annual Increase 2%

Region	% of SH Funds	Year 1	Year 2			Year 3			Year 4			Year 5		
			$ 20	$ 25	$ 50	$ 20	$ 25	$ 50	$ 20	$ 25	$ 50	$ 20	$ 25	$ 50
Auckland	22.14	0	1,032	1,290	2,579	1,053	1,316	2,631	1,074	1,342	2,683	1,095	1,369	2,737
Hamilton	21.91	0	1,021	1,276	2,552	1,041	1,302	2,603	1,062	1,328	2,655	1,083	1,354	2,708
Napier	9.17	0	427	534	1,068	436	545	1,089	444	556	1,111	453	567	1,133
Wanganui	9.74	0	454	567	1,134	463	578	1,157	472	590	1,180	482	602	1,203
Wellington	11.08	0	516	645	1,290	526	658	1,316	537	671	1,342	548	684	1,369
Christchurch	15.06	0	702	877	1,754	716	895	1,789	730	912	1,825	745	931	1,861
Dunedin	10.90	0	508	635	1,269	518	648	1,294	529	661	1,320	539	674	1,347
Head Office	-	0	14,360	17,950	35,900	14,647	18,309	36,618	14,940	18,675	37,350	15,239	19,049	38,097
Total	**100.00**	**0**	**19,020**	**23,774**	**47,546**	**19,400**	**24,249**	**48,497**	**19,788**	**24,734**	**49,467**	**20,184**	**25,229**	**50,456**

8.4 Cost Estimation

An indicative project cost schedule for Concept 1 (Table 8.3) was developed, based on the costs supplied by the vendors. These figures are representative of one system being implemented in Transit New Zealand Head Office and in each of its seven regional offices .

These costs were extended over a five-year period to establish the expenditure required to support Concept 1, and the annual cost estimates have each been adjusted by +2% to allow for inflation. The extended and adjusted costs are presented in Table 8.4.

The projection was limited to five years because towards the end of that period a large part of the system infrastructure, especially the hardware, would be replaced with more up-to-date equipment. Therefore any projected estimates of the capital expenditure are likely to be inaccurate. The assumption is also made that the conceptual solution would be replaced or advanced within this time frame.

8.5 Cost-Benefit Analysis

The cost-benefit analysis is based on the comparison of the costs over the five-year period with the benefits estimated by Transit New Zealand staff, and the results are presented in Table 8.5. The costs and benefits associated with Concept 1 are presented as annual values as well as accumulated values. (Note that the annual maintenance costs for year 1 reflect a 3-month warranty period.)

Focusing on annual values for Concept 1, the benefits exceed the costs only when the rate used to value time savings is set at $50 per hour.

However, when the establishment costs incurred in year one are included in the equation, by accumulating all the costs and comparing them with the accumulated benefits, this concept is not likely to provide a positive return on investment.

This analysis has been based on the indicative costs provided by the vendors and on the conservative benefit calculations by Transit New Zealand staff, so it is subject to the assumptions and caveats outlined in Stage 1 Sections 6 and 7 of this report.

Table 8.3 Concept 1 - Cost estimates.

Establishment Costs (8 sites) (excludes GST)	**$**	**Notes**
Hardware		
8 Workstations	80,000	
8 Printers	40,000	
Total Hardware	120,000	
Software		
Desktop GIS	25,000	
Records management	13,000	
Total Software	38,000	
Installation		
Customisation	5,000	
Training and implementation	20,000	
Total Installation Costs	25,000	
Digital Data	20,000	1
Total Establishment Costs	**203,000**	

Annual Costs (excludes GST)	**$**	**Notes**
Maintenance		
Hardware	14,400	2
Software	3,360	3
Telephone Support	8,000	
Consumables	8,000	4
Total Annual Costs	**33,760**	

Notes:

1. Based on estimates received from DOSLI.
2. Based on 12% of the average vendors' maintenance fees.
3. Based on 12% of the average vendors' maintenance fees.
4. Consumables, e.g. printer cartridges, back-up tapes, etc.

Table 8.4 Concept 1 - Expenditure budget.

Establishment Costs (excludes GST)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Hardware	120,000				
Software	38,000				
Installation	25,000				
Data	20,000				
Total Establishment Costs	**203,000**				

Annual Costs (2% increase pa)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Maintenance (see note)					
Hardware	10,800	14,688	14,981	15,281	15,587
Software	2,520	3,427	3,495	3,565	3,636
Support	8,000	8,160	8,323	8,489	8,659
Consumables	8,000	8,160	8,323	8,489	8,659
Total Annual Costs	**29,320**	**34,435**	**35,122**	**35,824**	**36,541**

Total Costs	**232,320**	**34,435**	**35,122**	**35,824**	**36,541**
Accumulated Costs	**232,320**	**266,755**	**301,877**	**337,701**	**374,242**

Notes:

Annual maintenance costs for Year 1 reflect a 3-month warranty period.

Table 8.5 Concept 1 - Cost-benefit analysis.

	Year 1			Year 2			Year 3			Year 4			Year 5		
Hourly Rate	**$20**	**$25**	**$50**	**$20**	**$25**	**$50**	**$20**	**$25**	**$50**	**$20**	**$25**	**$50**	**$20**	**$25**	**$50**
Annual Benefits															
Time saving	0	0	0	19,020	23,774	47,546	19,400	24,249	48,497	19,788	24,734	49,467	20,184	25,229	50,456
Total Benefit	0	0	0	19,020	23,774	47,546	19,400	24,249	48,497	19,788	24,734	49,467	20,184	25,229	50,456
Establishment Costs	203,000	203,000	203,000	0	0	0	0	0	0	0	0	0	0	0	0
Annual Costs	29,320	29,320	29,320	34,435	34,435	34,435	35,122	35,122	35,122	35,824	35,824	35,824	36,541	36,541	36,541
Total Costs	232,320	232,320	232,320	34,435	34,435	34,435	35,122	35,122	35,122	35,824	35,824	35,824	36,541	36,541	36,541
Annual Outcome	(232,320)	(232,320)	(232,320)	(15,415)	(10,661)	13,111	(15,722)	(10,873)	13,375	(16,036)	(11,090)	13,643	(16,357)	(11,312)	13,915
Accumulated Benefits															
Time Saving	0	0	0	19,020	23,774	47,546	38,420	48,023	96,043	58,208	72,757	145,570	78,392	97,986	195,966
Total Acc Benefits	0	0	0	19,020	23,774	47,546	38,420	48,023	96,043	58,208	72,757	145,570	78,392	97,986	195,966
Accumulated Costs	232,320	232,320	232,320	266,755	266,755	266,755	301,877	301,877	301,877	337,701	337,701	337,701	374,242	374,242	374,242
Accumulated Outcome	**(232,320)**	**(232,320)**	**(232,320)**	**(247,735)**	**(242,981)**	**(219,209)**	**(263,457)**	**(253,854)**	**(205,834)**	**(279,493)**	**(264,944)**	**(192,131)**	**(295,850)**	**(276,256)**	**(178,276)**

Note: Annual maintenance costs for year 1 reflect a 3-month warranty period.

8.6 Discussion

Concept 1 is based on a preference for a primarily textual records management system, interfacing with a limited function SIS system and is likely to include:

- PC or workstation equipment in Head Office and each regional office,
- a records management system integrated with a basic GIS system,
- an index or catalogue to other systems,
- schematic representation of the road network.

The issues requiring consideration prior to the implementation of Concept 1 include:

- Extent of catalogues (how many current systems, both computerised and paper, are likely to be incorporated?),
- Choice of catalogue categories (what are the subjects that Transit New Zealand is likely to enquire about?),
- Extent of road networks (should this cover the whole network including local minor roads?).

8.7 Conclusion

Based on the benefit estimates developed from information supplied by Transit New Zealand staff for Concept 1 and the cost estimates developed from the vendors' costings of the systems, the establishment of an SIS around Concept 1 would not be considered a worthwhile investment.

The many assumptions made in the development of the cost-benefit analysis and the caveats placed on much of the financial information used in this study, indicate that a more detailed study of Concept 1 is required.

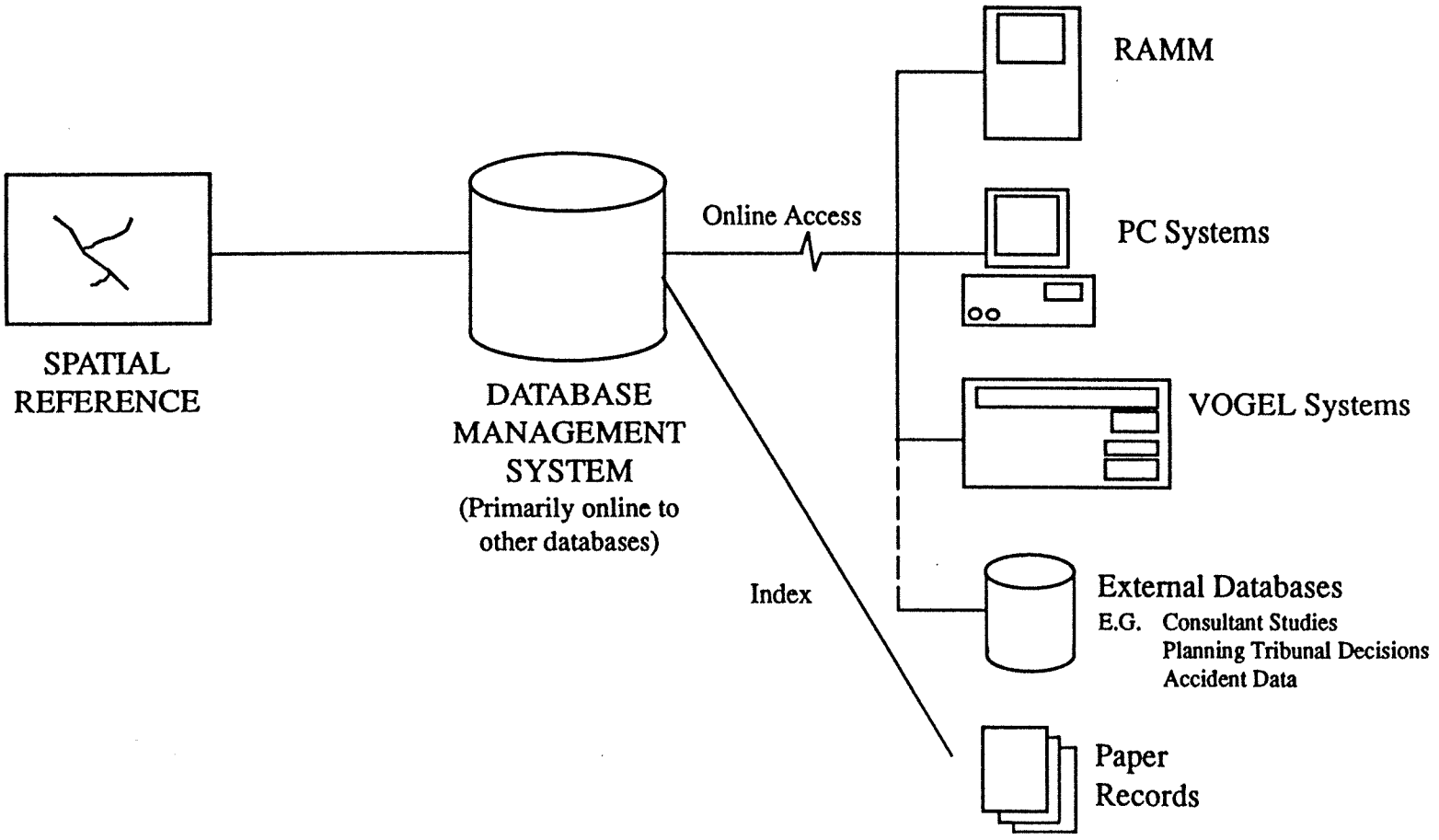
While some system customisation and training would be required for Concept 1 to become operational, considerable attention would have to be paid to the identification and cataloguing of information presently held in each Transit New Zealand office.

The system design, if Concept 1 is adopted, should also incorporate a national index which would allow access to information relating to similar roads in different parts of the country.

While this approach to SIS for Concept 1 would be expected to provide Transit New Zealand with a cost-effective index to its spatial records, future expansion to a more functional system may require the adoption of a basic GIS in place of the CAD system. The package selection criteria would therefore need to include the ability to transfer to a more functionally advanced system at a later date.

Figure 9.1 Concept 2 - Spatially linked information index system.

CONCEPT DIAGRAM



9. CONCEPT 2 - SPATIALLY LINKED INFORMATION INDEXING SYSTEM

9.1 Introduction

Concept 2 is an advance on Concept 1 as it provides for network access to existing and future computerised databases. Depending on the future direction of Transit New Zealand and the perceived level of needs to match its potential future roles, these links could be extended to connect into external databases. Figure 9.1 represents the concept in diagrammatic form.

The system would still maintain indices to paper-based systems. Computer-based catalogues could, accepting connectivity limitations, be linked to the SIS.

The characteristics of this concept are as follows:

- both schematic and geographic representations of the roading network to be available,
- information access to be based on a standard location reference,
- database management system to control the interface between the spatial representation and the associated information databases,
- new databases to be developed on the spatial information referencing system,
- ability to provide indices as paper-based records to be retained, where necessary,
- Transit New Zealand regional office systems to operate independently of the Head Office system,
- Transit New Zealand Head Office system to consolidate its regional office data,
- system to be based on a network between Transit New Zealand regional offices, Head Office and Vogel Computer Services, and potentially with other external databases,
- a higher level of automated maintenance of the spatial index to be incorporated.

The major advance in this concept over Concept 1 is the introduction of more advanced spatial analysis capabilities. These would allow for analysis and interpretation of multiple pieces of information relating to the same or similar sections of the state highway network. Concept 2 focuses more on spatial analysis and the potential for digital access to other computer data files.

Implementation of Concept 2 would provide Transit New Zealand with the initiative to computerise many existing manual records systems. As explained in Section 7, estimating the costs of such an implementation were not part of the brief for this study. However, such an estimation of costs would be necessary to enable a cost-benefit analysis of spatially related data using the analytical functions of SIS.

9.2 Suitable Technology

9.2.1 Textual Records Management System

All the elements relating to textual-based records management systems mentioned for Concept 1 are applicable to Concept 2. However, the hardware necessary to support the extended networking applications would need to be upgraded to file servers and workstations.

The increase in system functionality would allow:

- linkages to other databases (e.g. NLTP, RAMM, Vogel systems),
- a wider choice of databases (e.g. Oracle, Informix, Ingres),
- dynamic maintenance of digital indices held on other systems.

The existing cataloguing and index systems would still need to be maintained as Concept 2 is essentially a link or index to many other systems, both manual and computerised.

However, textual-based records management systems are not seen as appropriate for this concept as they do not provide the spatial component which is its key element. Spatial functionality provides for analytical capabilities, an example of which is to:

- display the location of all bridges on State Highway 2, which have ages greater than 30 years, with traffic volumes greater than 5000 vehicles per day.

The applicability of a textual database for this concept is also hindered by the lack of a commercially available system that could be applied to highway management in New Zealand. Such a system would require considerable custom software development to meet Transit New Zealand needs.

9.2.2 Combination of Spatial and Textual Systems

As Concept 2 provides for more spatial analysis, it is likely to include:

- networking capabilities between Transit New Zealand Head Office and its regional offices,
- file servers and workstations,
- a centralised database, maintained at Transit New Zealand Head Office with potential for subsets of this data to be available on autonomous systems in Transit New Zealand's regional offices,

- geographical representation of roading networks as a primary spatial interface,
- schematic representation available for national analysis,
- decision support tools available through a range of analytical tools and query systems,
- access for possible future external users (consultants or other road control authorities),
- potential for further development of new or existing systems within Transit New Zealand.

SIS which might be expected to meet the more sophisticated requirements of this concept include, but are not limited to, generic GIS products such as:

- ARC/INFO,
- Modular GIS Environment (MGE),
- Genamap.

9.3 Benefit Assessment

The majority of benefits identified with Concept 2 are in terms of time savings. Other savings identified were with operational contracts in the traffic monitoring (Transit New Zealand Head Office) and maintenance management (Transit New Zealand Auckland Regional Office). The net discounted financial benefits for Concept 2 for Transit New Zealand Head Office and each regional office are shown in Table 9.1.

Table 9.1 Concept 2 - Annual financial benefits
(based on three different rates of hourly charges).

Region	**$ per Annum (rounded to $100)**			
	Hourly charge rates			**Other Savings**
	$20	**$25**	**$50**	
Auckland	9,000	11,200	22,400	51,800
Hamilton	8,900	11,100	22,200	
Napier	3,700	4,700	9,300	
Wanganui	3,900	4,900	9,900	
Wellington	4,500	5,600	11,300	
Christchurch	6,100	7,600	15,200	
Dunedin	4,400	5,500	11,000	
Head Office	43,300	54,700	109,300	25,950
Total	**83,800**	**105,300**	**210,600**	**77,750**

Detailed activity benefits for Concept 2 are presented in Stage 1 Appendix 8. The benefit values were extended over 5 years to provide the financial worth of the project over a long period. No benefits were considered to accrue in the first 12 months.

The average annual inflation rate of +2% was used when adjusting the benefit values and these figures are presented in Table 9.2.

The intangible benefits listed for Concept 1 also apply to Concept 2. Further intangible benefits, not allowed for in the benefit assessment, include:

- a geographical linking of textual data with the road land base,
- improved accuracy of information as old data are converted and new data are input according to pre-defined standards for text and graphics,
- data analysis functionality, that would not be available under Concept 1,
- access to national data using on-line networking facilities.

To determine the potential value of these intangible benefits would necessitate a more comprehensive requirements study to be undertaken and development of a detailed system specification.

9.4 Cost Estimation

The indicative costs, as supplied by the vendor, for Concept 2 are presented in Table 9.3. These figures represent the implementation of one system into Transit New Zealand Head Office and each of its seven regional offices.

The cost schedule is considered to be conservative for the reasons given in Section 7. The costs were extended over a five-year period to establish the expenditure required to support Concept 2. The annual cost estimates have also been adjusted by +2% to allow for current inflation rates. These adjusted and extended costs are presented in Table 9.4.

9.5 Cost-Benefit Analysis

The development of the cost-benefit ratio for Concept 2 is based on the comparison of the costs over the five-year period with the benefits estimated by Transit New Zealand staff and presented in Table 9.5. (Note that the annual maintenance costs for year 1 reflect a 3-month warranty period.)

This analysis has been based on indicative costs provided by the vendors and on the conservative benefits provided by Transit New Zealand staff, and is subject to the assumptions and caveats outlined in Stage 1 Sections 6 and 7 of this report.

Table 9.2 Concept 2 - Estimated net monetary benefits.

Annual Increase 2%

Region	% of SH Funds	Year 1	Year 2				Year 3				Year 4				Year 5			
			$ 20	$ 25	$ 50	Other	$ 20	$ 25	$ 50	Other	$ 20	$ 25	$ 50	Other	$ 20	$ 25	$ 50	Other
Auckland	22.14	0	8,971	11,213	22,427	51,800	9,150	11,437	22,876	52,836	9,333	11,666	23,333	53,893	9,520	11,899	23,800	54,971
Hamilton	21.91	0	8,877	11,096	22,194		9,055	11,318	22,638		9,236	11,544	23,091		9,420	11,775	23,552	
Napier	9.17	0	3,715	4,644	9,288		3,789	4,737	9,474		3,865	4,832	9,663		3,942	4,928	9,856	
Wanganui	9.74	0	3,946	4,932	9,866		4,025	5,031	10,063		4,105	5,131	10,265		4,188	5,234	10,470	
Wellington	11.08	0	4,489	5,611	11,223		4,579	5,723	11,447		4,670	5,838	11,676		4,764	5,954	11,910	
Christchurch	15.06	0	6,102	7,627	15,255		6,224	7,780	15,560		6,349	7,935	15,871		6,475	8,094	16,189	
Dunedin	10.90	0	4,416	5,520	11,041		4,504	5,630	11,262		4,594	5,743	11,487		4,686	5,858	11,717	
Head Office	-	0	43,326	54,637	109,275	25,950	44,193	55,730	111,461	26,469	45,076	56,844	113,690	26,998	45,978	57,981	115,964	27,538
Total	**100.00**	**0**	**83,842**	**105,280**	**210,569**	**77,750**	**85,519**	**107,386**	**214,780**	**79,305**	**87,229**	**109,533**	**219,076**	**80,891**	**88,974**	**111,724**	**223,458**	**82,509**

Table 9.3 Concept 2 - Cost estimates.

Establishment Costs (8 sites) (excludes GST)	$	Notes
Hardware		
8 Workstations	435,000	
8 Printers	40,000	
8 Plotters	64,000	
Total Hardware	539,000	
Software		
GIS	422,000	
Database	33,000	
Total Software	455,000	
Installation		
System Customisation	2,100	
Training and Implementation	21,000	
Total Implementation Costs	23,100	
Digital Data	53,000	1
Total Establishment Costs	**1,070,100**	

Annual Costs (excludes GST)		$	Notes
Maintenance			
Hardware		64,680	2
Software	GIS	50,640	3
	Database	5,000	4
		120,320	
Support		8,000	
Consumables		16,000	5
Total Annual Costs		**144,320**	

Notes:

1. Based on estimates received from DOSLI.
2. Based on 12% of the average vendors' maintenance fees.
3. Based on 12% of the average vendors' maintenance fees.
4. Based on 15% of the average vendors' maintenance fees.
5. Consumables, e.g. printer cartridges, back-up tapes, paper supplies, plotter supplies, etc.

Table 9.4 Concept 2 - Expenditure budget.

Establishment Costs (excludes GST)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Hardware	539,000				
Software	455,000				
Installation	23,100				
Data	53,000				
Total Establishment Costs	**1,070,100**				

Annual Costs (2% increase pa)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Maintenance (see note)					
Hardware	48,510	65,973	67,293	68,638	70,011
Software	41,730	56,752	57,887	59,045	60,226
Support	8,000	8,160	8,323	8,489	8,659
Consumables	16,000	16,320	16,646	16,979	17,319
Total Annual Costs	**114,240**	**147,205**	**150,149**	**153,151**	**156,215**

Total Costs	**1,184,340**	**147,205**	**150,149**	**153,151**	**156,215**
Accumulated Costs	**1,184,340**	**1,331,545**	**1,481,694**	**1,634,845**	**1,791,060**

Notes:
Annual maintenance costs for Year 1 reflect a 3-month warranty period.

Table 9.5 Concept 2 - Cost-benefit analysis.

Hourly Rate	Year 1			Year 2			Year 3			Year 4			Year 5		
	$20	$25	$50	$20	$25	$50	$20	$25	$50	$20	$25	$50	$20	$25	$50
Annual Benefits															
Time Saving	0	0	0	83,842	105,280	210,569	85,519	107,386	214,780	87,229	109,533	219,076	88,974	111,724	223,458
Other	0	0	0	77,750	77,750	77,750	79,305	79,305	79,305	80,891	80,891	80,891	82,509	82,509	82,509
Total Benefits	0	0	0	161,592	183,030	288,319	164,824	186,691	294,085	168,120	190,424	299,967	171,483	194,233	305,967
Establishment Costs	1,070,100	1,070,100	1,070,100	0	0	0	0	0	0	0	0	0	0	0	0
Annual Costs	114,240	114,240	114,240	147,205	147,205	147,205	150,149	150,149	150,149	153,151	153,151	153,151	156,215	156,215	156,215
Total Costs	1,184,340	1,184,340	1,184,340	147,205	147,205	147,205	150,149	150,149	150,149	153,151	153,151	153,151	156,215	156,215	156,215
Annual Outcome	(1,184,340)	(1,184,340)	(1,184,340)	14,387	35,825	141,114	14,675	36,542	143,936	14,969	37,273	146,816	15,268	38,018	149,752
Accumulated Benefits															
Time Saving	0	0	0	83,842	105,280	210,569	169,361	212,666	425,349	256,590	322,199	644,425	345,564	433,923	867,883
Other	0	0	0	77,750	77,750	77,750	157,055	157,055	157,055	237,946	237,946	237,946	320,455	320,455	320,455
Total Acc Benefits	0	0	0	161,592	183,030	288,319	326,416	369,721	582,404	494,536	560,145	882,371	666,019	754,378	1,188,338
Accumulated Costs	1,184,340	1,184,340	1,184,340	1,331,545	1,331,545	1,331,545	1,481,694	1,481,694	1,481,694	1,634,845	1,634,845	1,634,845	1,791,060	1,791,060	1,791,060
Accumulated Outcome	(1,184,340)	(1,184,340)	(1,184,340)	(1,169,953)	(1,148,515)	(1,043,226)	(1,155,278)	(1,111,973)	(899,290)	(1,140,309)	(1,074,700)	(752,474)	(1,125,041)	(1,036,682)	(602,722)

Anticipated Annual (non-time) benefits 77,750

Note: Annual maintenance costs for year 1 reflect a 3-month warranty period.

9.6 Discussion

The most appropriate solution for Concept 2 is a spatially orientated system. Characteristics of such a system are represented in Figure 9.2 and are likely to include:

- high powered workstations,
- greater orientation towards spatial data,
- a GIS with greater analytical ability,
- both textual and spatial database access,
- linkages to other databases.

This approach may require substantial changes to existing systems and the extent of the changes would need to be defined by a detailed requirements study. The development of such a system and the modification to existing systems needs to be managed within the context of an overall Information Systems strategy for Transit New Zealand.

With the online access proposed in this concept, the use of a geographic representation of the network needs to be addressed with regard to such issues as communications requirements and maintenance of the road network diagram.

Because of the complexity of accessing graphic data over a telecommunications network, it may be more practical to distribute the spatial component of the database to all Transit New Zealand regional offices while the textual information only is accessed across the network.

9.7 Conclusion

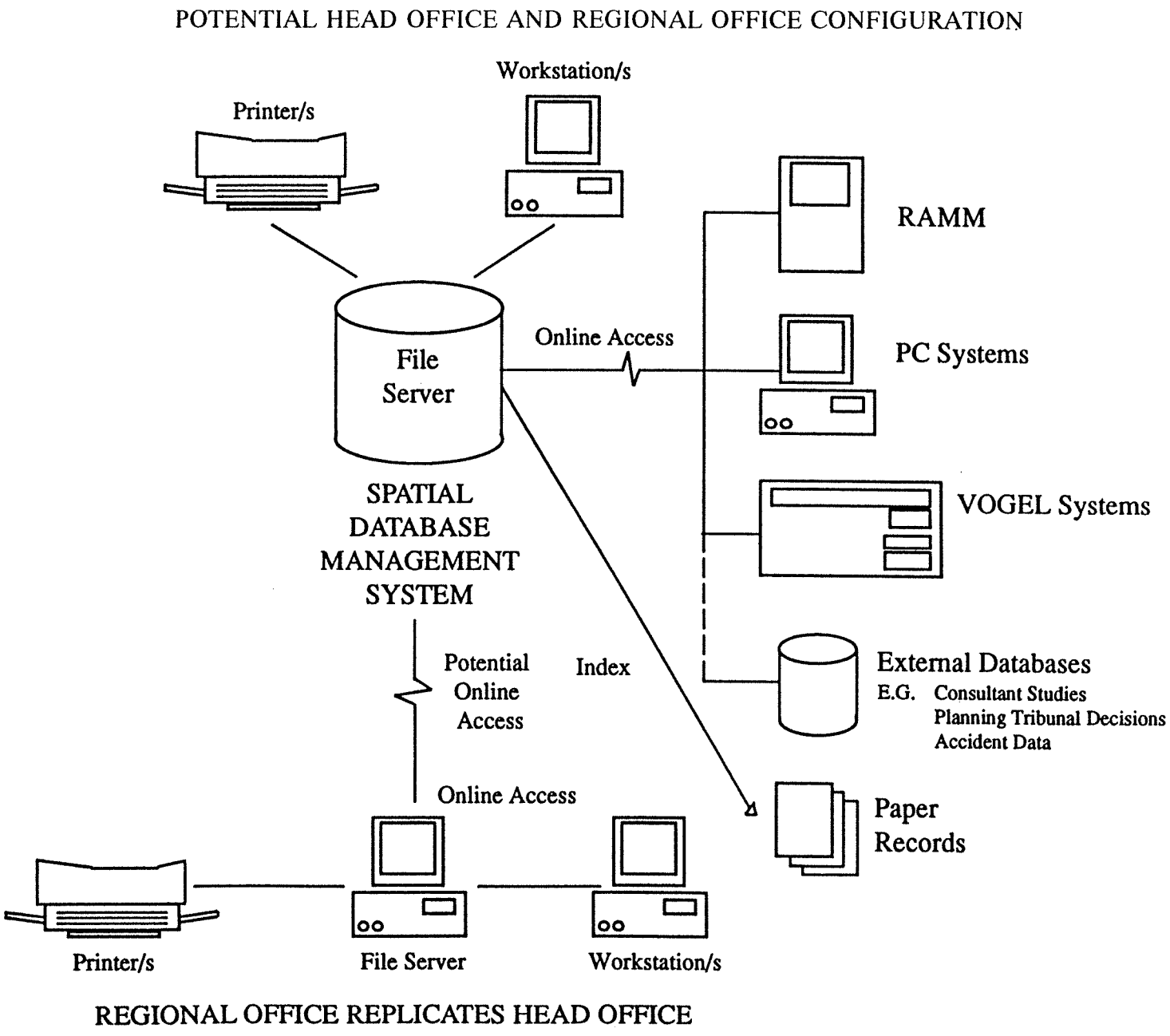
Based on the benefit estimates developed from information supplied by Transit New Zealand staff for Concept 2 and the cost estimates developed from the vendors' costing of the systems, the establishment of an SIS based around Concept 2 could not be considered a worthwhile investment.

The many assumptions made in the development of the cost-benefit analysis and the caveats placed on much of the financial information used in this study, indicate that a more detailed study of Concept 2 is required.

Although developments for SIS for roading applications are occurring overseas, the adoption of one of these packages would need customisation and development based on Transit New Zealand's specific requirements.

Data collection and data preparation are of critical importance. All of Transit New Zealand's existing records would still need to be catalogued and indexed to allow easy conversion of information into digital form.

Figure 9.2 Concept 2 - Spatially linked information index system.

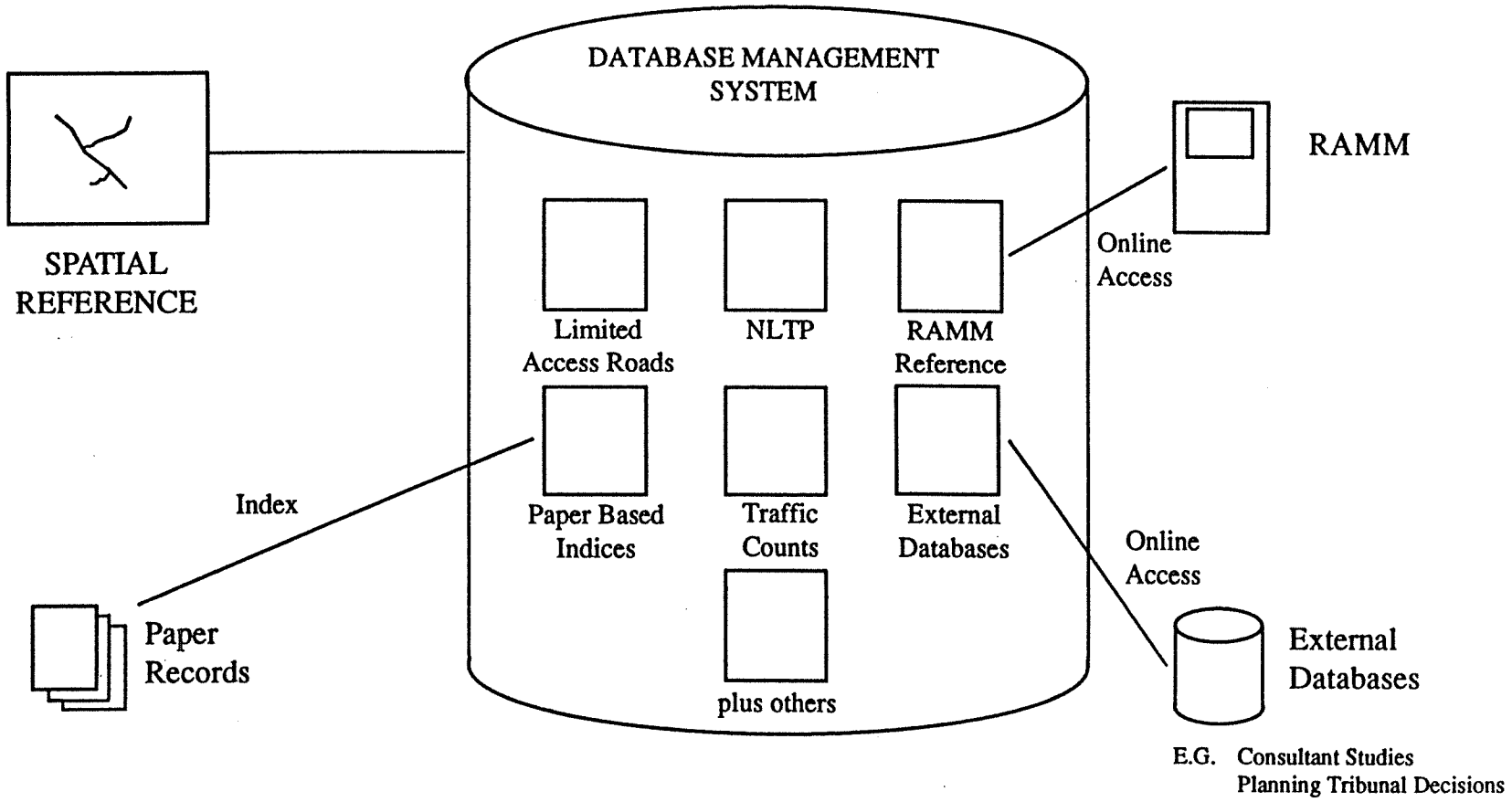


As with Concept 1, the issues regarding the extent of the database need to be determined, e.g. whether it should be nationally or regionally based? Whether it should include state highways only or local roads as well?

The degree of integration between Transit New Zealand and external information sources requires further consideration, and it is likely that modifications to its existing computer-based systems will be required to overcome any potential interfacing obstacles with external systems.

Figure 10.1 Concept 3 - Spatially integrated highway management system.

CONCEPT DIAGRAM



10. CONCEPT 3 - SPATIALLY INTEGRATED HIGHWAY MANAGEMENT SYSTEM

10.1 Introduction

Concept 3 recognises that a primary function of Transit New Zealand is asset management, and that the asset is geographically distributed throughout New Zealand. To do this, the concept incorporates all the information relating to New Zealand's state highway network, which is required by Transit New Zealand, into a spatially managed highway information system. Figure 10.1 presents this concept and highlights the all-encompassing nature of Concept 3 as an SIS.

The characteristics of this concept are:

- both schematic and geographic representations of the network to be available,
- Transit New Zealand Head Office and regional office systems to be linked to provide nationally integrated information,
- indices to paper-based records to be provided as required,
- system likely to be based on linked regional office file servers,
- links to external and application specific databases to be allowed,
- system would be highest cost option.

The development of this concept would be a major strategic investment by Transit New Zealand. It would involve the integration of existing information systems in to one system using the spatial relationships between information as the common index, and allowing interaction with systems external to Transit New Zealand.

10.2 Suitable Technology

Concept 3 is a fully integrated and centralised highway management information system with neither the textual nor spatial components as the primary overall focus. However textual references are still likely to be the primary access keys for staff when searching the database.

The technology necessary to meet the requirements of Concept 3 would have to be capable of supporting both textual and spatial components operating from a centralised database.

File servers in each Transit New Zealand office accessing a mini-computer capable of handling a database would provide the computing power necessary for:

- the inclusion of, or integration with, existing applications held on other systems,
- the faster retrieval of spatial data as a primary spatial index,
- the integration of all spatial data with textual data,
- online connection to all regional offices,
- potential online access to other external databases,
- the operation of suitable spatial software solutions as identified in Concept 2.

10.3 Benefit Assessment

Time savings were highlighted as the major benefits to be associated with Concept 3. Other savings identified were with operational contracts. The net discounted financial benefits for Concept 3 for Transit New Zealand Head Office and each regional office are shown in Table 10.1.

Table 10.1 Concept 3 - Annual financial benefits
(based on three different rates of hourly charges).

Region	**$ per Annum (rounded to $100) Hourly charge rates**			
	$ per Hour			**Other**
	$20	**$25**	**$50**	**Savings**
Auckland	7,500	9,300	18,700	
Hamilton	7,400	9,300	18,500	
Napier	3,100	3,900	7,800	
Wanganui	3,300	4,100	8,200	
Wellington	3,700	4,700	9,400	
Christchurch	5,100	6,400	12,700	
Dunedin	3,700	4,600	9,200	
Head Office	58,400	73,000	146,100	145,300
Total	**92,200**	**115,300**	**230,600**	**145,300**

Detailed activity benefits for Concept 3 are presented in Stage 1 Appendix 9. The benefit values for Concept 3 were extended over five years to obtain the financial worth of the project. However no benefits were considered to accrue in the first year.

An average annual inflation rate of +2% was used when adjusting the benefit values. These values are presented in Table 10.2.

While time savings have been consistently identified as tangible benefits, intangible benefits as identified for Concepts 1 and 2 also apply to Concept 3. Additional intangible benefits applying to Concept 3 include:

- All such fully integrated data would allow dynamic data maintenance throughout the entire database; this may lead to further time savings and less human error when updating data.
- Greater data analysis capability would be possible for more complex analytical projections; tangible benefits would soon be realised when this kind of work was conducted.
- More timely data, as would be required in front-line enquiries, would be available.

10.4 Cost Estimation

The vendors, who were asked for indicative costings of establishing a system for Concept 3 would not be committed to their cost estimates because they had not been provided with detailed specifications of requirements for the system.

A significant portion of costs for Concept 3 will be incurred in data conversion and in Transit New Zealand resources. These costs could not be determined and likewise no estimates for the likely costs of Concept 3 could be compiled.

10.5 Cost-Benefit Analysis

No cost estimates were available for Concept 3 and therefore a cost-benefit analysis for this concept has not been prepared.

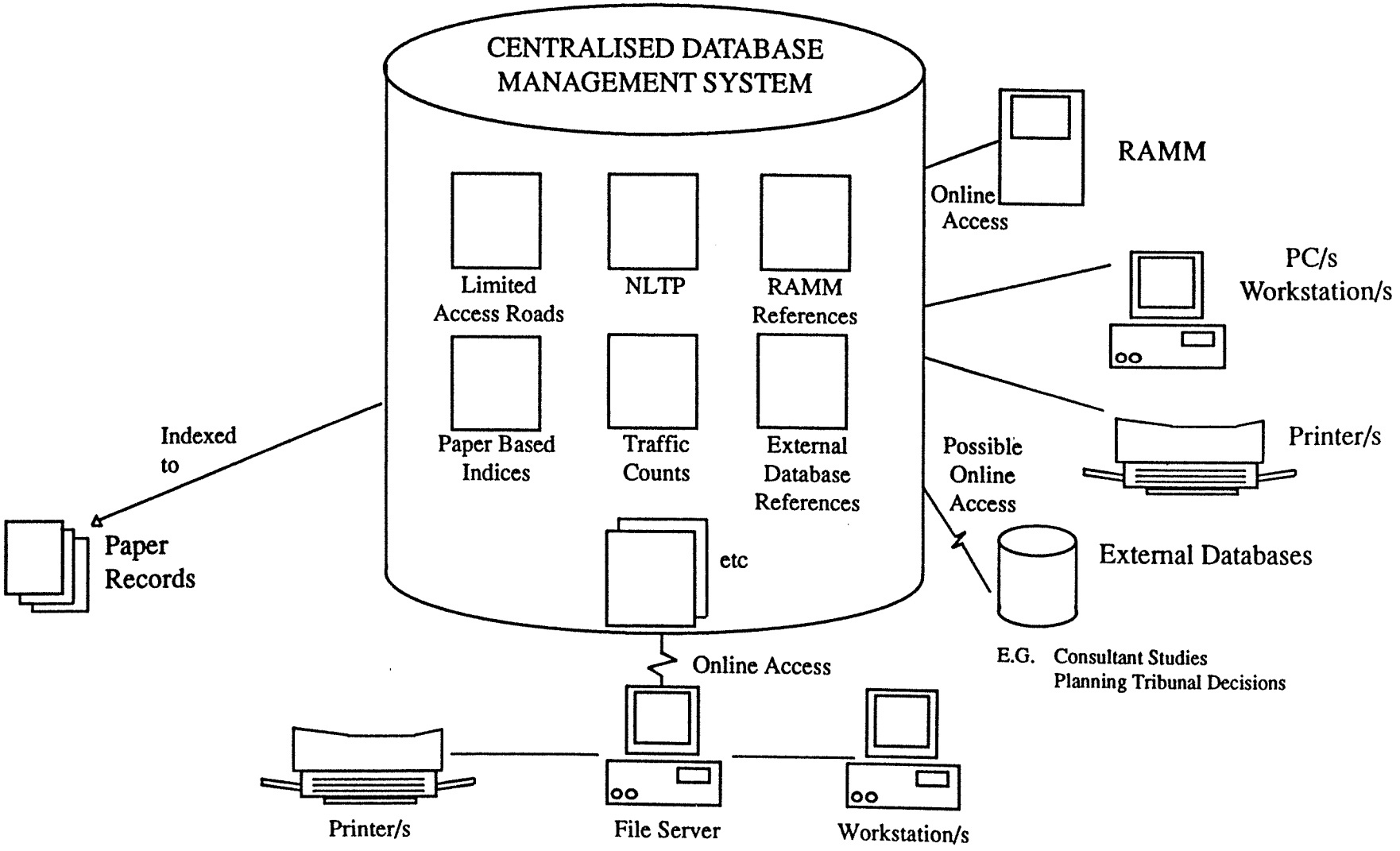
Table 10.2 Concept 3 - Estimated net monetary benefits.

Annual Increase 2%

Region	% of SH Funds	Year 1	Year 2				Year 3				Year 4				Year 5			
			$ 20	$ 25	$ 50	Other	$ 20	$ 25	$ 50	Other	$ 20	$ 25	$ 50	Other	$ 20	$ 25	$ 50	Other
Auckland	22.14	0	7,487	9,358	18,717		7,637	9,545	19,091		7,789	9,736	19,473		7,945	9,931	19,863	
Hamilton	21.91	0	7,409	9,260	18,522		7,557	9,445	18,892		7,708	9,634	19,270		7,862	9,827	19,656	
Napier	9.17	0	3,100	3,875	7,752		3,162	3,953	7,907		3,225	4,032	8,065		3,290	4,112	8,226	
Wanganui	9.74	0	3,293	4,116	8,234		3,359	4,198	8,399		3,426	4,282	8,567		3,495	4,368	8,738	
Wellington	11.08	0	3,746	4,683	9,366		3,821	4,777	9,553		3,897	4,872	9,744		3,975	4,970	9,939	
Christchurch	15.06	0	5,092	6,365	12,731		5,194	6,492	12,986		5,298	6,622	13,245		5,404	6,755	13,510	
Dunedin	10.90	0	3,686	4,607	9,214		3,760	4,699	9,398		3,835	4,793	9,586		3,912	4,889	9,778	
Head Office	-	0	58,414	73,017	146,035	145,250	59,582	74,477	148,956	148,155	60,774	75,967	151,935	151,118	61,989	77,486	154,974	154,140
Total	**100.00**	**0**	**92,227**	**115,281**	**230,571**	**145,250**	**94,072**	**117,587**	**235,182**	**148,155**	**95,953**	**119,938**	**239,886**	**151,118**	**97,872**	**122,337**	**244,684**	**154,140**

Figure 10.2 Concept 3 - Spatially integrated highway management system.

POTENTIAL HEAD OFFICE AND REGIONAL OFFICE CONFIGURATION



REGIONAL OFFICE SYSTEMS

10.6 Discussion

A possible configuration for Concept 3 is represented in Figure 10.2 and would:

- require a central database management system,
- utilise sophisticated SIS,
- include many existing systems,
- be connected to file servers in Transit New Zealand regional offices.

All the issues raised in the discussions for Concepts 1 and 2 are applicable to Concept 3. Issues specific to Concept 3 include the major task of porting and/or redevelopment of many of the existing systems onto the new system, to facilitate integration.

10.7 Conclusion

Similar to the conclusions drawn for Concepts 1 and 2, it is construed that the establishment of an SIS based on Concept 3 would not be a worthwhile investment.

While this concept would be the most advanced in terms of change to the existing Transit New Zealand systems, and possibly the most expensive of the three concepts, it should be seen as a major strategic investment for Transit New Zealand. Concept 3 may not necessarily be the highest overall cost option, when the costs of maintaining existing systems that would eventually have to be replaced are considered. However, a development of this scale will be subject to significant risks and would require the development to be undertaken within the bounds of an overall information management plan.

11. FUTURE CONSIDERATIONS

11.1 Overview

This study has identified a wide range of activities performed by Transit New Zealand which could possibly benefit from the establishment of advanced computer-based graphic/mapping systems. However, the depth and scope of the research brief did not require detailed analysis of the opportunities for SIS within Transit New Zealand. This has resulted in the study achieving an inconclusive result.

The results of the first two tasks presented clear opportunities for SIS and identified available technology which could meet the general specifications of each of the three concepts developed.

Organisations with similar responsibilities to Transit New Zealand are developing SIS to assist in the effective and efficient management of road networks. These developments are major investments for these organisations in terms of information systems, but are minor when compared with the level of expenditure outlaid on the road network itself.

The results of the third task - Cost Estimation and Benefit Assessment - did not support the introduction of SIS within Transit New Zealand. The estimation of the costs of establishing Concepts 1 and 2 highlighted the significant costs incurred when establishing such systems. The indicative costs received from vendors were developed from only general information and were therefore subject to various caveats.

The staff assessments of the likely benefits to accrue from SIS was also subject to significant limitations with respect to their accuracy. For example, only a small number of staff completed the benefit assessment forms for estimating the impact of using SIS for their operations. The combined total of this sample group of staff was then extrapolated across all Transit New Zealand's staff but it would have been more accurate to have had all staff complete an assessment. Other concerns relating to the accuracy of the benefit assessments have been outlined in Stage 1 Section 6 of this report.

11.2 Recommendations

To develop more conclusive results regarding the financial justification for one or more of the concepts identified will require further work. Some of the issues that should be considered before a final decision is made on the potential for SIS within Transit New Zealand include:

(a) *Information systems strategy* - before deciding on the direction Transit New Zealand will choose for SIS, it would be appropriate to review and update the Transit New Zealand strategic information systems plan; the development, and acceptance, of an overall plan directing investment in information systems would then establish investment priorities.

(b) *Strategic business plan* - investments in information systems must be based on clear and demonstrable support for the business objectives of Transit New Zealand; the development of an information systems plan must be founded on the objectives of the organisation as stated in its business plan; the absence of an overall business plan significantly increases the risk that an information systems plan will fail after implementation.

As these two issues are unlikely to affect the primary function of Transit New Zealand, which is the management of the state highway network, they are unlikely to significantly affect further investigation into SIS that support Transit New Zealand's primary function.

Further investigation is needed to clearly determine the areas where SIS would provide the greatest benefits to Transit New Zealand. Should Transit New Zealand decide to undertake such further research, some steps which should be completed include:

(a) *Appoint an appropriate person* - Transit New Zealand should appoint a member of staff responsible for the further research into SIS. This person should understand Transit New Zealand operations and be informed about SIS. The project manager must be empowered to perform further investigations and be allocated sufficient resources to ensure the research is completed to a standard in proportion to the likely expenditure.

(b) *Liaise with overseas roading authorities* - to learn about and review the experiences of similar organisations which have developed SIS for road network management. This will significantly assist Transit New Zealand in its assessment of the opportunities for SIS. Knowledge of other organisations' discoveries and mistakes would substantially improve the chances for Transit New Zealand to make the correct decisions.

(c) *Increase staff comprehension* - a major stumbling block in the benefit assessment task was the generally low level of comprehension among Transit New Zealand staff of SIS specifically and of information systems in general.

This lack of understanding of how computer systems can be employed to enhance operations must be addressed before a reliable estimate of the benefits of SIS can be developed.

Further definition of the opportunities for SIS and the subsequent identification of benefits should draw on a greater involvement of Transit New Zealand staff, with respect to both the number of staff and the extent of their use of SIS. Wider participation and greater understanding will lead to more reliable research results.

(d) *Assess all regional offices* - the scope of the research study allowed visits only to Transit New Zealand's Head Office and its Auckland Regional Office. Unfortunately the activities of the staff interviewed in these two offices were not representative of all the operations of Transit New Zealand and the results of the benefit assessment is only indicative rather than comprehensive.

All Transit New Zealand's operations need to be analysed to determine where the greatest benefits from SIS are likely to accrue. Assessments of all Transit New Zealand regional offices are also likely to identify other areas of operations which were not included in this research study as a result of its limited brief.

(e) *Prepare system requirement specifications* - the review of the operations of each office will identify staff who are able to develop the systems specifications which meet the needs of Transit New Zealand. These statements should be distributed to all staff for comment before being accepted as representative of the needs of the organisation.

(f) *Prepare more rigorous benefit assessments* - increased awareness of information systems, greater staff involvement in the process and more detailed systems specifications will ensure more accurate estimates of the financial value of establishing SIS.

(g) *Seek vendor submissions* - more detailed and comprehensive specifications of the systems required by Transit New Zealand will provide vendors with greater knowledge. Such details will provide them with more confidence and therefore greater accuracy when pricing their systems.

(h) *Prepare detailed cost-benefit analysis* - the final step towards a definite decision is comparison of the revised costs against the re-assessed benefits. The greater accuracy and integrity of both costs and benefits will provide a more reliable financial statement for the justification or otherwise of investing in SIS.

Depending on the outcome of the cost-benefit analysis, Transit New Zealand should define a suitable approach to acquiring the desired system. Typically this would entail a competitive proposal process which would include:

- incorporating detailed systems specifications into a Request For Proposal (RFP),
- distributing the RFP to selected vendors,
- ranking responses according to pre-defined evaluation criteria,
- identifying a short list of preferred suppliers (if required),
- visiting existing user sites,
- benchmarking short-listed systems, if appropriate,
- undertaking detailed contract negotiations,
- re-assessing the business case, once price negotiations have been completed and the preferred system has been identified.

Assuming satisfactory completion of the system acquisition process, the next steps will involve the implementation of the system. The principle tasks will be:

- developing a detailed implementation plan,
- determining the internal and external resource requirements,
- timetabling major project milestones,
- appointing an implementation project manager,
- establishing implementation project teams,
- training Transit New Zealand staff,
- finalising system delivery specifications,
- installing the SIS,
- purchasing digital map base,
- acceptance testing of system,
- commissioning of system,
- converting existing data,
- capturing additional data.

Once all these steps are completed the system will then become operational. After a short period of operation, a post-implementation review should be undertaken to ensure that the benefits identified and used to justify the system have been or are being achieved.

STAGE 1 APPENDICES

APPENDIX 1. RESEARCH STUDY PERSONNEL

Key personnel involved from Transit New Zealand were located in Head Office, Wellington, and Auckland Regional Office. These staff were:

Head Office

Jim McMillan	Research and Development Manager
David Robertson	Asset Management Engineer
Dave Wanty	Traffic Engineer
Dave Silvester	Transportation Planner
Ken Glew	Transportation Planning Consultant
Frank McGuire	Maintenance and Roading Engineering Manager
Rick van Barneveld	Land Transport Manager
Roger Faithfull	Computer Services Manager
Merv Lauder	State Highway Manager

Auckland regional office

Phillip Sutton	Regional Highways Manager
Russell Smith	Inspector of State Highways
Brian Rainford	Senior Design Draughting Officer
John Raines	Engineering Officer, Transport Planning
Rachel Harward	Senior Planner

APPENDIX 2. TRANSIT NEW ZEALAND ACTIVITIES

Research and Development
- Data collection
- Data analysis

Policy and Planning
- Traffic and transportation planning and strategy
- Development of policies and procedures, standards and guidelines, and specifications for maintenance and improvements
- Consult with Government, Local Authorities and Road Users

Traffic Safety
- Undertake accident investigations
- Monitor state highways
- Provide recommendations and justification for construction and maintenance work

Preparation of NLTP (National Land Transport Programme)
- Evaluate project proposals
- Authorise funding for approved projects

Administering of NLTP
- Make payments from fund for approved projects
- Review and revise programme

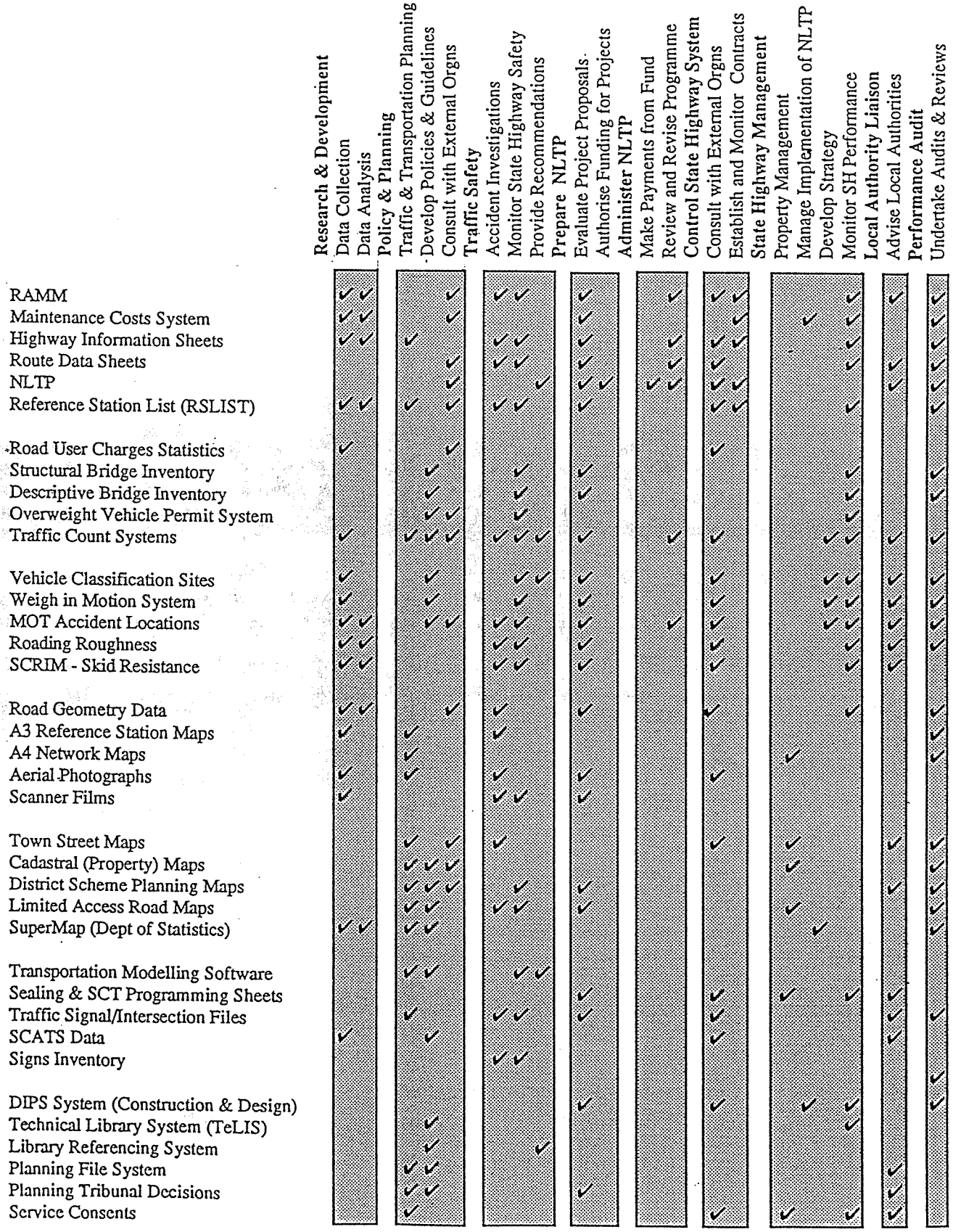
Controlling State Highway System
- Consult with Government, Local Authorities and Road Users
- Establish and monitor contracts

State Highway Management
- Property management
- Manage implementation of NLTP
- Develop strategy
- Monitor state highway performance

Local Authority Liaison
- Provide advice and information to Local Authorities

Performance Audit
- Undertake audits of project results and the performance of Transit New Zealand and Local Authorities

APPENDIX 3. OPPORTUNITIES FOR APPLYING SPATIAL INFORMATION SYSTEMS BY TRANSIT NEW ZEALAND



APPENDIX 4. INVENTORY OF SPATIAL INFORMATION SYSTEMS USED BY TRANSIT NEW ZEALAND

System Name	System	Use		Data Source*
		Head Office	Akld Region	
RAMM	NCR TOWER	X	X	Consult
Maintenance Cost System	PC		X	Consult
Highway Information Sheets	Manual	X	X	Consult
Reference Station List (RSLIST)	Vogel	X	X	TNZ
Route Data Sheets	Manual	X	X	Consult
NLTP	PC	X	X	TNZ
Road User Charges Statistics	Vogel	X		MOT
Structural Bridge Inventory	Vogel	X	X	Consult
Descriptive Bridge Inventory	Vogel	X	X	Consult
Overweight Vehicle Permit System	Vogel		X	TNZ
Traffic Count Systems	Vogel	X	X	TNZ
Vehicle Classification Sites	Vogel	X	X	TNZ
Weigh in Motion System	Vogel	X	X	TNZ
MOT Accident Locations	MOT	X	X	MOT
Roading Roughness	Vogel	X	X	TNZ
SCRIM - Skid Resistance	PC	X	X	TNZ
RG DAS Monitoring Data	Vogel	X	X	TNZ
A4 Network Maps	Manual	X		TNZ
A3 Reference Station Maps	Manual	X		TNZ
Aerial Photographs	Photos	X	X	TNZ
Scanner Films	Films	X	X	-
Town Street Maps	Manual		X	DOSLI
Cadastral (Property) Maps	Manual		X	DOSLI
District Scheme Planning Maps	Manual		X	LA
Limited Access Maps	Manual		X	TNZ
SuperMap (Dept of Statistics)	Vogel	X		Stats Dept
Transportation Modelling Software	PC	X		
Sealing & SCT Programming Sheets	Manual		X	TNZ
Traffic Signal/Intersection Files	Manual		X	TNZ
SCATS Data	PC		X	LA
Signs Inventory	Manual		X	TNZ
DIPS System (Construction & Design Drawings)	Manual	X	X	Consult
Library Referencing System	Manual		X	TNZ
Technical Library Referencing System (TeLIS)	Works	X	X	Consult
Planning File System	Manual		X	TNZ
Planning Tribunal Decisions	Manual		X	TNZ
Service Consents	Manual		X	TNZ

*Data Source - agency responsible for data
Consult - consultant; TNZ - Transit New Zealand;
MOT - Ministry of Transport (now Land Transport Safety Authority);
DOSLI - Department of Survey and Land Information;
LA - Local Authority; Stats Dept - Statistics Department

APPENDIX 5. GUIDELINES FOR BENEFIT ASSESSMENT OF SPATIAL INFORMATION SYSTEMS

June 1992

1. INTRODUCTION

1.1 This paper has been prepared to assist Transit New Zealand staff to assess the potential benefits likely to arise from the introduction of an automated spatial information system.

1.2 In assessing the benefits of a spatial information system, each person will be requested to:

- identify the activities relevant to their area which may potentially benefit from an automated spatial information system. A list of requirements identified during the interview process will be attached;
- identify the benefits (time savings, expenditure cuts etc) likely to accrue to each activity;
- complete one benefit assessment form (as attached) for each benefit identified for each activity.

1.3 In order to assist staff members to assess the benefits, the completion of these forms will be discussed at each interview.

1.4 The results of the cost-benefit analysis will collated by the Project Team and compared with the indicative costs for an improved spatial information system to evaluate the financial justification for the investment.

2. ANALYSIS OF BENEFITS OF A SPATIAL INFORMATION SYSTEM

Identification of Benefits

2.1 The potential benefits from a spatial information system must be quantified, so that a rigorous cost-benefit analysis can be performed. This will allow decisions to be made on which activities, if any, should be developed in a spatial information system.

2.2 When determining benefit(s) of a spatial information system to a particular activity of the section some of the questions to be considered are as follows:

e.g. will the improved spatial information system:

- save time for me or my staff ?
- reduce duplicate entry of data within this section or with other sections?
- provide more accurate information, and therefore reduce potential liability?
- allow faster access to information, including information usually the responsibility of other sections?
- reduce the time spent answering queries from other sections?
- allow us to improve customer service, e.g. by answering queries from the public or processing applications faster?
- provide better information for planning and decision making purposes?
- provide better performance information?
- allow us to monitor contractor performance better?
- reduce data storage requirements?

Measuring the Benefits

2.3 Benefits have to be reviewed against rigorous acceptance criteria to identify those benefits which can be included in a cost-benefit analysis. These criteria include:

- they must be **identified** and clearly described,
- they must be **quantified** and assigned a value,
- a **causal link** must be shown to exist between the implementation of the system and the forecast level of benefit,
- they must be **owned** by individuals who will be responsible for achieving them, and
- they must be **tracked** and measured following the completion of the project.

3. THE PROCESS

Identification of benefits

3.1 This can be done by generating a listing of benefits through discussions with staff who have an understanding of the functionality of a spatial information system and the potential applications within the section.

3.2 In identifying benefits, it should be noted that:

- estimation of the value of the benefit can be extremely time consuming,
- intangible benefits should not be disregarded and they should be noted on the form as they can have a significant bearing on the overall case for a spatial information system.

Quantifying the benefits

3.3 Some guidelines in quantifying benefits are included:

- it must be possible to provide a financial value to each benefit: often this will be an estimate of saving staff time and thus the value of that time,
- benefits can also be valued in terms of the risk of not pursuing a particular option (e.g. the quantified consequences of a lack of up-to-date information),
- benefits can be valued in terms of cost avoidance of not continuing with the existing system,
- each benefit can also be assigned a confidence level which reflects the probability that it will be achieved. The confidence levels to be set for weighting the benefit being achieved are:

High	- the benefit is certain to be obtained	80%
Medium	- the benefit will probably be obtained	50%
Low	- the benefit is only a rough estimate	20%

Linking the benefits

3.4 It is essential to show a direct link between a spatial information system and the achievement of a benefit. No benefit will accrue in cases where a benefit might arise independently of the introduction of a new system or where the benefit might arise through the introduction of an alternative form of information system.

3.5 Benefits which are not directly linked to the introduction of a spatial information system should be excluded or scaled down accordingly.

Ownership of benefits

3.6 Specified individuals within Transit New Zealand should "own" the benefits and be responsible for ensuring that the benefit is achieved following the implementation of the spatial information system. The ownership of benefits and commitment to achieving them form the key critical success factors against which the spatial information system can be measured and assessed.

Tracking the benefits

3.7 It must also be possible to establish a method by which benefits can be continuously monitored and compared against those projected. This will produce an early warning to Transit New Zealand management of problems or deficiencies in the spatial information system implemented, and will furnish information for use in the post-implementation review to establish the overall success of the project.

4. BENEFIT ASSESSMENT FORM

The benefits identified should be recorded on the Benefit Assessment form. The sections to be completed are listed:

Activity:
This should be one of the activities identified in the earlier stages of the study.

Area:
This is the name of the section in which the benefit is expected to be attained. Benefits will be identified for a number of activities in any one section, and vice versa.

Benefit:
A brief description of the benefit identified. Benefits may be of a number of forms, including the following:

- time savings
- improved service to tax-payers and road users
- improved accuracy of information
- more informed decision making
- improved access to common information
- reduced data storage requirements
- reduced duplicate data entry

Description of Benefit:
A more detailed description of the benefit.

Value of Benefit:
Valuation of specific benefits to be obtained where possible.

Level of Confidence:
A confidence level reflecting the probability that the benefit will be obtained.

H -	**High**	- the benefit is certain to be obtained
M -	**Medium**	- the benefit will probably be obtained
L -	**Low**	- the benefit is only a very rough estimate

Net Value:
This value reflects the confidence level described above. The Value of Benefit should be multiplied by a percentage reflecting the level of confidence entered, as follows:

H - 80%

M - 50%

L - 20%

Responsibility for Benefit:
The person who will be responsible for ensuring the benefit is obtained if implementation of a spatial information system goes ahead.

Method of Measurement and Tracking:
How the performance of the system in providing the benefits can be measured.

Identified by:
The person who identified the benefit and completed the form.

Date:
The date the form was completed.

BENEFIT ASSESSMENT FORM

Activity: Monitoring of planning proposals affecting State Highways

Area: Planning

Benefit: Reduction of time spent determining whether data exists and accessing the data

Description of Benefit

Currently it is difficult to determine whether similar types of proposals, or proposals for the same location have been received in the past. It is time consuming to attempt to find out whether such proposals exist when beyond the past experience of staff. It is important to have a historical perspective to ensure responses to proposals over time are consistent.

Time spent in determining whether past proposals exist is approx 3 hours. For 80% of proposals received there is a relevant past proposal and 80% of these are outside of past experience. Approx 25 proposals are received each year.

Value of Benefit: (description and hours saved)

Time reduced to 10 minutes in determining whether a past proposal exists

25 proposals x 80% x 80% x 2.83 hrs x $25 per hr = $ 1,132:00 per year

Accuracy (H/M/L): H

Net Value:

80% of $ 1,132:00 = $ 905.60

Responsibility for Benefit: Regional Planner

Method of Measurement and tracking:

Any problems with locating past proposals to be recorded and reviewed by Regional Manager.

Identified by:	**Date:** 14/9/92

APPENDIX 6. COMPLETED BENEFIT ASSESSMENT FORM

Activity: Accident investigation site monitoring

Area: Traffic Safety.

Benefit: Reduction in time obtaining more accurate data from HOT AIS system.

Description of Benefit

HOT runs AIS accident data system. Approx 15% of data is inaccurate with this system.

200 sites/yr 5 accidents/site.

Value of Benefit: (description and hours saved)

Time reduced to 10min from 1hr to obtain data.

200 × 5 × 15% × .83 × 20.38 $2537.

Accuracy (H)/M/L):

Net Value:

.8 × 2537. $2030

Responsibility for Benefit: RSO

Method of Measurement and tracking:

TAR reports scanned

Identified by: RJR	**Date:** 10/10/92

APPENDIX 7. BENEFIT ASSESSMENT FOR CONCEPT 1

a. Head Office

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate $ 20	Benefit Estimate $ 25	Benefit Estimate $ 50	Level of Confidence	Net Benefit $ 20	Net Benefit $ 20	Net Benefit $ 20
Supply of information for one-off enquiries	State Highway Maintenance	1,000	0.4	8,000	10,000	20,000	H	6,400	8,000	16,000
Review of maintenance funds		46	0.25	230	287	575	H	184	230	460
Manage Bridge Assets	Maintenance and Road Engineering	368	0.5	3,680	4,600	9,200	M	1,840	2,300	4,600
Reference to Highway Information sheets		46	1	920	1,150	2,300	H	736	920	1,840
Supply of information for one-off enquiries		52	25	26,000	32,500	65,000	L	5,200	6,500	13,000
TOTALS		1,512	27.15	38,830	48,537	97,075		14,360	17,950	35,900

APPENDIX 7. BENEFIT ASSESSMENT FOR CONCEPT 1 (continued)
b. Auckland Regional Office

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate $ 20	Benefit Estimate $ 25	Benefit Estimate $ 50	Level of Confidence	Net Benefit $ 20	Net Benefit $ 25	Net Benefit $ 50
Consultation with external organisations,previous projects plan/s	State Highway Management	20	0.083	33	42	83	H	27	33	66
Consultation with external organisations,previous projects,reports		92	0.05	92	115	230	M	46	58	115
Project proposal evaluation Reference to previous proposal plans		40	0.083	66	83	166	H	53	66	133
Project proposal evaluation Reference to previous proposal reports		46	0.05	46	58	115	M	23	29	58
Project Development and Vetting	Transportation Planning									
Location of all traffic data		18	0.33	119	149	297	M	59	74	149
Location of all accident data		18	0.083	30	37	75	M	15	19	37
Location of all aerial photography		18	0.083	30	37	75	M	15	19	37
Location of all construction and 'As Built' drawings		18	0.33	119	149	297	M	59	74	149
Location of all historic reports		18	0.66	238	297	594	H	190	238	475

APPENDIX 7b. Auckland Regional Office (continued)

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate $ 20	$ 25	$ 50	Level of Confidence	Net Benefit $ 20	$ 25	$ 50
Location of all highway parameters from highway information sheets		18	0	0	0	0	M	0	0	0
Location of all historic correspondence		18	0.5	180	225	450	M-	90	113	225
Location and copies of SCRIM and road roughness data		18	0.16	58	72	144	L	12	14	29
Special Event Traffic Management	Transportation Planning									
Location of traffic data from TNZ database and local Councils		4	0	0	0	0	L	0	0	0
Location of correspondence of roads operation		4	0.33	26	33	66	M	13	17	33
Location of roading network aerial photos		4	0.083	7	8	17	L	1	2	3
Landuse Application Traffic Management										
Location of traffic data pertaining to land use application		12	0	0	0	0	M	0	0	0
Location of aerial photography		12	0.083	20	25	50	L	4	5	10

APPENDIX 7b. Auckland Regional Office (continued)

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate $ 20	$ 25	$ 50	Level of Confidence	Net Benefit $ 20	$ 25	$ 50
Locate all correspondence of other landuse applications in the area		12	0.33	79	99	198	M	40	50	99
Locate planned modifications to roading system		12	0.16	38	48	96	L	8	10	19
Use of highway information sheets		12	0	0	0	0	L	0	0	0
Construction Traffic Management	Transportation Planning									
Locate traffic data to check safety and capacity layouts		25	0	0	0	0	H	0	0	0
Location of construction plans		25	0	0	0	0	H	0	0	0
Location of aerial photography		25	0.083	42	52	104	L	8	10	21
Evaluating proposed plan changes and reviews	Planning	12.8	0.83	212	266	531	M	106	133	266
Monitoring of proposals		45	0.5	450	563	1,125	M	225	281	563
Processing applications for signs and hawkers' licences		7.5	0.5	75	94	188	M	38	47	94
TOTALS		554	5	1,960	2,450	4,899		1,032	1,290	2,579

APPENDIX 8. BENEFIT ASSESSMENT FOR CONCEPT 2

a. Head Office

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate $ 20	$ 25	$ 50	Other	Level of Confidence	Net Benefit $ 20	$ 25	$ 50	Other
Visual Traffic Surveys	Traffic Monitoring Group						12,500	M				6250
Traffic Counting							10,000	H				8000
							17,000	M				8,500
		1	215	4,300	5,375	10,750		M	2,150	2,687	5,375	
Classifications							4,000	H				3,200
		1	60	1,200	1,500	3,000		H	960	1,200	2,400	
Manage Roughness Database	State Highway Maintenance	1	160	3,200	4,000	8,000		H	2,560	3,200	6,400	
Supply of information for one-off enquiries		1,000	0.6	12,000	15,000	30,000		H	9,600	12,000	24,000	
Use of Highway Information Sheets		46	2	1,840	2,300	4,600		M	920	1,150	2,300	
Information on State Highway projects		1	40	800	1,000	2,000		H	640	800	1,600	
Maintenance Funding Review		46	1	920	1,150	2,300		H	736	920	1,840	
SH Reference Station List	Maintenance and Road Engineering	600	0.16	1,920	2,400	4,800		H	1,536	1,920	3,840	
Manage Bridge Asset		12	8	1,920	2,400	4,800		H	1,536	2,400	4,800	
		46	7	6,440	8,050	16,100		M	3,220	4,025	8,050	
Overweight Permits		3,000	0.16	9,600	12,000	24,000		H	7,680	9,600	19,200	

APPENDIX 8a. Head Office (continued)

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate $ 20	$ 25	$ 50	Other	Level of Confidence	Net Benefit $ 20	$ 25	$ 50	Other
Supply of information for one-off enquiries		46	25	23,000	28,750	57,500		M	11,500	14,375	28,750	
Updating Highway Information Sheets		12	1.5	360	450	900		H	288	360	720	
TOTALS		4,812	520.42	67,500	84,375	168,750	43,500		43,326	54,637	109,275	25,950

APPENDIX 8. BENEFIT ASSESSMENT FOR CONCEPT 2 (continued)
b. Auckland Regional Office

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate				Level of Confidence	Net Benefit			
				$ 20	$ 25	$ 50	Other		$ 20	$ 25	$ 50	Other
Special event traffic management	Transportation Planning											
Location of traffic data from TNZ database and local Councils		4	0.16	13	16	32		M	6	8	16	
Location of letter history		4	0.5	40	50	100		M	20	25	50	
Location of all aerial photography		4	0.33	26	33	66		M	13	17	33	
Land-use application Traffic Management	Transportation Planning											
Location of all traffic data		12	0.16	38	48	96		M	19	24	48	
Location of all aerial photography		12	0.33	79	99	198		M	40	50	99	
Location of letter history		12	0.5	120	150	300		M	60	75	150	
Location of planned roading modifications		12	0.25	60	75	150		M	30	38	75	
Locating highway parameters		12	0.083	20	25	50		M	10	12	25	
Construction Traffic Management	Transportation Planning											
Location of traffic data		25	0.16	80	100	200		M	40	50	100	
Location of construction plans		25	0	0	0	0		M	0	0	0	
Location of all aerial photography		25	0.33	165	206	413		M	83	103	206	

APPENDIX 8b. Auckland Regional Office (continued)

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate				Level of Confidence	Net Benefit			
				$ 20	$ 25	$ 50	Other		$ 20	$ 25	$ 50	Other
Project Development and Vetting	Transportation Planning											
Location of traffic data directly related		18	0.5	180	225	450		M	90	113	225	
Location of all accident data		18	0.25	90	113	225		M	45	56	113	
Location of all aerial photography		18	0.33	119	149	297		M	59	74	149	
Location of all historic construction drawings		18	0.66	238	297	594		M	119	149	297	
Location of all historic RAIT studies and roading and technical reports		18	0.66	238	297	594		H	190	238	475	
Location of highway parameters		18	0.83	299	374	747		L	60	75	149	
Research of all old correspondence		18	1	360	450	900		M	180	225	450	
Location of SCRIM and road roughness reports		18	0.5	180	225	450		M	90	113	225	
Monitoring the State Highway	Traffic Safety								0	0	0	
Location of library data		20	0.42	168	210	420		H	134	168	336	
Locating drawing data		16	0.16	51	64	128		H	41	51	102	
Accident investigation site monitoring	Traffic Safety											

APPENDIX 8b. Auckland Regional Office (continued)

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate				Level of Confidence	Net Benefit			
				$ 20	$ 25	$ 50	Other		$ 20	$ 25	$ 50	Other
Obtain SCRIM results		20	1.33	532	665	1,330		L	106	133	266	
Locate previous reports		80	0.083	133	166	332		M	66	83	166	
Location of all previous corresspondence		160	0.33	1,056	1,320	2,640		M	528	660	1,320	
Location of signs		100	1.91	3,820	4,775	9,550		L	764	955	1,910	
MOT AIS data aquisition		150	0.83	2,490	3,113	6,225		H	1,992	2,490	4,980	
External organisation consultation	State Highway Control								0	0	0	
Obtain HIS & RD information		50	0.16	160	200	400		M	80	100	200	
Establish and monitor contracts												
Obtain drawing reference		10	0.16	32	40	80		H	26	32	64	
Locating previous contracts		14	8	2,240	2,800	5,600		L	448	560	1,120	
Obtain HIS & RD from TNZ regions for national aerial photo contract		1	96	1,920	2,400	4,800		H	1,536	1,920	3,840	
Maintenance and Construction - quick reference to standards	RAMMS	1	50	1,000	1,250	2,500	32,200	M	500	625	1,250	16,100
									0	0	0	
Construction - Shapecorrection. Initial identification and confirm needs		1	16	320	400	800	1,400	L	64	80	160	2,800

APPENDIX 8b. Auckland Regional Office (continued)

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate				Level of Confidence	Net Benefit			
				$ 20	$ 25	$ 50	Other		$ 20	$ 25	$ 50	Other
Construction - Pavement resurfacing							5,600	M	0	0	0	2,800
Designing surface		1	8	160	200	400	11,200	L	32	40	80	2,240
Identification and confirmation of needs		1	8	160	200	400		M	80	100	200	
Maintenance							139,300					27,860
Accertain volume of work to be done		1	38	760	950	1,900		L	152	190	380	
Improve programming		1	0	0	0	0		L	0	0	0	
Location of physical work achieved		1	50	1,000	1,250	2,500		L	200	250	500	
Evaluation of Project proposals	State Highway Management	1						L	0	0	0	
Manage RLTP implementation and review Sealing & SCT		20	0.25	100	125	250		M	50	63	125	
Consultation with external organisations. Service consents		6	0.91	109	137	273		L	22	27	55	
Project proposal evaluation		50	0.083	83	104	208		H	66	83	166	
Accident Investigation												
Locate all associated data for accident site		12	0.33	79	99	198		M	40	50	99	

APPENDIX 8b. Auckland Regional Office (continued)

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate				Level of Confidence	Net Benefit			
				$ 20	$ 25	$ 50	Other		$ 20	$ 25	$ 50	Other
Consultation with external organisation	Planning	184	0.05	184	230	460		M	92	115	230	
Process applications for signs and hawkers licenses		7.5	0.83	125	156	311		M	62	78	156	
Advise TNZ on planning processes for new construction work		10	0.75	150	188	375		L	30	38	75	
Evaluating proposed district plan changes and reviews		22.5	0.75	338	422	844		L	68	84	169	
Responding to public enquiries		200	0.33	1,320	1,650	3,300		L	264	330	660	
Monitoring of proposals affecting State Highways		45	0.83	747	934	1,868		M	374	467	934	
TOTALS		1,477	292	21,581	26,976	53,952	189,700		8,971	11,213	22,427	51,800

APPENDIX 9. BENEFIT ASSESSMENT FOR CONCEPT 3

a. Head Office

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate $ 20	Benefit Estimate $ 25	Benefit Estimate $ 50	Benefit Estimate Other	Level of Confidence	Net Benefit $ 20	Net Benefit $ 25	Net Benefit $ 50	Net Benefit Other
Visual Traffic Surveys	Traffic Monitoring Group						12,500	M				6,250
Traffic Counting							10,000	H				8,000
							17,000	M				8,500
		1	215	4,300	5,375	10,750		M	2,150	2,687	5,375	
Classification		1	60	1,200	1,500	3,000		H	960	1,200	2,400	
		1	40	800	1,000	2,000		M	400	500	1,000	
							1,000	M				500
							60,000	H				48,000
Weigh in Motion							80,000	H				64,000
							50,000	L				10,000
		1	60	1,200	1,500	3,000		M	600	750	1,500	
Manage Roughness Database	State Highway Maintenance	1	184	3,680	4,600	9,200		H	2,944	3,680	7,360	
Supply of information for oneoff enquiries		1,000	0.7	14,000	17,500	35,000		H	11,200	14,000	28,000	
Use of Highway Information sheets		46	2	1,840	2,300	4,600		M	920	1,150	2,300	
Information on State Highway Projects		1	80	1,600	2,000	4,000		H	1,280	1,600	3,200	
Review of Maintenance Funding		46	1.5	1,380	1,725	3,450		H	1,104	1,380	2,760	

APPENDIX 9a. Head Office (continued)

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate $ 20	$ 25	$ 50	Other	Level of Confidence	Net Benefit $ 20	$ 25	$ 50	Other
SH Reference Station List	Maintenance and Road Engineering	600	0.33	3,960	4,950	9,900		H	3,168	3,960	7,920	
Manage Bridge Asset		12	8	1,920	2,400	4,800		H	1,536	1,920	3,840	
		46	8.4	7,728	9,660	19,320		M	3,864	4,830	9,660	
Overweight Permits		3,000	0.2	12,000	15,000	30,000		H	9,600	12,000	24,000	
Supply of information for one-off enquiries		46	25	23,000	28,750	57,500		H	18,400	23,000	46,000	
Update of Highway Information sheets		12	1.5	360	450	900		H	288	360	720	
TOTALS		4,814	686.63	78,968	98,710	197,420	230,500		58,414	73,017	146,035	145,250

APPENDIX 9. BENEFIT ASSESSMENT FOR CONCEPT 3 (continued)

b. Auckland Regional Office

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate			Level of Confidence	Net Benefit		
				$ 20	$ 25	$ 50		$ 20	$ 25	$ 50
Monitoring the State Highway	Traffic Safety									
Location of library data		20	0.42	168	210	420	H	134	168	336
Sourcing drawings		160	0.23	736	920	1,840	H	589	736	1,472
Accident investigation site monitoring	Traffic safety							0	0	0
Obtaining SCRIM results		20	1.33	532	665	1,330	L	106	133	266
Location of previous reports		80	0.083	133	166	332	M	66	83	166
Locating/obtaining previous correspondence		160	0.33	1,056	1,320	2,640	M	528	660	1,320
Location of accurate sign and marking information		200	1.91	7,640	9,550	19,100	L	1,528	1,910	3,820
Obtaining data from MOT AIS		150	0.83	2,490	3,113	6,225	H	1,992	2,490	4,980
Consultation with external organisations	State Highway Control									
Obtaining HIS and RD information		50	0.16	160	200	400	M	80	100	200
Establish and monitor contracts	State Highway Control									
Locate previous contacts		14	15	4,200	5,250	10,500	L	840	1,050	2,100
Obtain drawing reference		100	0.23	460	575	1,150	H	368	460	920

APPENDIX 9b. Auckland Regional Office (continued)

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate $ 20	$ 25	$ 50	Level of Confidence	Net Benefit $ 20	$ 25	$ 50
Project Development and Vetting	Transportation Planning									
Locate all possible traffic data		18	0.5	180	225	450	M	90	113	225
Locate all accident data		18	0.25	90	113	225	M	45	56	113
Locate all aerial photography		18	0.33	119	149	297	M	59	74	149
Locate all historical construction and 'as built' drawings		18	0.66	238	297	594	M	119	149	297
Locate all historic roading and technical reports and RAIT studies		18	0.66	238	297	594	H	190	238	475
Locating all highway information		18	0.083	30	37	75	L	6	7	15
Locate all historic correspondence		18	1	360	450	900	M	180	225	450
Locate and obtain copy of SCRIM and road roughness data		18	0.5	180	225	450	M	90	113	225
Construction Traffic Management	Transportation Planning									
Locate all traffic data		25	0.16	80	100	200	M	40	50	100
Locate all construction plans		25	0				M	0	0	0
Location of aerial photography		25	0.5	250	313	625	M	125	156	313

APPENDIX 9b. Auckland Regional Office (continued)

Activity	Division	Annual Volume	Time Saving Hours	Benefit Estimate $ 20	Benefit Estimate $ 25	Benefit Estimate $ 50	Level of Confidence	Net Benefit $ 20	Net Benefit $ 25	Net Benefit $ 50
Land-use Application Traffic management	Transportation Planning							0	0	0
Locate all traffic data		12	0.16	38	48	96	M	19	24	48
Locate all aerial photography		12	0.5	120	150	300	M	60	75	150
Location of letter history and development and operational history		12	0.5	120	150	300	M	60	75	150
Location of planned roading system modifications		12	0.15	36	45	90	H	29	36	72
Use of highway information data		12	0.5	120	150	300	H	96	120	240
Special Event Traffic Management	Transportation Planning							0	0	0
Locate all traffic data		4	0.16	13	16	32	M	6	8	16
Letter history		4	0.5	40	50	100	M	20	25	50
Locate all aerial photography		4	0.5	40	50	100	M	20	25	50
TOTALS		1,245	28	19,866	24,832	49,665		7,487	9,358	18,717

SPATIAL INFORMATION SYSTEMS

STAGE 2

1. INTRODUCTION

1.1 Background

Transit New Zealand is investigating the applicability of spatial information systems (SIS) as a management tool to make better use of information systems which it already uses in order to improve the management of the state highway network in New Zealand.

Stage 1 of the SIS research project identified three concepts that would enable Transit New Zealand to utilise spatial information technology. Each concept was developed to a stage where preliminary costs and benefits could be defined. The analysis of the concepts highlighted the need for further research into how SIS can be effectively applied to the management of road networks.

To advance its investigation into SIS, Transit New Zealand commissioned Stage 2 in 1993, and in June of that year, a study team visited two Australian authorities responsible for the management of principal road networks. The two Authorities visited, the Roads and Traffic Authority of New South Wales (hereafter abbreviated as RTA) in Sydney, and Roads Corporation of Victoria (VIC ROADS) in Melbourne, have implemented SIS in a number of areas of their business.

1.2 Objectives

The objective of Stage 2 of the SIS project is to advance Transit New Zealand's understanding of the application of SIS to its business functions.

Two significant functions performed by Transit New Zealand that require up to date, reliable and easily accessed information are:

- Strategic management of the state highway asset,
- Policy development, and where appropriate, provision of advice to Government.

In consequence, discussions with the two Australian transportation Authorities were expected to help clarify how Transit New Zealand may benefit from the development of SIS appropriate to Transit New Zealand's needs.

1.3 Research Tasks

The tasks to be investigated in Stage 2 of the SIS research project were:

1. Identify differences in management, functions and structure between Transit New Zealand and the two Australian transportation Authorities visited.

2. Obtain an overview of the approach to SIS adopted by the Australian transportation Authorities.

3. Investigate the analysis of costs and benefits for the SIS, focusing on the approaches used by the two Australian transportation Authorities.

4. Review the project management structures and procedures that the two Australian transportation Authorities established to control the implementation project.

5. Investigate technical implications for interfacing SIS with existing (more text-oriented) information systems.

6. Review the digital data requirements for the systems implemented.

1.4 Approach Adopted

The study team comprised:

Rick van Barneveld	Land Transport Manager, Transit New Zealand
David Robertson	Asset Management Engineer, Transit New Zealand
Roger Faithfull	Computer Services Manager, Transit New Zealand
Donald Bowie	Researcher, Coopers & Lybrand.

The study team spent two days in consultation with staff from each of the two Australian Authorities. At both RTA and VIC ROADS an introductory session was held to confirm the objectives of the visit and to introduce each member of the study team. Subsequently, visits were made to different divisions to learn of their use of SIS and assess the applicability to Transit New Zealand.

The study team was given access to senior management involved in decisions on SIS and these people spoke frankly about their perceptions of this relatively new technology. The study team was also given copies of documents pertaining to the development of SIS.

1.5 Research Output

This report, which is the output from Stage 2, encapsulates the Transit New Zealand study team's findings and conclusions reached. The report covers:

- The findings of the study team (under the headings outlined above under Research Tasks).
- The relevance of the study team's findings to Transit New Zealand's situation and environment.
- The relevance of the study team's findings to the three concepts already identified in Stage 1 of this project.
- The conclusions of the study team.
- Recommendations for the next steps in Transit New Zealand's research into SIS.

2. ROADS & TRAFFIC AUTHORITY OF NEW SOUTH WALES

2.1 Organisational Similarities

The RTA has a number of similarities with Transit New Zealand including:

- Responsibility as the state authority for the control of the strategic road network
- Accountability for strategic road asset management
- Leadership in road and traffic safety issues
- Funding sources
- Government setting the revenue levels
- Requirement to consult with road users
- Relationships with road users
- Responsibility for social and environmental aspects of road management

RTA and Transit New Zealand have the following objectives in common:

- Securing adequate funding
- Preserving the existing road network
- Promoting road safety
- Reducing the impact of road transport on the environment
- Developing the road network to improve economic well being and quality of life for the community
- Advancing technology through research and innovation
- Establishing quality management to ensure all services meet specified levels of performance
- Remaining responsive to the community

The RTA separates its corporate policy and monitoring roles from its regional operational responsibilities in a manner similar to Transit New Zealand. RTA's corporate divisions are structured along functional lines while the regional divisions are structured geographically, as follows:

Corporate Divisions

- Corporate Strategy
- Finance and Performance Evaluation
- Registration and Licensing Strategy and Central Operations
- Corporate Services
- Technical Services

Regional Divisions

- Sydney Region
- Southern Region
- Northern Region
- Western Region

The roles and responsibilities of each of these corporate and regional divisions are described in Stage 2 Appendix 1.

Similar to Transit New Zealand, the RTA measures its performance in specific key result areas including:

- Road safety
- Environment
- Efficiency
- Customer service
- Economic development
- Transport Efficiency
- Driver and vehicle regulation
- Community service obligations

Descriptions of these key result areas are given in Stage 2 Appendix 2.

2.2 Organisational Differences

The RTA is also responsible for a number of services which Transit New Zealand does not provide, including:

- Testing motorcycle riders and motor vehicle drivers for licences, collecting licence fees, recording licence details and offences, cancelling licences under certain conditions, and the enforcement of regulations relating to driving instructors.
- Inspecting, registering and recording details of motor vehicles, collecting registration charges, cancelling registrations, enforcing weight restrictions for loads and public passenger vehicle safety requirements.

These services employ approximately 50% of the RTA's 8,500 staff.

Strategies for these services are developed centrally while delivery is state-wide under the control of the Regional Directors.

The RTA receives funding from:

Source of Funds	**A$m**
Commonwealth funds	141.5
State funds	635.9
Other	208.2
Total	**A$985.6**

The principal sources of revenue are given in Stage 2 Appendix 3.

The RTA's operating expenses for 1991/92 were incurred in the following areas:

Operating Expense	A$m
State road maintenance	788.0
Financial	214.0
Other	151.6
Total	**A$1,153.6**

The RTA had an operating deficit for 1991/92 of A$168.0m. More details on the their operating expenses are provided in Stage 2 Appendix 4.

Other differences which the RTA has from Transit New Zealand include:

- Retention of in-house professional services functions
- Retention of a substantial physical contracting function
- Restricted use of external contractors and consultants
- Considerable internal business activity with respect to property management
- Responsibility for safety on all roads including local roads
- Substantial property holdings with consequential land survey and title data management of the type which, in New Zealand, is performed by Department of Justice Land Registries
- Sizeable mapping function and commitment to road mapping similar to the functions undertaken by Department of Survey and Land Information in New Zealand

2.3 Approach Adopted by RTA

SIS technology was first introduced to the RTA in 1989 from an initiative to improve the management of property information. For example, the RTA receives approximately 50,000 inquiries per year relating to roading projects affecting properties adjacent to state highways and the required information was, at that time, held on ageing 14-foot-long strip maps of all state highways.

The team responsible for the property mapping project selected Genamap as the preferred SIS and a complex property information management system has been developed using a variety of technologies.

Since this initial project was introduced, several other SIS projects have been undertaken. No formal strategy for SIS was in existence and other divisions have acquired different SIS to meet their own needs, without co-ordination with existing SIS

users. These projects have resulted in a number of different systems being used in different parts of the RTA including:

- Genamap
- ACT GIS
- ARC/INFO
- MAP/INFO
- AutoTrol

In addition to the use of a variety of SIS, a number of separate teams are developing systems with varying degrees of user involvement in, or responsibility for, the development. These teams work independently using different SIS which they feel are most appropriate for their business area within the RTA.

These teams, along with the projects they work on, include:

- *Asset Control Technology* Development of a generic user interface
- *Road Safety Bureau* Development of a traffic accident database
- *Geographic Information Services* Development of a graphical database of classified road networks linked to the existing road location inventory (ROADLOC)
- *Photogrammetric Services* Development of detailed three dimensional models of the road network

Of interest to the Transit New Zealand study team was the approach that the RTA had adopted towards linking pavement management to SIS. The Asset Control Technology section is developing a pilot system to integrate a variety of information systems to facilitate analysis applicable to road management using SIS. The various applications include accident locations, line marking, sign posting, road condition, road inventory, bridge data, property data and speed zones. The first sub-systems to be developed for the pilot are currently being tested by a limited number of users. The pilot is still in a formative stage with much work yet to be completed before it becomes an operational system.

A recent review performed by a consultant for the RTA identified the lack of co-ordination between the different SIS development teams and recommended the establishment of a SIS Co-ordination Committee. It was also recommended that this Committee would bring together all of the RTA's expertise in SIS to establish a single group of experts.

This Committee was established and recognised the potential implications of continuing to use multiple systems. Its major initiative has been to commission a review of all of RTA's requirements for spatial information with the objective of selecting the preferred SIS from the variety of systems currently used. The results of this study have yet to be reported.

The RTA has, however, recently appointed a new Director of Information Technology who reports directly to the Chief Executive of the RTA. The appointee has already identified SIS as a key element in RTA's information systems strategy.

Another significant move to establish some control over SIS developments has been the appointment of a Graphics Database Manager responsible for ensuring consistency and co-ordination of data used in existing and future developments.

2.4 Costs and Benefits

As far as could be determined, no comprehensive cost-benefit case has been developed for the introduction of SIS to meet RTA's corporate requirements. The initial property information SIS was justified financially although this was primarily based upon the cost of replacing the existing, dilapidated strip maps. The requirement to service approximately 50,000 property-related inquiries per year and the need to provide access for RTA's regional offices to the central property database also provided substantial grounds for automation.

A second "in-house" development has been undertaken by the RTA Road Safety Bureau which is responsible for tracking and locating accidents. This project was commissioned as a research study into the "Use of Geographic Information Systems for the Capture of Traffic Crash Location Data". The development of the pilot system has been carried out with Road Safety Bureau staff using the MapInfo GIS. This pilot has demonstrated a potential pay back period for this single application SIS in the order of three years. Some assumptions were made, however, within the cost-benefit analysis on the potential value of having accident data coded with geographical co-ordinates.

The other initiatives appear to have been funded as part of the ongoing operational budgets, as part of research and development or on the basis of a cost-benefit case that relied on a link between the SIS project and a potential 1% saving in the RTA maintenance budget.

The RTA has only recently recognised the need for systems to be cost justified and has established an approach to SIS development that is reliant on either a corporate division or a region directly funding the project on a user-pays basis.

By June 1993, RTA had also amalgamated the two principal SIS development groups and established more structured relationships with user divisions.

2.5 Project Management

Overall project ownership and management of SIS developments in RTA appeared to be lacking but two projects have been developed within its operational divisions.

1. The property SIS was initiated by the Survey and Land Information Department and has been managed by that department throughout. The development team was established within the department to undertake this project and had little contact with other SIS projects.

2. The RTA Road Safety Bureau accident location project appears to have been undertaken with limited resources and required only limited project management. As with the property system, this project has been performed and managed within the user department. This has precluded the need to involve users in a rigorous approach to systems development. As the project was a research study undertaken by one person there has not been the need to apply formal project management techniques.

Other projects, especially those initiated by the Asset Control Technology and the Geographical Information Services sections, have not had the same user commitment to and involvement with their projects. This has lead to the development of technically elegant systems that do not appear to have met user expectations. Few, if any, rigorous project management methods with a customer orientation have been adopted. Internal project management techniques may have been applied but these have not influenced the system that has been delivered.

2.6 Technical Implications

Each of the SIS projects undertaken by the RTA has required some interfacing to existing databases. The property information system required integration with the textual property information system that provides the attribute data associated with each parcel of land adjoining all classified roads.

The Road Safety Bureau's Traffic Crash Location system, if implemented across all offices of the RTA, will need to be interfaced to the current accident database. This database records crash characteristics including textual descriptions of where the crash occurred.

The other SIS initiatives have also required the transfer of data from an existing system to the spatial system for graphical presentation. In each case a specific interface program has been written to access the existing database. In some instances, several existing datasets are able to be accessed and the results presented simultaneously.

A pivotal system that has been integrated with several SIS applications is the RTA's pavement management system. The attribute data held within this system are key to many of the RTA's roading applications. Operational users of SIS have identified the graphical presentation of pavement data as a key output from such systems.

As far as was able to be determined, few obstacles were encountered in linking into the existing corporate databases. The RTA has a large information systems department and has considerable expertise in the technology it uses to deliver its corporate systems.

In addition, many of the projects have been run as research studies with limited control over their funding and resources. This has provided the environment where technical difficulties can be overcome apparently without regard for the constraints of fixed budgets and cost justification.

2.7 Digital Data Requirements

At the outset of the property spatial information project, the RTA sought a digital map database it could use for a number of spatial information applications. It initially purchased a digital road centreline database covering only part of New South Wales (NSW), from NSW Government's Land Information Centre. The RTA subsequently acquired coverage of the remainder of the state from a commercial supplier of digital map data who had been supplying the Road Safety Bureau with maps suitable for the accident location system. RTA has since concluded that these map databases had insufficient specification and quality assurance.

As a result, it is now participating in a project to integrate global positioning systems (GPS), using satellite technology, with inertial positioning technology to accurately pinpoint true geographical positions of road features in terms of X, Y and Z co-ordinates. This project, GIPSITRAC, is a collaborative effort with several state roading authorities in Australia, the Australian Road Research Board (ARRB), and the University of Melbourne. If the development project is successful, the RTA will use this new technology to upgrade the accuracy and integrity of its digital road centreline database.

While developing this technology, the RTA recognised that it had made considerable investment in, and that it relies heavily on, digital graphics data. Management has accepted that it has placed too much emphasis on the applications and has not paid enough attention to the data required to support its business functions. This has lead to the establishment of the position of a Graphics Database Manager, as mentioned in Stage 2 Section 2.3.

A number of policies regarding graphics data have been developed by the RTA including:

- Replacing the existing road centreline database to improve quality,
- Maintaining its own digital map databases, once established, and resisting the temptation to implement map database upgrades,
- Establishing graphics data as a corporate resource to be used for a number of applications,
- Maintaining high data quality through effective data management,
- Co-ordinating all graphics data purchases to take advantage of cost savings, map database consistency and reduced duplication,
- Purchasing cadastral (land parcel) data for specific projects only and providing input to the Land Information Centre to influence policy.

The RTA has specified its map database requirements and identified the following elements as necessary:

- Road centrelines
- Government and other administrative boundaries
- Waterways
- Railways
- Geographic place names

Because RTA has developed a number of methods of referencing classified road locations, one of its projects is now attempting to develop a consistent referencing system that can be used with existing databases, through the use of a common index, without substantial changes being required. This project is proving to be time consuming and difficult to manage. It requires considerable commitment from all users and developers of systems using geographically referenced data.

3. ROADS CORPORATION OF VICTORIA

3.1 Organisational Similarities

Significant similarities exist between Roads Corporation of Victoria (VIC ROADS) and Transit New Zealand particularly in relation to:

- Responsibility as the state authority for the control of the strategic road network
- Funding sources
- Government setting the revenue levels
- Accountability for strategic road asset management
- Relationships and consultation with road users
- Relationships with local authorities
- Recognition of social and environmental impact of roading

VIC ROADS and Transit New Zealand have the following objectives in common:

- Maintaining, upgrading, varying and extending the state highway network
- In conjunction with local authorities, assisting in the maintenance, upgrading and construction of other roads
- Determining load limits and advisory speed for roads, bridges and culverts
- Establishing guidelines for over-size vehicles and loads
- Developing and implementing road safety strategies, developing and promoting road safety education
- Developing and implementing traffic management strategies and practices
- Providing and maintaining roadside reserves adjacent to any road

Of the five principal aims of VIC ROADS, the following three are also applicable to Transit New Zealand:

Access and Mobility - to assist the efficient movement of people and freight and improve access to services for all users of the transport system;

Economic Development - to assist growth by improving the effectiveness and efficiency of the transport system;

Environment - to be sensitive to the environment through responsible management of the transport network.

VIC ROADS organisation structure is similar to that of Transit New Zealand in that its policy and monitoring functions are divided into seven corporate divisions, and its operational responsibilities are structured into two operational divisions comprising eight geographic regions, as follows:

Corporate Divisions

- Corporate Development
- Road Safety
- Quality and Technical Resources
- Business Services
- Human Resources
- Finance
- Information Technology

Operational Divisions

- Metropolitan Operations
  - comprising three metropolitan regions centred on Melbourne
- Rural Operations - comprising five rural regions

The responsibilities of these divisions are outlined in Stage 2 Appendix 5.

VIC ROADS measures its performance on a range of key indicators similar to those used by Transit New Zealand, including:

- Financial Measures (both cash and programme expenditures)
- Employees
- Road Safety
- Road Network Access Services
- Customer Services

Details of performance indicators are given in Stage 2 Appendix 6.

3.2 Organisational Differences

Of the five main aims of VIC ROADS, the following have little or no relevance to Transit New Zealand:

Road Safety - to achieve a safe road system for the people of Victoria, which equates to the objective of the Land Transport Safety Authority (LTSA) in New Zealand;

Commercial Services - to provide information, financial and technical services to clients on a commercial basis.

VIC ROADS has responsibility for the management of approximately 22,000km of classified roads including freeways, state highways, forest, tourist and main roads. Approximately 50% of VIC ROADS' 4,300 employees are assigned to classified road management, development and maintenance.

Functions provided by VIC ROADS that are not delivered by Transit New Zealand include:

- Traffic safety services
- Motor vehicle registrations
- Driver licensing
- Road network mapping
- Competitive tending for work outside legislated areas of responsibilities.

Although VIC ROADS is responsible for funding and direct maintenance of the 12,700km of main roads, it has transferred the management of maintenance for two thirds of the classified roads to local government. Little use is made of private sector consultants in the management of classified roads.

VIC ROADS' operating revenues for 1992 were sourced from:

Revenue Flow	**A$m**
Government appropriations	563.3
Operating fees & other funding	26.3
Regulatory, licence & other revenue	76.2
Total	**A$665.8**

More detailed breakdowns of these fund inflows are given in Stage 2 Appendix 7.

VIC ROADS' operating expenditure for 1992 was incurred in the following areas:

Expenditure Area	**A$m**
Road network management programmes	543.7
Management & operating expenses	101.1
School crossing supervision	8.1
Multiple purpose taxi programme	16.6
Total	**A$669.5**

More detailed breakdowns of both the road network management programme expenses, and management and operating expenses are given in Stage 2 Appendix 8.

Other differences that VIC ROADS has from Transit New Zealand include:

- Responsibility for safety on all roads including local roads
- Considerable internal business activity with respect to property management (VIC ROADS is Victoria's second largest property owner)
- Land survey and title data management of the type which, in New Zealand, is performed by Department of Justice Land Registries
- Commitment to road mapping, requiring functions similar to those functions performed by Department of Survey and Land Information in New Zealand
- Retention of some in-house professional services functions
- Retention of a reduced physical contracting function
- Restricted use of external contractors and consultants

3.3 Approach Adopted by VIC ROADS

VIC ROADS has maintained a consistent approach to SIS in line with its centralised philosophy for information systems. All SIS initiatives are managed within the Land Information and Survey branch of the Quality and Technical Services division and there is no SIS steering committee or user representative group. The overall direction for information systems within VIC ROADS is maintained by the Corporate Information Management Committee which has responsibility for SIS as well as all other initiatives.

Spatial information technology was first introduced to VIC ROADS in 1988 and the first full-time geographic information analyst was appointed in 1989. Since then the Geographic Information Services team has grown to 10 staff working full time on either the development of applications or the completion of specific projects using spatial information technology.

The Geographic Information Services group has worked from the bottom up to get SIS integrated into VIC ROADS operations. It has sought to link data held on VIC ROADS corporate databases with digital maps for presentation purposes. These initiatives have been funded from corporate research and development budgets and Quality and Technical Services division funds. All work has been enthusiastically promoted by the Director of Quality and Technical Services and supported by the Chief Executive.

A strategy for the development of SIS within VIC ROADS was prepared in 1992 and identified the following areas of benefit:

- Road network management
- Strategic transportation planning
- Executive decision making

- Road usage
- Project planning (corridor analysis)
- Property management

It has been proposed that initial efforts focus on applications to support the first two areas. Other objectives for SIS identified by the strategy include:

- Integration of data
- Visualisation of information to aid interpretation, validation and analysis
- Presentation of project and operational results
- Identifying new areas of potential benefit and solutions to existing problems

VIC ROADS is also contributing to an 18-month study of the Victorian Government's spatial information requirements made by the State Government's Office of Geographic Data Co-ordination. This study seeks to co-ordinate the State Government's SIS efforts and is considering the following user areas:

- Electoral Office
- Land Status and Assets
- Human Services
- Landcare
- Planning and Infrastructure

3.4 Costs and Benefits

VIC ROADS did not attempt to cost-justify its initial investment in SIS and still does not attempt to cost-justify all of its SIS projects. VIC ROADS perceives SIS as important tools required to enhance the management of the classified road network in Victoria. As a result VIC ROADS is prepared to proceed with its development of SIS in the belief that the management of the road network will improve as a consequence.

Many of VIC ROADS projects have been exploratory, trying to provide more usable information from the corporate database. These projects have been charged against the Geographic Information Services group budget and provided to operational divisions as requested.

Where work has been performed on behalf of a client such as a local authority, the projects have had to be justified by the client. VIC ROADS has little input to this process apart from providing indicative costs for its involvement. The level of cost recovery of these charges was not determined.

A major transportation planning study, undertaken in conjunction with local authorities, has used SIS to aggregate information from a variety of sources and present more meaningful interpretations of that data by means of maps. These maps have been easily modified to support "what if" scenario modelling.

The study currently being performed by the Office of Geographic Data Co-ordination has an objective to investigate the justification for a single map database for the participating organisations. The consultants contracted to complete the study are assessing the costs and benefits of establishing a state-wide digital map database that would meet the needs of all Victorian Government holders of land-related information.

3.5 Project Management

The Geographic Information Services group has established project management structures with each major project having a Project Leader. Each project undertaken on behalf of clients is documented and approved by that client. Where the client is another department of VIC ROADS the client may sometimes second a staff member to the Geographic Information Services group.

The selection of ARC/INFO as VIC ROADS' preferred SIS followed a rigorous evaluation procedure. Initially VIC ROADS required a PC-based product that could be used to assess the applicability of the technology. Subsequent to the successful trial of SIS, the decision was made to acquire a fully featured system that operated across a local communications network.

The selection procedure extensively tested the capabilities of the two leading products available at the time. Operational personnel as well as technical staff participated in the evaluation process which involved week-long vendor presentations based on VIC ROADS' specifications and data. The selection process established ARC/INFO as the most suitable SIS for VIC ROADS at the time. VIC ROADS has subsequently purchased an Intergraph licence to support applications more appropriately developed using Intergraph products.

The definition of spatial information applications developed for specific clients are prepared in conjunction with the client. Sometimes this work is carried out on a contract basis for external customers such as local roading authorities and other government departments.

In some cases applications are developed in anticipation of being implemented across operating divisions. These are typically conceived within the Geographic Information Services group. The concepts generated are then tested with operating personnel before commencing development. Initially system prototypes are developed and demonstrated to operational staff. When sufficient support is gained from operational divisions the development of the complete system is commenced.

3.6 Technical Implications

As mentioned under Approach Adopted by VIC ROADS (Stage 2 Section 3.3), the Geographic Information Services group has endeavoured to provide systems that integrate data from several sources and use digital maps as the medium for alternative representations of this data. The corporate databases maintained by VIC ROADS Information Technology Division (ITD) hold a wide range of road network- and land-related data.

Advanced management information systems are used to collect, manipulate and distribute this information to all areas of VIC ROADS operations. A large portion of the ITD budget is spent supporting the registration and licensing operations. Only a few initiatives are under development to support road network operations. One of these is the implementation of standard pavement management systems across all rural and metropolitan regions.

The Geographic Information Services group has been successful in extracting data from the corporate databases and interactively compiling client-specified maps presenting data from a number of separate files. The pavement management system has recently been integrated with PC ARC/INFO allowing road surface conditions to be presented on a map according to user-defined criteria.

The integration of existing datasets with the SIS operated by VIC ROADS has not posed a difficult technical problem. VIC ROADS has a large ITD with the requisite experience necessary to develop mechanisms for exchanging data between systems.

3.7 Digital Data Requirements

The integration of the data sourced from the corporate databases has been more difficult as VIC ROADS has not developed a standard method for referencing locations on the road network. This has lead to numerous referencing systems being developed to suit each application and to problems associated with trying to inter-relate the data.

Problems faced included:

- Different place names
- Different keys to databases
- Different geographical boundaries

VIC ROADS is presently endeavouring to develop a Standard Road Referencing System (SRRS) which will provide an index to the many databases holding spatial information related to the road network. This project is similar to the project being undertaken by RTA's Graphic Data Manager. It is less complex, however, as VIC ROADS already had a more co-ordinated approach to the development of SIS.

VIC ROADS proposed that SRRS will be maintained as a separate relational database with five index tables:

- Roads
- Links
- Reference points
- Local government boundaries
- VIC ROADS regional boundaries

The SRRS will potentially provide up to five location methods:

- Kilometre breaks
- Route measures
- Intersections
- Geographical co-ordinates
- Street addresses

A key element in VIC ROADS' success with SIS is the consistent use of a single digital road map in all of its applications. VIC ROADS recognised early in its development of SIS that a consistent map database was necessary to achieve its objectives.

VIC ROADS survey and cartography sections have maintained an up-to-date road map of all roads, classified and local, in Victoria. This paper-based map was used as the source for the development of a road centreline database for rural regions of Victoria. The digital map of the metropolitan areas of Melbourne was provided by Melbourne City Council's Water Department at no charge on the basis that improvements to the maps would be made available back to the Council at no cost. Other potential sources of digital maps covering Victoria were considered to be too low in quality to meet VIC ROADS' requirements.

VIC ROADS has continued to enhance the digital map database to achieve a level of integrity and accuracy to meet its needs. This has, for the most part, been undertaken by contractors whose outputs are required to meet a specification developed for the VIC ROADS map database.

This database has now reached such a standard of quality that it is being sought by both public and private organisations for use on their SIS. In addition the study by the Office of Geographic Data Co-ordination has identified the VIC ROADS digital map as the most suitable to support road-related spatial information applications with Victorian Government departments.

VIC ROADS has developed a policy that non-commercial users may have access to the digital map at the cost of compiling and distributing the information. For a typical local authority this cost is between A$450-900. Any improvements they may make to the map have to be submitted to VIC ROADS who can then amend the original copy of the map.

4. RELEVANCE OF AUSTRALIAN EXPERIENCES

4.1 Similarities

Many similarities exist between the modes of operation of the two Australian transportation Authorities and those of Transit New Zealand. These similarities include:

- Policy development and operational function of government for road transport
- Controlling authority for strategic roads
- Accountability to government for strategic road asset value
- Government setting the revenue, and thus, expenditure levels
- Relationships with road users
- Consultation for projects and policy
- Growing importance of environmental and social concerns

4.2 Differences

RTA and VIC ROADS are significantly different from Transit New Zealand in the following ways:

- Direct involvement in project engineering as a basic business activity
- Greater size, in staff numbers, of the road-related divisions and associated support functions such as information technology
- Greater responsibility for safety
- More reliance on internal staff, than on contractors, to perform many of the road network management and maintenance functions
- Higher level of research and development
- Limited involvement and interaction with local authorities
- Direct involvement in motor vehicle registration and driver licensing
- Less rigorous project justification procedures and approval criteria for SIS

4.3 Staff Requirements

The number of full time staff that RTA and VIC ROADS employ is a multiple of the number that Transit New Zealand employs when compared on the basis of staff employed per kilometre of road controlled. This is in part directly related to the continued employment of roading gangs, the maintenance of a wide range of technical services (including mapping services), and the perceived propensity to prefer projects to be undertaken by internal resources, by the Australian Authorities.

4.4 Contracting Out

Both RTA and VIC ROADS have, however, moved much more slowly than Transit New Zealand towards contracting out functions that could be as effectively performed by private enterprise as by a government agency. The RTA is presently running a trial project using a consultant to manage the maintenance of a subset of the classified roads in a region. VIC ROADS has transferred its main roads maintenance responsibility to some local roading authorities. The practice of developing this responsibility to consultants is not widespread and there appeared little interest, among the VIC ROADS staff encountered, for this to occur.

4.5 Research and Development

Both Australian Authorities had significantly higher research and development budgets than Transit New Zealand. The divisions of the RTA that the study team visited appeared to undertake a lot of research funded by their own operating budgets. The control of research spending appeared more stringent within VIC ROADS than within the RTA. However, a large proportion of the staff employed within VIC ROADS Land Information and Survey section appeared to be primarily committed to technical development projects.

4.6 Local Roads

The RTA and VIC ROADS are not involved in funding local road development or maintenance although joint funding is available from the RTA for regional roads within New South Wales. Both organisations have relatively less contact with the local roading authorities compared with Transit New Zealand.

The RTA subcontracts the maintenance of approximately half of NSW's classified roads to local roading authorities. These relationships have been established within the regional divisions. Funding for maintenance is based on the expenditure for the previous year plus an allowance for inflation.

VIC ROADS, as mentioned above, has authorised some local roading authorities to maintain state roads in their areas. While at present only a few local roading authorities use pavement management systems (PMS), those performing maintenance management functions for VIC ROADS are required to use the VIC ROADS PMS.

4.7 Registration and Licensing

Both Australian Authorities are responsible for motor vehicle registration and drivers licensing within their respective states. These functions expose the Authorities to a high public profile, require the maintenance of a network of offices employing a high number of staff and require considerable investment in information systems.

Approximately half of the budget of each Authority is committed to supporting these functions.

4.8 Approving Spatial Information Systems Projects

The way in which information systems development projects are approved within the Australian Authorities and within Transit New Zealand are significantly different. Neither of the Australian Authorities required the level of justification for information systems developments sought by Transit New Zealand.

The approval criteria for SIS appeared to be quite vague with cost-benefit reports being restricted to relatively cursory analysis. Transit New Zealand's requirements are more rigorous. Both Australian Authorities had, however, committed themselves to SIS as a technology required for improved road network management.

4.9 Relationship to New Zealand

Both Australian Authorities were able to impart their experiences and apply them to Transit New Zealand's operating environment for the benefit of the study team.

Stage 1 of the SIS project identified Transit New Zealand's primary functions as:

- Research and Development
- Policy and Planning
- Development of the National Land Transport Programme
- Administering the National Land Transport Programme
- Control of State Highway System
- State Highway Management
- Local Roading Authority Liaison
- Performance Audit

Both RTA and VIC ROADS are responsible for similar functions as well as being involved in motor vehicle registration, driver licensing, "on the ground" maintenance management, delivery of professional services and, to a lesser degree, contracting services.

Most of the SIS effort expended by RTA and VIC ROADS has been to assist the operational areas of their roading business. In comparison, Transit New Zealand has less involvement in the operational functions. Therefore it has a lesser requirement for an SIS that supports such functions.

The key issue is, however, that both Australian Authorities perceive considerable benefits flowing from improved strategic planning of transportation and of road

networks as a consequence of SIS implementation. Both organisations are endeavouring to establish a digital map database to support their strategic objectives.

VIC ROADS has undertaken a study of transportation needs in partnership with other state and local government authorities using SIS. VIC ROADS considers the use of spatial information technology to have contributed significantly to the identification, analysis and prioritising of the transportation options examined.

4.10 Strategic Planning

The area of strategic planning is one of particular relevance to Transit New Zealand's situation. Each Transit New Zealand regional office periodically updates its strategic plan for the state highways in its own region. In many cases this task is completed by a contractor with the output of the study consisting, primarily, of a report. Each region approaches these studies independently and neighbouring regions often use different contractors.

Transit New Zealand does not have a system to combine the results of these regional plans into a single strategic plan for the state highways in New Zealand. Furthermore, conceptualising this single strategic plan in a textual or non-pictorial form would not be feasible. When the location information is simplified as on digitised maps, the appropriate information can be superimposed so that the decision makers can readily assimilate the single strategic plan.

4.11 Development of Systems and Standards

Other areas of relevance are those related to the development of the technical systems and data standards that are necessary to implement a successful SIS. Both of the Australian Authorities are currently attempting to develop corporate standards for referencing road locations to allow integration of disparate datasets.

The development of the road referencing standards are difficult tasks and as Transit New Zealand does not have the depth of technical expertise that is available within the two Australian Authorities, it could learn a lot from the results of these projects.

Both Australian Authorities are also researching new technology developments which they expect will increase the effectiveness of their SIS significantly. These include the evaluation of GPS and vehicle location systems for road user charges. Again Transit New Zealand stands to gain much knowledge through maintaining contact with those responsible for these projects.

5. RELEVANCE OF SPATIAL INFORMATION SYSTEM CONCEPTS

Stage 1 of this SIS project identified three concepts in which SIS might be developed to assist Transit New Zealand in the management of the state highway network. These concepts are:

1. ***Spatial Information Indexing System*** (Stage 1 Section 8). Primarily this is a geographic index to information relating to sections of the state highway network. The index would be a catalogue to the different systems already established in Transit New Zealand that collect, store, maintain and distribute information that is in some way spatially related. This concept would incorporate only limited access to data and not be capable of complex data analysis.

2. ***Spatially Linked Information Indexing System*** (Stage 1 Section 9). Built upon the first concept, this system would provide greater spatial analysis capability and would allow on-line access to data held in existing digital databases. It would provide indexing facilities to information held in databases not linked to the SIS.

3. ***Spatially Integrated Highway Management System*** (Stage 1 Section 10). This concept would involve integrating all existing information relating to the state highway network. Adoption of this concept would require the establishment of corporate databases and systems to support the use of the analysis and presentation capabilities of the SIS.

To date neither the RTA nor VIC ROADS have established a framework within which SIS are to be developed. Both have approached SIS development on an application by application basis.

The RTA is currently undertaking a study of the requirements for SIS with the objective of determining which SIS is most suitable. The study is identifying business areas and associated potential applications for these systems, and should also provide a framework for the development of information systems, something that has been lacking to date.

VIC ROADS has displayed greater co-ordination in its approach than the RTA by limiting the development of SIS to a single group in its organisation and to consistent use of a preferred SIS. Both organisations accept that a framework is necessary and are trying to build common practices through the development of a standard map database and road referencing system.

The VIC ROADS study has identified a range of areas where SIS might be applied to benefit road network management (Stage 2 Section 3.3). However, it did not provide any clear indication how SIS development would integrate, in the long term, with the development of broader management information systems.

The Information Technology Division at VIC ROADS maintains a range of databases to support the transportation functions of that Authority. These are developed in line with an overall direction set by the Corporate Information Management Committee. The Geographic Information Services team has developed VIC ROADS' SIS within this framework but has had little influence upon it. SIS are developed on an "as required" basis or as consequential research projects. There is, as yet, no integrated plan that will see SIS become a crucial element in the delivery of management information.

All three SIS concepts developed in Stage 1 of this study for Transit New Zealand rely on the development of a consistent digital map database for the whole country and on the acceptance of a standard location referencing system suitable for all applications. Without common approaches to data and its indexing, many of the facilities that make SIS into powerful analysis tools are lost through incompatibility of data.

The three concepts identified in Stage 1 of this study provide appropriate models against which Transit New Zealand can assess its direction for SIS. The Transit New Zealand study team believe that, because of the broad range of approaches available for SIS, Transit New Zealand must still test the results of further steps against these concepts.

6. DISCUSSION

The Transit New Zealand study team approached the development of conclusions to be drawn from the visit to the two Australian transportation Authorities in a structured way. Because the Australian experience suggested that SIS might make strategic decision-making a viable possibility, the study team used a *force field analysis* to examine the issues related to Transit New Zealand's current practice of making more discrete decisions (Table 6.1). The types of potential strategic decisions that could be made using spatial integrated information were also investigated.

Table 6.1 Discrete versus strategic decisions.

Factors which Favour	
Discrete Decisions	**Strategic Decisions**
• lower up-front costs • limited technology requirements • less resource intensive • less people • less information demand interactive • avoid requiring national co-operation • consultants can maintain their commercial edge through owning discrete information • focus on project cost-benefit viability • Government's short term investment criteria • users are high priority on short term project-oriented needs • current decisions are not challenged	• strategic planning framework recognising national resource management and longer term view • Ministerial Directive on GIS • Transit New Zealand's strategic direction • consistency with RAMM • national co-operation and economies of scale • avoids discrete management • maintains Transit New Zealand's leadership • users seek co-ordination • environmental concerns need national response • social responsibilities need national approach

In reviewing a number of initiatives that have been identified as opportunities for more strategic development for Transit New Zealand, the study team concluded that all these initiatives were currently being addressed in a discrete fashion (Table 6.2).

The study team's view is that the integration of the strategic initiatives that Transit New Zealand is currently undertaking cannot be conceptualised in its current textual information systems environment. Many of the decisions made with respect to the initiatives listed above should take account of actions being taken as parts of other initiatives but, at present, integrated information cannot be presented to decision-makers.

Table 6.2 Transit New Zealand's strategic initiatives.

Strategic Initiative	Project Type
Land Transport Pricing Study	Discrete
Intelligent Vehicle Highway System	Discrete
Sealing unsealed state highways	Discrete
Regional land transport strategies	Discrete
Heavy transport routes	Discrete
Forestry traffic planning	Discrete
Tourism development	Discrete
CO_2 emission strategy	Discrete
Noise criteria	Discrete
Stock effluent guidelines	Discrete
State highway roadside planting strategy	Discrete

SIS were seen by the study team to provide the mechanism whereby the impact of each decision made can be assessed by Transit New Zealand management, the Transit New Zealand Authority, Government, and other agencies with whom Transit New Zealand consults.

For example, developing Transit New Zealand's regional land transport strategies on an SIS would provide the assurance that the information used by the planning consultants in one region is understood by the consultants in neighbouring regions. Thus the potential impacts of changes to the state highway network in one region are accounted for in the development of the land transport strategy in adjoining regions.

Similarly, SIS may ensure that decisions being taken on the likely growth in tourism-related traffic or forestry-related traffic are made with access to information on other issues, such as sealing unsealed roads in the region or Transit New Zealand's commitment to a CO_2 emission reduction strategy.

To analyse the extent to which SIS might be utilised with respect to Transit New Zealand's responsibilities, the study team used the Australian experience to define six principal areas of operation that might benefit from SIS. These were matched with the functions of Transit New Zealand identified in Stage 1 of this research project (Stage 1 Section 3).

To simplify the analysis, the functions "Control State Highways" and "State Highway Asset Management" were combined into one function called "State Highway Control and Management".

The opportunities for SIS identified within each principal area of operation were assessed for the likely impact on that function and assigned on a range from small, medium, large, extensive. The opportunities and their impact assessments are shown in Table 6.3.

Those opportunities that were considered to provide large or extensive benefits were ranked in order, from 1 to 10 according to the potential benefits likely to accrue to Transit New Zealand. The following rankings are also presented in Table 6.3:

1. Strategic Planning/State Highway Control and Management
2. Road Usage/Policy and Planning
3. Strategic Planning/Policy and Planning
4= State Highway Asset Management/Prepare NLTP
4= Road Usage/State Highway Control and Management
6. Strategic Planning/Performance Audit
7. Road Usage/Traffic Safety
8. State Highway Asset Management/Performance Audit
9. Local Authority Asset Management/Performance Audit
10. Strategic Planning/Research and Development.

Table 6.3 Opportunities for applying SIS.

Function	SH Asset Manage/t	LA Asset Manage/t	Strategic Planning	Road Usage	Project Planning	Property Manage/t
Research & Develop/t	S	S	L10	M	S	
Policy & Planning	S	S	E3	E2		
Traffic Safety	M	M	M	L7		
Prepare NLTP	L4=	M	M	M	S	
Administer NLTP						
SH Control & Manage/t	M		E1	L4=	S	M
LA Liaison		S	M	S	S	S
Performance Audit	L8	L9	L6	M	S	S

Key:
S small L large (assessments of the likely impact of SIS on each function)
M medium E extensive
E1 – L10 (rankings of the opportunities assessed as extensive (E) or large (L) (on a scale of 1 (greatest) to 10 (lowest)
SH State Highway Manage/t management
LA Local Authority Develop/t development
NLTP National Land Transport Programme

Table 6.4 Potential applications for SIS, and their benefits, to key Transit New Zealand business activities.

Potential Applications	Benefits/Outputs
1. Strategic Planning/ SH Control & Management • consult and report nationally • monitor and management performance • respond to strategic imperatives • develop national land transport strategy	• national aggregated view • improved interpretation • visual presentation of complex issues • reduced analysis and reporting time • improved data quality and integrity
2. Road Usage/ Policy & Planning • analyse what is moving where • predict how roads will respond • plan transport capacity • implement pricing strategies • manage pricing data	• recognise trends across boundaries • present scenarios in understandable manner • co-ordinated transport capacity • respond to user pays initiatives • develop pricing strategies • national aggregated view • improved interpretation • visual presentation of complex issues
3. Strategic Planning/ Policy & Planning • plan national impact of land transport • import new, previously un-utilised information	• national aggregated view • improved interpretation • visual presentation of complex issues
4= SH Asset Management/ Prepare NLTP • evaluate project proposals • rank project proposals for best cost-benefit returns • present consequences of budget decisions	• identify impact of discrete cost-benefit decisions • examine alignment with strategic planning • reduce risk of discontinuity of service levels
4= Road Usage/ SH Control and Management • collect information • deliver strategic response to use • consult with external organisations	• national aggregated view • improved interpretation • visual presentation of complex issues

SH - state highway

This list highlights that the greatest potential for SIS within Transit New Zealand lies in the areas of:

- Strategic Planning
- Road Usage Analysis
- State Highway Asset Management

The potential applications for SIS within the top five priority areas were considered in more detail and the benefits likely to arise were identified. These are presented in Table 6.4.

The analysis in Table 6.4 indicates that the strategic management of the state highway network by Transit New Zealand could benefit significantly from the application of SIS.

The study team has concluded that sufficient opportunities would benefit from spatial information technology within Transit New Zealand to warrant continued investigation of the systems.

7. CONCLUSIONS

The Transit New Zealand study team has concluded that:

(a) Transit New Zealand cannot realise the full potential for the strategic applications described in Stage 2 Table 6.4 without the implementation of an SIS environment.

(b) The potential benefits from implementation of an SIS environment for strategic decision-making, as set out in Table 6.4, justify further examination, part of which should be more analytical confirmation of the study team's assumption that strategic decision-making is a critical activity in terms of Transit New Zealand's mission.

(c) Because well structured relational databases for each type of information are an essential prerequisite to an ordered SIS, an SIS that interactively accesses information from a series of files is likely to be the preferred approach. Australian experience suggests that this approach offers opportunities for staged implementation and early realisation of benefits. Of the three broad SIS concepts developed in Stage 1 of this project, Concept 2 therefore seems to be the more appropriate.

(d) The further examination proposed in 7(b) above should not attempt to quantify these benefits as Australian experience has shown convincingly that this is only possible in service delivery (or doing) operations. Furthermore, Australian experience has shown that quantification will either degenerate to a trivial assessment of percentage savings in activity areas or a project-by-project assessment of time savings. Neither of these approaches will in fact be sufficiently rigorous or robust to convincingly support decisions in the Transit New Zealand environment.

(e) Notwithstanding the need for a firmer establishment of the benefits which will flow from a new approach to strategic decision-making, a decision on implementation of an SIS will, in the end, be made on the importance that Transit New Zealand assigns to strategic decision-making based on a complex range of spatial information.

8. FUTURE CONSIDERATIONS

8.1 Outcome of Australian Study Visit

The Australian study visit improved Transit New Zealand's knowledge and appreciation of how SIS could be applied to the management of the state highways in New Zealand.

8.2 Recommendations

Further research into SIS should be undertaken to more fully describe the opportunities for these systems within the Transit New Zealand functions that have been identified as having potentially large or extensive impacts. The following steps outline that research.

Phase I

1. Maintain communication with RTA (NSW) and VIC ROADS (Victoria) in Australia to learn the outcomes of their respective road referencing system projects.

2. Describe in more detail the functions performed in the areas identified in Stage 2 Tables 6.3 and 6.4, and document the existing resources, systems and data used. This activity can draw upon Transit New Zealand's draft Strategic Information Systems Plan.

Phase II

As the investment in information systems and specifically in SIS has a high cost, and an associated high risk, information systems projects must support the objectives of the organisation.

3. Either in parallel with Phase I or before proceeding to Phase III, Transit New Zealand, in its current review of its Strategic Information Systems Plan, must examine whether the strategic decision-making applications and benefits set out in Stage 2 Table 6.4 justify further attention and what priority this activity should have.

Phase III

4. Confirm which of the three concepts developed in Stage 1 of the SIS project (Stage 1 Sections 8, 9, 10) best meets Transit New Zealand's requirements. Develop an overall view defining how to integrate SIS with Transit New Zealand's existing and future information systems.

5. Prepare a specification for the staged development of a corporate database of commonly referenced road and road-related information defining Transit New Zealand's future requirements for strategic and road use information, and meet the applications described initially in Stage 2 Table 6.4.

6. Define in more detail the applications and data likely to be required.

7. Elaborate on the likely benefits listed in Stage 2 Table 6.4 which will accrue from implementing the preferred concept and identified applications.

8. Re-assess the potential cost of implementing and operating the preferred concept.

9. Prepare appropriate recommendations for Transit New Zealand to consider, which review and develop the further steps tentatively set out in Phases II and III of these recommendations.

Phase IV

If a decision is taken in favour of implementing an SIS (perhaps along the lines of Concept 2 as presented in Stage 1 Section 9), three further steps will need to be taken.

10. Define a suitable approach to acquire the desired system. Typically this should entail a competitive tendering process that might involve:
    - Incorporating the detailed systems specifications into a Request For Proposal (RFP) document
    - Distributing the RFP to selected vendors
    - Ranking responses according to pre-defined evaluation criteria
    - Identifying a short list of preferred suppliers, if required
    - Visiting existing user sites
    - Bench marking short listed systems, if required
    - Undertaking detailed contract negotiations, if appropriate
    - Re-assessing the cost-benefit analysis once the preferred system has been identified and price negotiations have been completed

11. Acquire a suitable digital map database for the SIS, in parallel with the selection of the system. If no map database is available that has significant advantages over its competitors, a tendering process may also have to be undertaken to select the appropriate base map. This would require the development of a detailed data specification that would form the basis for the RFP document.

12. Assuming satisfactory completion of the system and map database acquisition processes, implement the system and load the data. The principal tasks will be:

- Developing detailed implementation plans
- Determining the internal and external resource requirements
- Time-tabling major project milestones
- Appointing an implementation project manager
- Establishing implementation project teams
- Identifying the potential organisational impacts
- Customising the system to meet Transit New Zealand's requirements
- Training users

8.3 Costs of Future Research

- Costs associated with completing Phase I, Step 1 of the Stage 2 recommendations are considered to be nominal and part of Transit New Zealand's continual contact with Australian transportation authorities.

- Costs likely to be incurred in completing Phase I, Step 2 of the Stage 2 recommendations include:
  - Preparatory work involving Transit New Zealand staff in determining applications of SIS, identified in Tables 6.3 and 6.4
  - Assistance in determining the processes and information used in applications of SIS, identified in Tables 6.3 and 6.4
  - Five weeks consulting assistance to compile descriptions of these applications (estimated to cost $30,000 plus travel and accommodation)
  - Involvement of Transit New Zealand staff from both Head Office and regional offices in interviews and reviews during the consulting assignment

- Costs incurred in completing Phase II of the Stage 2 recommendations will be incurred as part of Transit New Zealand's already planned review of the Strategic Information Systems Plan.

STAGE 2 APPENDICES

APPENDIX 1. NSW ROADS AND TRAFFIC AUTHORITY DIVISION RESPONSIBILITIES

Corporate Strategy

- To set the strategic direction for the RTA and to provide the performance improvement guidance to regions
- To develop state-wide road safety, network efficiency, upkeep and pricing strategies and ensure consistency of regional strategies

Finance and Performance Evaluation

- To effectively manage and control RTA's finance functions
- To monitor, evaluate and report on the operational and programme performance of the RTA in all key result areas
- To monitor, evaluate and report on the financial performance of the RTA in all key result areas

Registration and Licensing Strategy and Central Operations

- To ensure the effective co-ordination and implementations of strategies that affect vehicle ownership and use
- To develop policies and strategies which improve information on vehicle ownership and driver status
- To develop standards for customer service and ensure they are adhered to

Corporate Services

- To ensure the effective and efficient provision of corporate services
- To ensure personnel are appropriately trained and developed
- To develop policies, guidelines and standards for quality management

Technical Services

- To manage viable "Services" business on a fee for service basis.

Regional Divisions

- To develop Regional strategies consistent with Corporate objectives
- To develop and manage programmes for the road and traffic system of the region consistent with regional strategies and state-wide road safety, network efficiency and asset management strategies
- Take line responsibilities for all key result areas
- To manage regional registration and licensing functions

APPENDIX 2. NSW ROADS AND TRAFFIC AUTHORITY'S KEY RESULT AREAS

- *Road Safety* - the prevention and mitigation of injury to all drivers, passengers, cyclists and pedestrians, and the protection of vehicles and other property from damage in road crashes.

- *Environment* - the development and management of the roads and traffic system in harmony with the natural attributes and community characteristics of our surroundings that are potentially affected by RTA activities.

- *Customer Service* - the provision of information, consultative process and appropriate business facilities to meet its obligations to, and the needs of, people and organisations having an interest in the roads and traffic system.

- *Economic Development* - the enhancement of the roads and traffic system to support state and national economic development.

- *Transport Efficiency* - the provision of an efficient transport system that minimises total community costs for the movement of people and goods taking into account direct and indirect cost of providing and using each mode of transport.

- *Driver and Vehicle Regulation* - the regulation of access to and use of the roads by drivers and vehicles.

- *Community Service Obligations* - the provision of elements of the RTA's programmes which are provided to selected road users at a price below the normal charge where the cost-benefit ratio is less than the RTA target.

APPENDIX 3. NSW ROADS AND TRAFFIC AUTHORITY 1991/92 FUNDING SOURCES

The RTA receives funding from a variety of sources, of which the principal ones, with 1991/92 revenues, are:

Source of Funds	**A$m**	**A$m**
Commonwealth Funds		
Land Transport Development	134.4	
Interstate Road transport	7.1	
		141.5
State Funds		
Motor Vehicle Tax	420.4	
Allocation from consolidated fund	69.8	
		490.2
Fuel Franchise Levy		
General	99.7	
Additional (3x3)	36.9	
		136.6
Natural Disaster Restoration	5.0	
Local Roads	4.1	
		9.1
		635.9
Other		
Sale of Property	59.7	
Sale of Other Assets	23.7	
Toll Revenue	51.6	
Rental Income	15.0	
Interest Income	3.1	
Specific Works Contributions	6.3	
Other Income	48.8	
		208.2
Total		**985.6**

Source: NSW Road amd Traffic Authority's Annual Report 1991-1992

APPENDIX 4. NSW ROAD AND TRAFFIC AUTHORITY 1991/92 EXPENDITURE

RTA's state road system expenditure for 1991/92 was targeted in the following areas:

Expenditure Area	**A$m**
State Road System Expenditure	
State road maintenance	403.3
Provision for asset restoration	141.8
Local roads disaster restoration	12.1
Local roads	4.0
Vehicle safety	53.0
Registry services	105.3
Toll operations	5.6
Property maintenance and management	7.1
Research and development	14.5
Management and administration	41.3
Total	**788.0**

RTA's financial expenditure for 1991/92 was targeted in the following areas:

Expenditure Area	**A$m**
Financial Expenditure	
Discount on loans	12.8
Loan restructure	(7.7)
Debt servicing charges	167.7
Doubtful debts	0.1
Depreciation	41.1
Total	**214.0**

RTA's remaining expenditure for 1991/92 was in the following areas:

Expenditure Area	**A$m**
Other Expenditure	
Cost of sales - properties	58.3
Cost of sales - other assets	23.6
Land sale expenses	2.8
Revaluation of properties	25.7
Superannuation	(27.9)
Personal injury settlements	1.3
Staff redundancy settlements	73.0
Rebates - tachograph and 3x3 levies	1.9
Stolen vehicle registrations	0.1
Annual leave expense	(3.9)
Long service leave expense	(3.4)
Fringe Benefits Tax	0.1
Total	**151.6**
Total Expenditure	**1,153.6**

( ) Amount to be deducted

Source: NSW Road and Traffic Authority's Annual Report 1991-1992

APPENDIX 5. ROADS CORPORATION OF VICTORIA DIVISION RESPONSIBILITIES

Corporate Development Division

Provide strategic management of the road network through corporate planning, road planning investigations, legal services, strategic transportation planning, and environmental and community services together with development of the organisation and its major projects.

Road Safety Division

Conduct research, and develop and implement programmes to reduce the road toll. It is active in formulating legislative changes, training and licensing, vehicle, traffic and road environment safety.

Quality and Technical Resources Division

Design major roads and bridges and conduct material investigations. It also oversees traffic engineering and develops technical standards and practices. It provides Regional and Project Managers with technical support services. It develops quality services as a culture throughout VIC ROADS and implements quality management systems.

Business Services Division

Provide commercial and other support services within VIC ROADS including - property acquisition and management, plant and stores, road and traffic information, office systems, corporate affairs, public information, libraries, communication services to Government and promotion of external marketing.

Human Resources Division

Develop VIC ROADS human resources through workforce planning, training and development and occupational health and safety, and provide consultancy to line managers throughout Victoria.

Finance Division

Responsible for budget and account management and financial performance, financial strategies and reports, and the analysis of business operations.

Information Technology (IT) Division

Develop and transfer IT skills and systems throughout the organisation. It conducts strategic IT planning and provides integrated computer and communication systems.

Two Operations Divisions
(comprising three metropolitan and five rural regions)

Provide day to day operational management of the principal road network, assist municipalities, development and implementation of detailed works programmes, project management and construction maintenance activities, together with shop-front services for registration and licensing through a decentralised network of offices.

APPENDIX 6. ROADS CORPORATION OF VICTORIA PERFORMANCE INDICATORS

Financial (cash)

Total Recurrent Expenditure
Total Capital Expenditure

Financial (by programme)

Road Safety
Road Network Access Services
Road System Development Services
Road Systems Environment Enhancements
Customer Services
Corporate Services

Employees

Total Employment
Hours Lost Through Sickness
Lost Time Injuries
Hours Lost Through Industrial Disputes

Road Safety

Road fatalities per 10,000 registered vehicles
Pedestrian fatalities per 100,000 population
Motorcyclist fatalities per 10,000 registered vehicles
Serious casualties per 10,000 registered vehicles

Road Network Access Services

Freeway and state highway - surface retreatment
Freeway and state highway - pavement rehabilitation
New structures commenced under VIC ROADS supervision
Additional lane kilometres opened to traffic
Traffic signal sites maintained
Percent of time for on-road presence of enforcement officers

Customer Services

Working days to process vehicle registration
Working days to process driver licence issue

APPENDIX 7. ROADS CORPORATION OF VICTORIA 1992 FUNDING SOURCES

Source of Funds	A$m	A$m
Government Appropriations		
Recurrent appropriations	294.7	
Works and services appropriations	306.5	
	601.2	
Less transfer to contributed capital	-37.9	
		563.3
Operating Fees and Other Funding		
Transport Accident Commission	13.9	
Road Safety Accident Funding	7.6	
Other fees	4.8	
		26.3
Regulatory, Licence & Other Revenue		
Regulatory, licence and other fees	25.5	
External works	32.0	
Rental revenue	9.0	
Municipal contributions	0.3	
Interest	1.0	
Property inquiry fees	1.5	
Other	6.9	
		76.2
Total		**665.8**

Source: VIC ROADS Annual Report 1991-1992

APPENDIX 8. ROADS CORPORATION OF VICTORIA 1992 EXPENDITURE

Expenditure Area	A$m
Road Network Management Programmes	
Road safety	47.5
Access and mobility	254.6
Economic development	190.2
Environment enhancement	2.0
Customer Services	46.4
Corporate Services	3.0
Total	**543.7**
Management and Operating Expenses	
Salaries and associated costs	145.2
Data processing	11.8
Finance charges	0.6
Data processing	21.8
Promotion and publicity	0.3
Audit fees	0.3
Bad debts	0.3
Doubtful debts	(0.4)
Special payment to Ministry of Transport	0.5
Management and operating expenditure	(79.3)
Total	**101.1**

( ) Amount to be deducted

Source: VIC ROADS Annual Report 1991-1992