MANAGEMENT OF STOCK EFFLUENT SPILLAGE FROM TRUCKS IN NEW ZEALAND

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by J.-P. Thull

The key objective of this multi-disciplinary research was to seek for feasible solutions to avoid effluent from livestock trucks spilling onto roads. Stock effluent spillage mainly poses road safety hazards and environmental damage, and also causes offence to road users and tourists. This task required reviewing previous institutional actions, assessing the power of the existing legislation, and evaluating the interests and attitudes of the stakeholder groups involved in the overall livestock supply chain. It was also necessary to consider politics, administration, public policy and economics, gaining the willing cooperation and confidence of the stakeholder groups through application of 'Soft Systems Methodology' (SSM). A key component was the creation of a 13 minute video and its associated brochure as a primary tool for a stakeholder educational awareness programme. It was necessary to analyse the complex relationships between livestock preparation prior to transport; effluent produced in-transit; and end product quality factors. Detailed information pertaining to the nature of livestock shipments by truck in the South Island of New Zealand had to be collected and verified. All the above information were fed into the calculation of an ideal network of in-transit effluent discharge sites on State Highways in the South Island of New Zealand. Assuming the adoption of best practice throughout the supply chain, it was possible to recommend sustainable solutions. The problem is amenable to solution. Adoption of a strong Industry Code of Practice, coupled with the construction of a strategic network of dump sites will enable the industry to avoid the heavy-handed legal consequences of allowing the status quo to continue.

Key words: Livestock effluent production during transport, waste management, meat quality, supply chain management, soft systems methodology, educational programme (video), network modelling

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1 AN INTRODUCTION TO THE PROBLEM

1.1 The Problem and interested parties

The problem is easily stated. Stock effluent is being spilled on New Zealand roads (Figure 1.1) or deliberately dumped on the road side from stock trucks carting livestock. It is a significant problem that the general public and the National Stock Effluent Workgroup have stated as being not acceptable (Russel, 1995; National Stock Effluent Workgroup, 1997).

Figure 1.1 Stock effluent spilled on the road

There is a concern that spillage from stock trucks pose both environmental and safety problems. Road users are concerned about road safety and the problems of spray on their windscreens. Communities have indicated their concern regarding the undesirable environmental effects, particularly in urban areas.

The involvement of the various stakeholders needs to be analysed in its complexity. The stakeholder groups contributing to the stock truck effluent problem are the farmers, the stock and station agents, the livestock carriers, the meat industry, and the road controlling authorities. The involvement of the different stakeholders and their role in the livestock supply management chain is explained in detail in chapter five.

1.2 Effects of Stock Effluent Spillage

1.2.1 Road safety

The New Zealand Land Transport Safety Authority defines '*safety*' as "*the minimisation of the risks from land transport to the personal security, health and wellbeing of people*" (Tilley, 1994). Community wellbeing cannot just be seen in the traditional view of safety, such as the prevention of crashes but needs to deal with the expanded view of controlling adverse impacts of land transport on people. In this sense, stock effluent from trucks is of particular concern to New Zealand's Road Controlling Authorities. It poses a risk to the safety of road users both in terms of contributing to crashes and affecting the quality of life of the community. Effluent is considered as a significant cause of accidents that could be avoided. Unfortunately, effluent has never been cited specifically and thus it is difficult to provide examples. The worst accident involved was a motorcyclist who lost his life near Tokoroa in 1992. Another example reported to Transit New Zealand was a motorcyclist who lost control of his bike at a corner south of Kaikoura in May 1997, skidding on stock effluent (NZ Police, 1997). In addition to the danger of slippery roads, drivers may incur increased stress levels from reduced visibility as windows are splattered by effluent spray (Figure 1.2).

1.2.2 A Nuisance and Annoyance to road travellers and residents

New Zealand's motor car drivers have probably all experienced the blinding effect of stock effluent sprayed across the front windscreen and the difficulty the

wipers had in removing the material. They may even perceive, over a longer period, the penetrating smell through the car ventilation. The odour problem can be offensive in rural towns or cities, particularly where trucks negotiate roundabout junctions, turn around sharp bends or drive on steep hill sections.

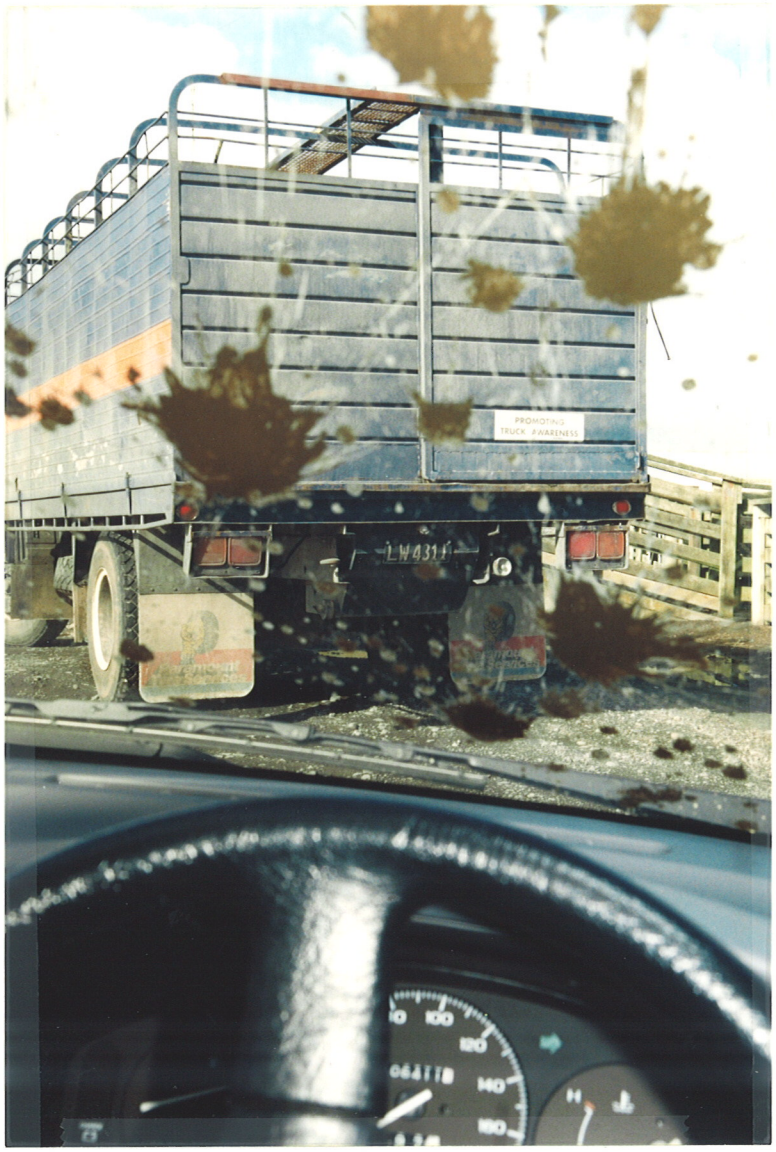


Figure 1.2 Stock effluent spray as perceived by a car following a stock truck (Automobile Association NZ, 1999)

1.2.3 An Image Problem for the Tourism Industry

New Zealand has well-established traditions of catering for domestic and international visitors. Tourism is a major source of overseas income and supports a significant number of jobs in a wide range of areas. The Ministry for the Environment estimated 190,000 jobs can be attributed to domestic and international tourism (Ministry for the Environment, 1997). Especially in rural areas, the local incomes can be improved through tourism services, such as craft shops, food-stalls and accommodation. International tourism has grown rapidly in recent years. However the industry is subject to external influences, such as fluctuating foreign exchange rates or overseas perceptions of environment. The terms of reference for the study "*Management of the Environmental Effects associated with the Tourism Sector*" (Blaschke, 1997), includes "*identify the principal environmental effects associated with the tourism sector*". The word "*effects*" is defined as *"to include any effect regardless of the scale, intensity, duration or frequency, which may be positive or adverse, temporary or permanent, past, present or future, cumulative, or potential*". The tourism industry is a powerful lobby for conservation of the environment (Ministry for the Environment, 1997).

During a presentation in 1997, the Hon Minister of Conservation, Dr Nick Smith, described the key ingredients for a more environmentally friendly 21st century. He said that the Government needed "*to have a vision of a clean, healthy and unique environment*". He added further that "*whether it was tourism, kiwifruit, dairy products or a New Zealand holiday experience, the green reputation had to be more than just image*" (Smith, 1997).

There have been repeated concerns expressed regarding the effects of stock effluent spillage on roads and ongoing debate about the implications of these effects for New Zealanders and the tourism industry (Automobile Association NZ 1992 and 1999). If tourism is to continue to provide wealth to the country, and sustain the environmental, cultural, social and economic values that are the basis of New Zealand's tourism product, the effects associated with effluent

spillage must be identified, understood and addressed. There is a need to find efficient mechanisms and systems to deal with the problem to ensure, especially overseas, the on-going value of New Zealand's sustainable 'clean green image'.

1.2.4 Environmental issue

Stock effluent discharged deliberately can generate water pollution from the contaminated run-off if the load is dumped too close to a stream or to a storm water system. This potential danger of transport effects is a concern for the responsible bodies such as Regional Councils who are responsible under the Resource Management Act (RMA) for discharges to the environment (Chapter 4) (Ministry for the Environment, 1999).

1.2.5 Health hazard

Fresh manure from livestock is a potential source of a number of disease vectors affecting livestock and humans. The cartoon in figure 1.3 gives an overview. While the degree of transmission would be difficult to assess, it is still possible for all of them to be a health risk.

However, this list of potential diseases does not imply automatically that fresh manure is inevitably infectious. These diseases are usually transmitted through specific entry pathways, such as the exposure of an open wound to infected urine for leptospirosis transmission to humans. In the last ten years, a number of stock truck drivers in New Zealand claimed to have caught leptospirosis over, due to the handling of livestock (unsubstantiated personal communication by drivers). A higher potential risk arises from effluent being discharged at highways rest areas, where children are likely to be at play during breaks in long distance journeys.

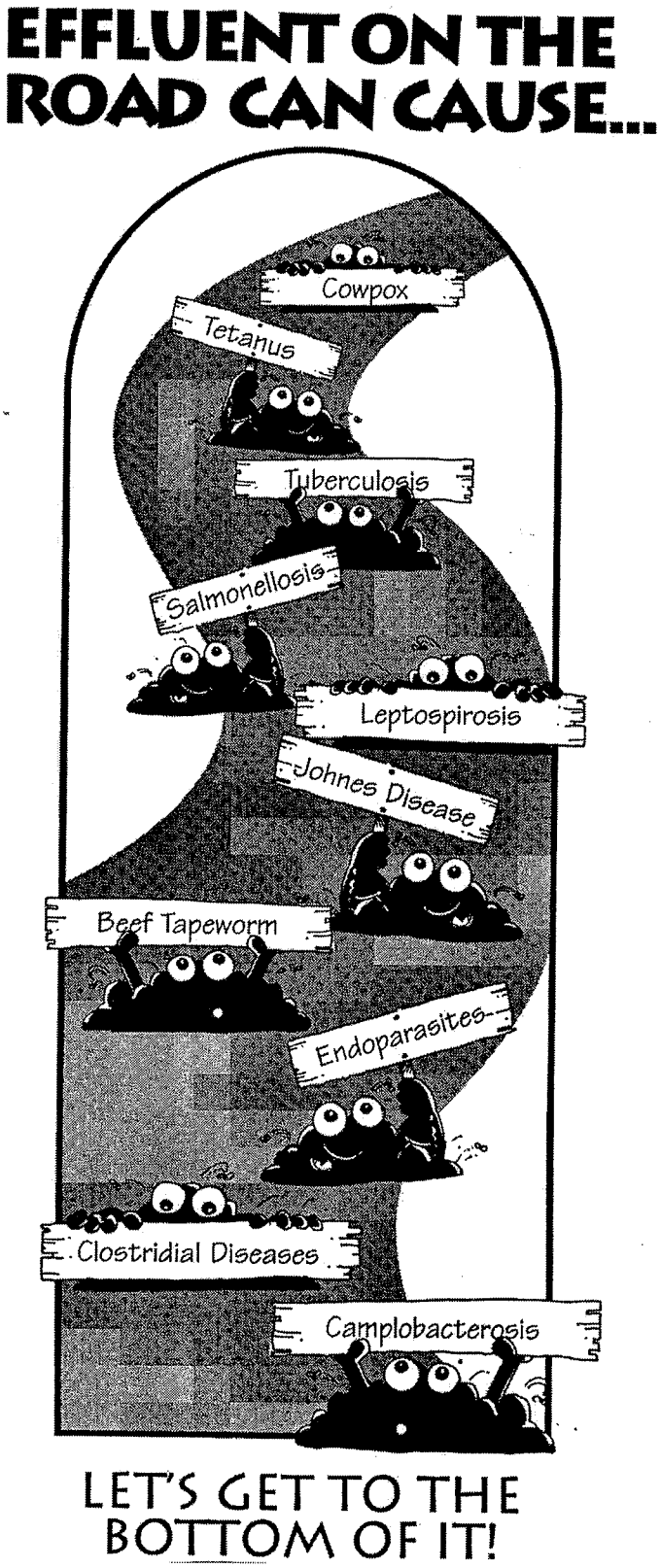


Figure 1.3 Overview of potential diseases that can be caught through contact with stock effluent (Environment Waikato, 1994)

1.2.6 Maintenance problem for roads

An article published in the New Zealand Automobile Association magazine 'Directions' mentions stock effluent spillage that "*it's not just a matter of road safety and hygiene*". Messy roads are likely to increase the maintenance cost of roads. Studies by local authorities showed that maintenance costs on roads subject to effluent problems could be five times greater than on other road surfaces (Automobile Association NZ, 1992). Unfortunately, the complete text of these studies could not be made available to the author. It is probable that the studies mentioned included both the spillage of effluent caused by stock trucks and the mess caused by cattle crossing or walking on roads shifting between paddocks. These two situations cannot be combined when considering road maintenance, as the specific quantity of effluent dropped on a certain surface is far smaller for effluent spilled by moving trucks than by walking cattle. A biological degradation of the road surface may occur in association with appropriate conditions, as micro-organisms use the carbon particles from the tar seal and the nitrates and the phosphates from the stock effluent as nutrients. However, a biodegradable process only occurs in the presence of sufficient water or humidity. In the case of effluent spilled from trucks, the water amount is insufficient and the wind may dry it quickly. Therefore these spills may not cause the biological process of degradability. A deterioration of the road surface due to chemicals contained in the effluent such as acidity, is not likely for small quantities. Thus a wear and tear of the road surface due to effluent spilled from trucks seems to be limited due to the fact that the quantities deposited are small. It is different, however for cattle crossing roads and leaving behind considerable samples of faeces on the tar seal.

1.3 Size of the problem

As described in later chapters, the magnitude of the problem is intensified in areas populated by a high density of cattle. Although sheep produce far less faeces and urine than cattle, they still contribute to messy roads, especially if

the livestock vehicles are fitted with small tanks or tanks that are not used. The main problem areas in the North Island are the Waikato, Taranaki, followed by the Bay of Plenty, Northland, Manawatu-Wanganui, Hawke's Bay and the Wellington region. The South Island has problem areas along the East Coast, the main city areas, the Buller and Grey regions, and the Lewis and Lindis Passes, to mention the more relevant ones (cf. New Zealand road map in Appendix 1). There has been an increase in cattle production over the last ten years, especially in the South Island which is adding to the volumes of effluent on the move.

Although it can be found all year long, stock effluent spillage is mostly a seasonal problem, accentuated in the period from November to July with a peak in May to July when farm to farm relocations are prevalent.

Specific conditions prior to transport such as the pasture type, the type of feed, the fasting time as well as the climatic conditions (i.e. areas of high rainfall) contribute to the volume of effluent captured in the truck and trailer units during a journey.

1.4 Transport of livestock in New Zealand

Historically, livestock transport by rail preceded road transport. The expansion of the dairy industry spurred road construction to enable the transport of milk to dairy factories (Lomas, 1986). It was around the 1950's that livestock started to be transported by road. In those days, the road transport regulations were tough as trucks were only allowed to compete with rail over short distances. Each region had local abattoirs, and the farmers usually carted their animals with their own farm trucks (single deck without trailer) to destinations. With the closure of local abattoirs and the rationalisation of meat processing plants, travel distances increased. A 1975/76 study stated that 40% of South Island sheep transported were not sent to the 'nearest' meat processing plant (Young et al., 1979). Transport by rail and road competed against one another for long distance along the East Coast of the South Island. However, over the years,

livestock transport by road has dominated. The transport time from farm to destination by road compared to rail is shorter. The whole transport process is more flexible and less difficult to plan as less people are involved. As shunting in rail yards is stressful for livestock, the shipment by road contributes to a reduction of animal stress (Chapter 5) due to fewer loading and unloading processes, less in-transit time and less waiting time during the rail journey resulting from marshalling trains.

It is not unusual to shift livestock from the North Island to the South Island and vice-versa. This situation may happen because of farm to farm shifting or price competition between the different meat processing companies. The main transport route in the South Island is the State Highway 1, located along the East Coast. The South Island based meat processing plants are mostly located along the State Highway 1, from Blenheim to Invercargill.

The most common currently operated livestock cartage units in New Zealand are a combination of a truck and trailer able to load approximately 35 to 40 adult cattle or 450 to 500 sheep. The industry has progressed from small single deck typed crates to double decks for cattle transport and for sheep to three and four decks. In the busy part of the slaughter season, approximately 550-600 livestock cartage units circulate within the South Island of New Zealand six days a week. The modern livestock cartage units are purpose designed for animal transport and are usually fitted with effluent holding tanks. However, some stock crates are built for multi-purpose use and usually are not fitted with effluent holding tanks. The Code of Practice for stock crates requires approximately a volume of 400 litres to contain the effluent produced by the livestock in-transit. The survey conducted by Lincoln University in 1997-98 showed that less than 50 percent of the truck and trailer units were equipped with tanks in the South Island. The tank size fitted on livestock cartage units ranged from 50 to 200 litres. Because truck drivers do not have many possibilities to discharge their effluent tanks in-transit or at destination, the

tanks quickly overflow. The policy of some transport companies is to leave the taps open.

Rural transport including livestock cartage is an important but competitive industry in New Zealand, providing sustainable jobs and support for many services in the rural town areas. The involvement of the livestock carriers in this problem is explained in chapter five.

1.5 Livestock farming in New Zealand

In 1882, the ship 'DUNEDIN' transported for the first time 5,000 frozen sheep carcasses to England (Lomas, 1996). This milestone represented the introduction of New Zealand as an agricultural trading nation to the world. Since then, New Zealand has built up an export-oriented farming industry that enjoys an international reputation for quality and efficiency. Agriculture contributes to 17 percent of New Zealand's employment, including farm-related transport, processing and support industries. The livestock industry represents 74 percent of the agricultural production (Ministry of Agriculture, 1996 in Ministry for the Environment, 1997).

New Zealand, with a population of only 3,7 million has a yearly production of approximately 50 million sheep and just under 10 million cattle (Statistics New Zealand, 1997). The temperate climate of New Zealand, with few extremes of heat or cold and sufficient rainfall is an advantage and allows livestock to be left outside all year round and thus produce livestock at a lower price than other competitive countries.

Sheep farming can be divided from an economical point of view, into two categories: the high country sheep mainly used for their wool and the lower hill country sheep mainly for breeding and contributing to the supply of fattened lambs. Cattle farming are divided into dairy and beef. Dairy farming has risen in importance over the last few decades as more than a third of all international trade in dairy products originates from New Zealand (Lomas, 1997). Beef

farming has grown considerably in recent years since the opening of export markets, such as the United States of America. The production costs for fattening livestock are low, as they only require high quality grassland and do not need to be housed indoors in winter.

High meat quality standards have always been a priority for New Zealand's lucrative meat industry. Nearly 25 years ago, the export meat processors required the farmers to have their livestock (sheep and cattle) arriving at the plant not less than 24 hours prior to slaughter (Young et al., 1979). From 1 November 1977, these regulations were eased to allow stock to arrive before noon to be slaughtered the following day. This preparation period was designed to allow stock to empty out and rest prior to slaughter. Animal stress is a relevant factor associated with the ultimate meat quality (Chapter 5). A number of problems were raised for transport operators in meeting these requirements, including the high cost of Sunday working that might disrupt the personal life of stock truck drivers and added to weekend traffic congestion. Hence the question of using on-farm facilities for standing livestock arose. While the use of holding yards would not meet the resting requirements prior to slaughter, they would meet the emptying requirements. The facilities were required to be covered and allow access to water (Young et al., 1979). The meat companies then allowed the farmers to 'stand" or hold stock for part of the requisite period under cover on grates at their farm (Young et al., 1979). Once transported to the processing plant, the stock would only require a specified resting period prior to slaughter. The farmers have always been reluctant to stand the stock off grass prior to transport, as they want the animals to look big and healthy at destination. The study conducted by Young et al. revealed that only 23 percent of the 1664 farmers surveyed in the South Island were willing to stand cattle. However, 76 percent of these farmers were prepared to stand sheep (ewes). Farmers were also asked to indicate the number of ewes and cattle they could safely stand overnight under cover on a grated floor. These percentages were quite low: 18 percent for sheep and only 3 percent for cattle. This situation of holding yards to keep livestock off feed has improved over the

years, due to the increase of dairy farmers needing a waiting area for cows next to the milking shed.

Already in the mid-seventies, the meat companies realised the benefits of encouragement to prepare livestock prior to transport by 'standing' them off grass or feed to allow them to empty out. 'Standing' animals off feed in specifically designed holding yards for a few hours contributes to reduced stress and fear through the socialisation process and it also minimises the production of effluent produced in-transit (Chapter 5). The result of this stock 'standing' practice leads to less spillage from stock trucks on the road, less need for washing trucks between loads, stock that is easier to handle, less bruising and cleaner animals at destination. The specific details are elaborated in chapter 5.

1.6 Overseas approaches

Stock effluent spillage from trucks is mainly a New Zealand problem, although it is also encountered in different parts of Australia and South America (personal information). Although the European communities have only directives, the regulation of some European countries are rather tough when it comes to effluent spillage (Chapter 4). It probably happens in rural areas as the researcher saw a few brown lines on hilly roads in Ireland in 1997. This is similar to the United States, as farmers or transport operators can be fined if anything is spread on the State Highway (Cadwallader, 1999).

Communication via the Internet using search machines or through personal approaches to Agricultural Universities or farmers listed in newsgroups has facilitated assembling a broader picture of the situation world-wide. Some countries (i.e. Australia or countries in South America) currently do not see effluent spillage as a big problem, but may be influenced by the outcome and approach taken in this case study.

2 THE RESEARCH

2.1 Background

Stock truck effluent spillage came to the attention of the researcher as he was push-biking on a three months holiday trip through New Zealand in 1995. The fun of fast downhill cycling was negated and endangered by the disgusting slippery bends that had to be negotiated carefully. Often in the mornings, the sweet smell of manure in the tent, originating from of the bicycle panniers, reminded the researcher that he had encountered messy roads the day before.

In 1996, the Canterbury Regional Council (CRC) acknowledged that many regional authorities increasingly were concerned about this environmental issue. At that time, two pilot dump sites in the South Waikato area had commenced operation (Chapter 3). Collection of effluent was the policy option chosen as there appeared to be little prospect for reducing the volume of effluent being generated. A reduction of stock effluent spillage was not considered to be realistic as the trend for restructuring including closure of further meat processing plants was leading to increased long haul livestock transport to the remaining plants. The desired outputs of the Canterbury Regional Land Transport Strategy (RLTS) for 1997/98 identified effluent spillage from stock trucks as an issue to be resolved in the region (Canterbury Regional Council, 1996). The implementation of the RLTS included a call to look at the "*adoption of improved management practices across the industry to reduce effluent spillage from stock trucks*" (Canterbury Regional Council, 1997). The CRC recognised the importance of New Zealand's 'clean green image' for tourists and was looking for ways to eliminate messy roads in its region. Canterbury is a significant arrival and departure point for tourists visiting New Zealand. The CRC also needed to respond to the many individual complaints regarding effluent spillage it was receiving.

The CRC readily supported the idea put forward by the Division of Environmental Management and Design at Lincoln University to provide

independent research into this multi-stakeholder problem. They proposed that a PhD student (the researcher) would conduct a comprehensive analysis of the stock effluent problem leading to the recommendation of practical and effective guidelines for elimination of effluent spilling from stock trucks.

2.2 Practical aspects

The research was conducted at Lincoln University, over the period October 1996 – September 1999. It examined factors affecting the management of livestock giving rise to effluent escaping from trucks onto New Zealand roads. The research consisted of three Action stages as follows:

Stage 1: Scoping the problem; identifying the stakeholders and their interests; collection of relevant data.

Stage 2: Creating an educational programme including a professional produced video and its associated brochure; implementing a pilot educational programme for all stakeholder groups.

Stage 3: Modelling livestock transport patterns to ascertain what would be an efficient and effective network of stock effluent discharge facilities for the State Highway system in the South Island of New Zealand, taking into account any behavioural changes that might be achieved through the educational programme.

2.3 Objectives

The objectives established for the project included:

- To describe why the problem existed.
- To identify the stakeholders and their needs within a complex system of interdependencies.
- To provide an overview of the current institutional and statutory situation.

- To propose acceptable best practice solutions to reduce effluent spillage, that will engender benefits for all stakeholders and foster the adoption of these solutions within the agribusiness industry.
- To outline an appropriate management system for this multi-stakeholder and politically sensitive problem.
- To create an educational programme (i.e. video) promoting best practice throughout the whole livestock supply chain, and to evaluate this as a pilot programme.
- To gain the confidence of the leadership of each stakeholder group in the livestock supply chain for them to 'own' the problem and promote self-regulating and self-policing solutions via an Industry Code of Practice.
- To find or create a suitable computer simulation model that would help identify an effective and efficient network of effluent dump sites under various conditions in the South Island of New Zealand.
- To recommend that network of effluent discharge sites as a potential, cost effective and politically attainable reality.
- To achieve not just an elegant academic exercise, but a feasible and practical solution that could benefit all New Zealanders.

2.4 Academic worth

The challenge of this doctoral research was to 'demonstrate' how to approach and help to solve an 'obvious' problem related to the farming community that was politically and socio-economically sensitive, and involving different stakeholder groups all represented by strong national lobby organisations. The aim was, diplomatically, to find a practical and cost-effective solution with a win win outcome for everybody involved.

The strategy was to demonstrate that not one but a package of management tools are required to deal with the problem. An on-going educational programme is required to encourage behavioural change within and between the stakeholder groups leading to the adoption of best practice. From a policy perspective it proved vital to have all stakeholder groups acknowledge that it is

an Industry-wide problem that needs to be collectively owned. The development of an Industry Code of Practice was the outcome.

The finding of ideal locations for dump sites was primarily a technical problem that needed to be solved by the use of adequate technical tools. The requested parameters that needed to be handled by the computer software were (1) the use of the South Island road network, (2) the calculation of location-allocation flow pattern assignments by using always the shortest distance, (3) the use of data input in spreadsheet format, (4) the output in map form, (5) the easy handling for further assignments, (6) the potential application of the model for the North Island, and (7) the possibility of manually interacting regarding the location of dump sites.

The use of Geographical Information Systems (G.I.S.) associated software seemed to be the best tool to allow the simulation of location-allocation scenarios. It was a matter of choosing the best compatible software to simulate the livestock movements. 'Arc View' was used in the first instance to demonstrate a technique of finding the positions that a truck and trailer unit could reach under certain conditions before its effluent tanks would overflow. This worked well for sample assignments, but no way could be found to automate the system for large scale simulations. 'Arc/Info with its road network module, able to calculate routes, proved to be a more appropriate software for this task. The required macro-programming was specified and given to a G.I.S. macro-programmer specialist to write. The model was created in a way that permits an interactive human-machine decision-making approach. This interactive human-machine approach allowed, for example, acknowledgement of political realities in the computer simulations. To create a workable, affordable system wherein all stakeholder groups would benefit, presented the researcher with a great challenge requiring a multi-disciplinary holistic approach.

3 RETROSPECT

3.1 Introduction

This chapter summarises the scale and extent of the problem to which various parties and governmental institutions have been involved nationwide between 1987 and 1998 (Thull, 1998b). The purpose of this chapter is to show that some working groups have been dealing with the issue of stock effluent spillage for some time. It also gives an overview of what the National Stock Effluent Workgroup (NSEW) has been doing since its creation in 1997. Some locations (i.e. saleyards or wastewater treatment plants) mentioned in this chapter do not appear in the New Zealand map included in Appendix 1. These locations are not relevant for the thesis in itself. They are only included for purposes of completion.

3.2 Institutional actions from 1987 – 1998

3.2.1 Period of 1987 to 1993

In **1987**, a **first National Working Group** was created to look for solutions. The participants included members of Local Government Association, New Zealand Road Transport Association (NZ RTA), Federated Farmers (FF), New Zealand Meat Industry Association (NZ MIA), Abattoirs Association, New Zealand Stock and Station Agents Association and the Ministry of Transport (MoT). The outcome was published under the title "*Guidelines for reducing stock effluent spillage from transport vehicles*" (NZ Local Government Association Inc., 1991). The basic recommendations were to encourage best practice, including the farmers to 'stand' their stock prior to transport and to improve communication among all stakeholders. The aim at that stage was to avoid enforcement of available legislation or to prescribe the mandatory fitting of effluent tanks for trucks.

In **1991, the Regional Councils** (RC) of **Taranaki** and **Waikato** held meetings to discuss the issue of threats to road safety, to public health and to the environment. At the same time, the Whangarei District Council looked at the possibility of enforcing compulsory holding tanks, and providing disposal points.

In **1992**, a motorcyclist lost his life in the Waikato as a result of losing control of his motorcycle when he skidded on effluent spilled from a stock truck. Shortly after this fatal accident, His Worship the Mayor of the South Waikato District Council petitioned the Minister of Transport and further senior officials from various organisations to take action. A few months later, the first two regional stock effluent working parties were founded by the Taranaki Regional Council and Environment Waikato, involving the South Waikato District Council.

In **1993**, the **South Waikato District Council** presented a report recommending two effluent discharge sites north of Tokoroa (Putaruru saleyards and Tapapa, South East of Tirau on State Highway 5). Environment Waikato released the first Regional Land Transport Strategy that contained policy relating to stock truck effluent spillage. A few months later, Works Consultancy Services (now Opus) were commissioned by the Taranaki RC to investigate potential locations for dump sites. The Otago Regional Council was the first Regional Council in the South Island to identify stock effluent spillage as an environmental and road safety issue in that council's first Regional Land Transport Strategy plan.

3.2.2 Year 1994

In **February 1994, the Hawke's Bay Regional Council** undertook a survey of local authorities and transport operators to ascertain the magnitude of the problem in its area. The results of this survey showed that stock effluent spillage was not seen as an environmental problem and did not cause significant roadside pollution (Hawke's Bay Regional Council, 1994).

The **Taranaki Regional Council** received a report *called "Stock Truck Effluent - Discharge System"* from Works Consultancy in February 1994 (Taranaki Regional Council, 1994).

In **March 1994**, a Regional Forum on 'Stock Truck Effluent Spillage' was held in the **Waikato region**. The outcomes of this Forum were to go ahead with education, to seek for a network of dump sites in the region and to amend the Transport Act by including 'animal waste' as part of the load. This Forum was followed by several meetings of the Waikato Stock Effluent Workgroup. By the end of 1994, an Auckland based consultancy had completed the details of the resource consent application for two pilot dump sites in the South Waikato District (South Waikato District Council, 1994).

In **June 1994**, a **second National Stock Effluent Working Party** met to discuss the issue, as the problem had not improved since 1987. The group was made up by the following participants: Local Government Association, South Waikato District Council, Environment Waikato, Transit New Zealand, Land Transport Safety Authority, NZ Road Transport Association, NZ Automobile Association, NZ Police, Ministry of Tourism, NZ Tourism Board, Federated Farmers, Ministry of Agriculture, Public Health Commission, NZ Stock & Station Agents Association, New Zealand Meat Industry Association/Abattoirs Association and Local Government Association. This National Stock Effluent Workgroup did not meet again. The outcome can be summarised as follows:

- To investigate an education programme (i.e. print media, field days)
- To check out existing disposal sites (meat processing plants, sale yards).
- To assess RMA planning provisions regarding effluent disposal sites at various destinations.
- To research effects and ideal periods of standing stock to help to convince farmers to 'stand' their stock.
- To liaise with other regional councils for further action.

This group did not agree on many new actions. They only confirmed the suggestions of the Waikato and Taranaki working groups. The most relevant decisions were:

- To coordinate an educational programme at national level for farmers and other key agencies to promote 'standing' stock prior to transport.
- To develop a national code of practice for key national agencies.
- To identify the adequacy of the current legislation, and where necessary, to make amendment recommendations to the Government.

In **June 1994, Environment Bay of Plenty** reported to their Environmental Monitoring Committee that the illegal discharge or spillage of stock effluent from trucks was seen as a growing concern in the region. In **July 1994**, they created a regional working party that was requested by their Regional Council (November 1994) to develop and run an educational awareness campaign on the issue of 'standing' stock prior to transport, and to investigate the need for further research and the costs involved. This initiative failed and similar questions were asked in July 1997.

3.2.3 Year 1995

In **1995, Environment Bay of Plenty** added a section to their Regional Land Transport Strategy plan regarding the development and implementation of an educational awareness programme that promotes preparation of livestock prior to transport.

In September 1995, **Environment Waikato** started to collect stock truck effluent in the South Waikato District Council in Putaruru sale yards (only collection) and on State Highway 5 near Tapapa (collection and treatment through 2-ponds system). These facilities were constructed as a pilot site for New Zealand.

At **Putaruru** sale yard, the effluent runs from the receptor into an in-ground 23m^3 concrete reservoir. The level of effluent in the reservoir is monitored by remote telemetry at the Council's base station. The effluent is removed by a contractor and taken by tanker to the Tapapa treatment site.

At **Tapapa,** both, the effluent from the tanker and the effluent discharged directly from the trucks runs into a conventional two-pond anaerobic/aerobic oxidation pond system. The treated effluent is finally discharged into soakage trenches.

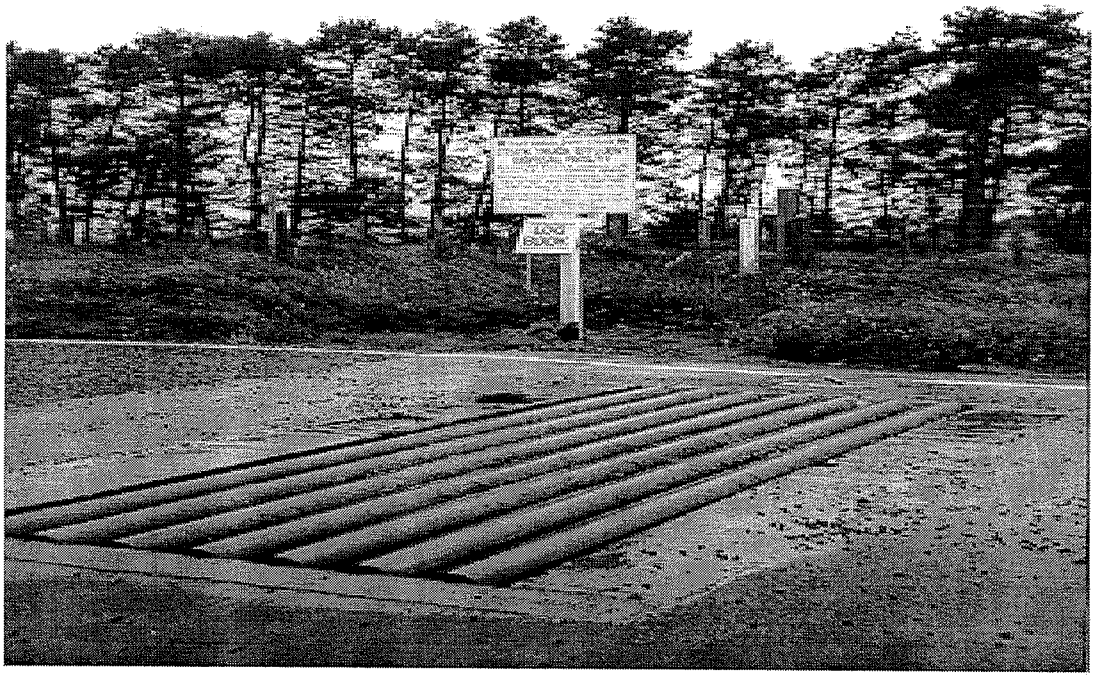


Figure 3.1 Pilot stock effluent pilot site in Tapapa

Fisher (1997) presented in his report an overview on capital and running costs. The costs below exclude land purchase costs, resource consent, engineering & consultancy costs and Goods & Services Taxes (GST).

Tapapa site (including treatment)

Highway widening and lay-by		$ 52,000
Receptor		$ 13,000
Ponds, soakage drains & fencing		$ 48,000
	Total capital costs	**$113,000**

Putaruru site

Access road		$ 14,000
Truck manoeuvring area		$ 10,000
Receptor and tank		$ 30,000
Telemetry		$ 8,000
	Total capital costs	**$ 62,000**

Operating costs (report 1996 & 1997)

The costs include effluent cartage from Putaruru to Tapapa ($8.75 per m^3 for 17 km), effluent testing ($140 per sample), checking & cleaning ($400 per month), maintenance of telemetry, fences, grounds, and water supply. The running costs were $16,750 for 1996/97 (Fisher, 1997).

A site management plan was completed by an Auckland consultancy firm (South Waikato District Council, 1995).

The **Taranaki Regional Council** received in 1995 estimated costs of $150,000 regarding two discharge sites for the Taranaki region.

The **Wellington Regional Council** assessed, unfortunately without success, in 1995 the possibility of providing a dump site at Wellington port.

3.2.4 Year 1996

The **Northland Regional Council** reviewed their Regional Land Transport Strategy plan and included a section to undertake a study regarding the need for dump sites in Northland.

The **Wellington Regional Council** inquired by letter about on-going matters regarding stock truck effluent at regional and local authorities. The outcome was poor.

The **Taranaki Regional Council** was confident in 1996 it would have two dump sites operating by 1997 and outlined their strategy on continuing education of farmers and on upgrading discharge facilities at destination.

In late 1996 the first South Island Workgroup was convened by the **Canterbury Regional Council.** This Canterbury Stock Effluent Workgroup (CSEW) was represented by the following members: Canterbury Regional Council, NZ Road Transport Association, Federated Farmers, Commercial Vehicle Investigation Unit, and the Division of Environmental Management (the Transport group and the Natural Resources Engineering group) of Lincoln University. The work group was joined later by representatives of MAF Qual, Transit New Zealand, Land Transport Safety Authority (LTSA), Ashburton District Council, New Zealand Game Industry Board, Meat Industry Association NZ, NZ Stock & Station Agents Association, Transfund NZ, and the Christchurch City Council. This was the first working party that included a close liaison with an independent research institute. The group agreed to the concept of organising a workshop to bring all parties together, listen to people's constraints and try to find a way of obtaining action.

3.2.5 Year 1997

The **Northland Regional Council** commissioned a study to analyse the situation in Northland (Kloostermann, 1997).

Environment Bay of Plenty acknowledged that unless the farmers perceived benefits of 'standing' the stock, based on sound and credible data, any educational programme was bound to fail. They clearly stated the need for further research.

The **Taranaki Regional Council** received in early 1997 a report from Opus consultancy regarding the best methods of disposing of stock truck effluent. The recommended treatments were a 'Sequencing Batch Reactor' or an anaerobic digester in combination with an aerobic trickling filter. A couple of months later, the Taranaki workgroup met to discuss the Opus Consultancy (1997) report regarding the design and costs for a proposed site in Motunui. The costs had risen from around $75,000 to $240,000 for one single site. Due to the cost explosion, the Taranaki Regional Council decided to look for cheaper options and a more efficient educational programme (Taranaki Regional Council, 1997a & b).

The **Wellington Regional Council** presented in March 1997 a report called "*Scoping Study of Stock Truck Effluent Discharges in the Wellington Region*" (Wellington Regional Council, 1997). A Wellington Stock Truck Effluent Workgroup met for the first time in May 1997. They discussed possible ways to prosecute, but agreed that enforcement would not be successful unless a network of dump sites was in place. They assessed different sites in the Wellington area such as Plimmerton Weigh Bridge, Old Hutt Road, Lindale Weigh Station, and Glasgow and/or Ferry areas. The Wellington Work Group wound up in July 1997, as the new National Stock Effluent Workgroup was created.

The **Marlborough District and Unitary Council** had considerable problems and many complaints due to effluent spillage, in particular with trucks discharging full tanks onto roadsides before or after the 'Cook Strait' crossing. The Marlborough DC addressed the problem in its Regional Land Transport Strategy plan (1997-2002) under environmental effects. The relevant policies

include to investigate controls to prevent roadside dumping and to provide discharge facilities for stock trucks at the Riverlands saleyards (State Highway 1) in Blenheim and at the Port of Picton (Marlborough District Council, 1997).

The Canterbury Stock Effluent Workgroup (CSEW) in association with the **Canterbury Regional Council** held a workshop in Ashburton on 14 April 1997. Lincoln University presented three papers in the morning (Heffernan; Kissling; Thull, 1997) in order to have a discussion background for the afternoon workshop sessions. The outcome of this workshop was similar to previous decisions (i.e. improving communication, coordination, logistics, responsibility, animal welfare and meat quality). However, all parties seemed strongly committed to obtain workable solutions and wanted Lincoln University as an independent research institute to go ahead with the preparation of an educational programme and seeking for a network of in-transit dump sites. The CSEW continued to meet on a regular base to participate in the preparation of a pilot educational campaign.

In December 1997, the **Otago Regional Council,** encouraged by its Regional Land Transport Committee and the terms of reference of the newly established National Stock Effluent Workgroup (NSEW), considered in the 1998/99 Annual Plan the provision of eight stock truck effluent disposal sites throughout Otago by 2001.

The need to deal with the problem of stock effluent spillage on a national level was decided at a meeting of the Road Controlling Authorities in June 1997. Thus a new **National Stock Effluent Workgroup (NSEW)** was convened by Transit New Zealand. The first actions regarding the terms of reference were discussed by telephone conference calls. The group met the first time physically in November 1997 and on a regular base from there on. The active participants were members of: Transit New Zealand (Robin Odams as the Convenor); Local Government New Zealand (LGNZ), South Waikato District Council; Wellington Regional Council; New Zealand Road Transport Forum;

Federated Farmers; New Zealand Meat Industry Association; New Zealand Stock and Station Agents Association; Lincoln University (LU). At the meeting in November 1997 the following actions were agreed:

- Local Government NZ was in charge of sending a letter to each regional council to request information on their current position.
- The key issues were that "*it is unacceptable to have large amounts of stock effluent on the road*" and that "*the status quo is unacceptable*".
- Development of a proposed network of sites for affected areas: it was considered that a **basic approach** (incorporating all existing facilities at saleyards, meat processing plants etc.) on a regional scale was requested. On the other hand it was important to develop a **methodology** to seek for an ideal minimum network of in-transit dump sites. Lincoln University was designated to complete this task and needed sufficient funding for this research.
- Transit New Zealand was in charge of supervising a subgroup assessing the legislation. The NZ Police should be part of the subgroup.
- Lincoln University should develop a pilot educational programme and test it in 1998 within Central Canterbury. The production of a high quality video was seen as an excellent educational promotion tool. The video script and the overall picture needed to be produced in close liaison with the NSEW. All stakeholders agreed that the consumer was the leading factor and that sustainability in the Meat Industry (domestic and overseas markets) could only be achieved through the highest quality standards. Therefore all players in the chain should be encouraged to change current behaviour and be prepared to adopt best practice in the future. This message needed to reach all stakeholder groups involved in the livestock supply chain.

In summary, those agreed actions were associated with the responsibilities of the different groups:

Task 1: Find out the extent of the problem: (Transit NZ; Lincoln University; South Waikato DC)

Task 2: Evaluate a network of sites: (Regional Councils; Lincoln University; Wellington RC)

Task 3: Practicalities: i.e. checklist for sites, model resource consent and site management plan (South Waikato District Council; Lincoln University)

Task 4: Funding issues (Transit NZ; NZ Road Transport Forum; Federated Farmers; Lincoln University)

Task 5a: Pilot Communication Strategy (Lincoln University)

Task 5b: National Communication Strategy (Transit New Zealand)

Task 6: Legislation (Transit New Zealand)

Task 7: Development of Industry Code of Practice/Guidelines (All members Of the NSEW)

3.2.6 Year 1998

The **Northland Regional Council** received the second report from VK Consultancy (Kloostermann, 1998) regarding seven recommended sites in Northland. These were AFFCO (Auckland Farmers Freezing Company) Moerewa, AFFCO Whangarei, Lowe Walker Dargaville, either Whangarei or Hikurangi wastewater treatment plant, Kawakawa wastewater treatment plant, either Kaiwaka or Maungaturoto wastewater treatment plant and Kauri/Kaikaohe saleyards. Some of these locations are situated 1-2 km from the main State Highways and are not suitable, as the dump sites need to be right on the State Highway. The time pressure put on the truck drivers do not allow them to make detours. They will only use the sites if they are located on the State Highway or just adjacent (i.e. saleyard).

The **Auckland Regional Council** (1998) asked the NZ Road Transport Forum to conduct a survey of their members to designate suitable locations for

potential dump sites. Wellsford and Tuakau saleyards, Albany Hill in the North and Bombay Hill in the South were found to be best locations.

Environment Waikato produced a map of possible new dump sites in their region. The saleyards in Frankton and Morrinsville were seen as the highest priority sites to build. Environment Waikato joined the National Stock Effluent Workgroup in 1998 to liaise more efficiently with the Waikato Workgroup.

Environment Bay of Plenty published a report regarding potential sites in their region. Unfortunately a high number of trucks passing one specific location does not automatically mean an ideal location for a dump site. Most of the consultancy reports suggesting potential dump site locations are based on number of passing trucks. This is not a valid indication for choosing a site as explained in chapter 10.

The **Taranaki Regional Council** decided in February 1998 to delay the two in-transit facilities as the costs appeared to outweigh the benefits and to wait for the outcome and recommendations of the National Stock Effluent Workgroup.

The **Hawke's Bay Regional Council** identified for the first time stock truck effluent to be a safety hazard in their region (February 1998).

The **West Coast Regional Council** identified the Buller and the Grey region, as well as the Reefton and Lewis Pass area as major spillage or illegal discharge locations.

The **Canterbury Regional Council** convened several meetings of the Canterbury Stock Effluent Workgroup (CSEW) in order to allow a full integration of all stakeholder groups into the video script editing process. The aim of the video was to enhance a win win situation by showing best practice all along the supply chain. The CSEW assisted to establish contacts between Industry stakeholders and Lincoln University as the video production and the editing

process were scheduled, organised and supervised by Lincoln University. After the successful completion of the educational video (May 1998), an accompanying two colour pamphlet was created. The video as well as the brochure were peer reviewed by the Canterbury and National Stock Effluent Workgroup. After finalisation of the educational tools, Lincoln University ran a pilot educational programme in Canterbury over six months to assess the efficiency of the educational material and to figure out what needed to be improved to become successful nationwide. The CSEW and the NSEW helped to arrange specific meetings and for the researcher to be accepted as a guest speaker at stakeholders' annual meetings or workshops. The pilot communication strategy was tested in 13 different presentations, including each stakeholder groups (Chapters 7 and 8).

The **Otago Regional Council** proposed in their draft Annual Plan to overcome the lack of dump sites in the region by allocating $250,000 to install eight discharge facilities in the region by June 2000. This sum had been allocated for year 1999/2000. They intended to consult with meat processing plants and saleyards in their region regarding the potential for improvements of disposal and cleaning facilities. The eight potential sites were identified as being Dunedin, Oamaru, Palmerston, Milton, Alexandra, Balclutha, Clinton and Ranfurly. However, they decided to wait for the outcome of the Lincoln University modelling exercise.

The **National Stock Effluent Workgroup** (NSEW) met regularly in 1998 to assess the progress gained by the various stakeholder groups. Lincoln University liaised closely with the NSEW, as the video script and the contents of the brochure were hotly discussed topics over the period from October 1997 until June 1998. Lincoln presented a draft report in March 1998, called "*Stock Effluent Spillage from Trucks in New Zealand – A Survey of Institutional Actions 1987-1998*" (Thull, 1998b) and handed in the final version in June 1998.

The pilot video was completed by May 1998 and satisfied all stakeholder groups as it had succeeded in conveying a positive attitude wherever possible and encouragement of best practice through the whole supply chain. The brochure was completed by June 1998 (Thull et al., 1998a).

Over the second half of 1998, the NSEW monitored closely the progress in developing the simulation model (i.e. calibration of the input data, debugging process).

3.2.7 Year 1999

In the first half-year of 1999, most regional councils were waiting to see the outcome of the Lincoln University computer simulation model. The Canterbury Workgroup and the National Workgroup were updated regularly before the final results were presented in mid-April. The outcome of the model was peer reviewed by these two workgroups and by an academic committee that organised the "Australasian Environmental Engineering Conference" held in Auckland in July (Kissling & Thull, 1999).

The **Canterbury Regional Council** has been convening meetings of the Canterbury Stock Effluent Workgroup since the release of the model results. The model suggests five sites (Kaikoura, Amberley, Sheffield Junction, Ashburton and Timaru) for the Canterbury area by assuming 300 litre effluent storage capacity on a truck and trailer unit. The funding mechanism and the intentions of the council were not clear in September 1999 and could not be discussed further.

The **National Stock Effluent Workgroup** (NSEW) is currently (Aug–Oct 1999) assessing ways to establish the funding mechanism to build a network of sites for the South Island. Based on previous funding for the two Waikato pilot sites, the acceptance to split the costs 1/3 Transfund (Funding Authority for State Highways), 1/3 Road User Funds (Road Transport Forum) and 1/3 Regional Councils is likely to be high. The Hon Minister John Luxton, Minister for Food,

Fibre, Biosecurity and Border Control, presented in June the new voluntary code of practice called "*Industry Code of Practice for the Minimisation of Stock Effluent Spillage from Trucks on Roads*", released by the NSEW. The NSEW is also preparing a nationwide communication strategy.

Most councils are reluctant to go their own way, before the National Stock Effluent Workgroup releases a report on the modelling results and estimated costs involved.

3.3 Summary

This chapter gives a clear picture of the actions taken over the last twelve years to try to reduce stock effluent spillage on New Zealand roads. Two national workgroups failed and a motorcyclist unfortunately had to lose his life to make authorities wake up and become active. The Mayor of South Waikato District Council mobilised the whole 'ministerial system' to find a solution to this issue and persevered to achieve the establishment of two pilot discharge sites in the Waikato. Unfortunately the location of these two sites is far from optimal, however, their design has proven over the last few years to be well founded. The Taranaki Regional Council stopped their activities as they were told by a consultancy that the costs for two potential sites would reach $500,000. The Canterbury Regional Council in association with Lincoln University organised in April 1997 a South Island based 'Stock Effluent Workshop' to gain the confidence of the Road Controlling Authorities and to encourage a National Stock Effluent Workgroup to reform. This group, convened by an experienced leader, through a professional approach and through perseverance has gained recognition for the first time, to ensure that stock effluent spillage issues are being dealt with efficiently at a national level. The outcomes of this group are a professional educational video and brochure, a new Industry Code of Practice and a recommended network for discharge facilities in the South Island in a timeframe of less than two years. The basic barriers have been broken and actions are on the way.

4 LEGISLATION

4.1 Introduction

Heffernan (1997) stated that no matter what enforcement method or which piece of legislation was used, it would not deal with the problem ad hoc, as hardly any disposal facilities are currently available. The New Zealand legislation does not deal directly with the issue of stock truck effluent spillage. Any enforcement authority is restricted by inadequacies of the current legislation which effects the ability to prosecute successfully in cases involving the release of stock effluent onto roads including the adjacent areas.

This chapter will deal with the available guidelines, the pieces of New Zealand legislation that could be applied, their restrictions and how the problem is dealt with overseas. This chapter does not explore enacting a new statute.

4.2 Guidelines

A certain number of guidelines have been promoted over the last twelve years to deal with the problem of stock effluent on the road. Everybody saw the problem as somebody else's, so no resolution was found. The first working party looking at the issue of stock effluent spillage elaborated on the 1987 guidelines to reduce stock effluent spillage from transport vehicles (NZ Local Government Association Inc., 1991). The guidelines explained the benefits of livestock preparation ('standing' time 4-6 hours) and encouraged better communication and coordination among all the stakeholders. They wanted the farmers to 'stand' the stock in the holding yards for 4-6 hours off feed and water, local authorities to provide stock truck by-passes away from towns, transport operators to wash down their vehicles immediately after stock had been delivered, and meat companies to provide truck washing facilities at their plant. These guidelines resulted from the working party balancing the reduction without causing a substantial increase in costs (fitting tanks to stock trucks) and inconvenience to the rural sector.

In January 1993 these guidelines were taken seriously by the Road Transport Association (RTA) when they released a draft code of practice for stock crates, including a section on effluent containment (Standards NZ, 1993). RTA required an effluent containment volume of a minimum capacity of 10 litres per cattle beast/ dairy cow or 0.7 litres per ewe/lamb/deer. As a maximum loading capacity of a modern truck and trailer unit is about forty cattle or 550 lambs/ ewes, this assumed a volume around 400 litres. These draft guidelines were reproduced in the Stock Crate Quality Assurance Programme that requested the same effluent tank size of transport operators wishing to certify their stock crates (NZ Road Transport Association, 1997).

The Animal Health Division of the New Zealand Ministry of Agriculture & Forestry (previously Fisheries), set out a "*Code of Recommendations and Minimum Standards for the Transport of Livestock by Road over Long Distances*" (MAF, 1979) and a "*Code of Animal Welfare*" (1994 & 1996). The preparation of livestock prior to transport took an important place in the new code of 1994. Section 4 of the code recommends to withdraw food for a period of 4-6 hours prior to transport. The code refers to the 'Code of Practice for the Manufacture and Use of Stockcrates on Heavy Vehicles' (that include 400 litre tanks), when it comes to recommended standards for livestock vehicles. Section 4 requires the vehicles to be clean before the animals are loaded. The code stated that a journey including the time animals were off-feed, should not exceed 18 hours without an off-loading stop for rest, food, and water. The only exception (24 hours) is when the destination of the animals results in immediate slaughter.

The latest guiding document released by the National Stock Effluent Working Group in April 1999, is the "*Industry Code of Practice for the Minimisation of Stock Effluent Spillage from Trucks on Roads*" (National Stock Effluent Working Group, 1999a). The purpose of the code is to show the benefits of minimising effluent spillage, the responsible parties involved and the responsibilities of each stakeholder group. The code includes the proposal for future declaration

cards including factors such as time taken off pasture or feed, time arranged for livestock pick-up, real time of pick-up and the arrival time at the destination. This proposal could help to build up confidence between all stakeholder groups with each step in the supply chain subjected to monitoring. A lack of perceived confidence drives some farmers not to 'stand' their animals off feed prior to transport as they believe the stock would loose too much weight if not processed in time. This effects the commercial returns of the farmer. This voluntary code is the first industry code of practice acknowledging that stock effluent spillage from trucks is not *"someone else's problem".* In the words of the Hon John Luxton, Minister for Food, Fibre, Biosecurity and Border Control, *"The working group is to be congratulated for taking the bull by the horns"*(Media release, 1999).

A breach of any code of practice discussed in this chapter would not be an offence. This creates an enforcement problem when a breach has no legal consequence. Self-policing has been shown from an international perspective to be inferior in relation to the rulings of the International Court of Justice. The code has no legal status in the New Zealand legal system.

4.3 Legislation in relation to the possible control of stock effluent

4.3.1 The powers of control under the current legislation

There are a number of Acts of Parliament that have a bearing on the control of animal effluent discharge from stock trucks. Unfortunately, there are no reported cases of prosecutions and the level of penalties imposed. It is therefore difficult to make academic comment on any success of the controls available in the legislation discussed below. The enquiry of the researcher is limited to the sections of the legislation available in New Zealand that could control stock effluent on public roads. As part of this analysis, enforcement has been a fundamental consideration to determine the overall effectiveness of the existing law. This section seeks to examine and summarise these pieces of legislation.

4.3.1.1 Transit New Zealand Act (1989)

The Transit New Zealand Act establishes the main statutory framework for the control of effluent discharge from stock trucks on State Highways. An information must be laid under the authority of Transit New Zealand, the Commissioner or the Minister of Transport or an officer or employee of the same or a member of the New Zealand Police (S51(4) (a) & (b)).

Section 51 Penalties for damage to roads, bridges, etc states

S51 (2) every person commits an offence who....

(e) causes or allows any water, tailings, or sludge, or any offensive matter, to flow from any vehicle ... on to a road, or into a ditch or drain associated with the road, whether or not on the road; or

(f) causes or allows any material or thing to fall on to a road from any vehicle to the danger of lawful road users; or

(g) wilfully or negligently causes or allows any substance harmful to sealed or paved road surfaces, or likely to create a danger to vehicles on such surfaces, to escape on to any road having a sealed or paved surface; or

(f) does or causes or permits to be done any act whatever by which any damage or obstruction is caused to a road ... is liable on summary conviction to a fine not exceeding $,1000 (amended in 1995) and to a further fine of $50 for each day the offence continues.

S51 (3) provides for a further penalty for the clean up costs undertaken by the Minister of Transport or by Transit New Zealand for removing the stock effluent from the road. Stock effluent can fall within the meaning of an "*encroachment , obstruction, hazard, disfigurement, or matter*". "*Matter*" in this legal sense is used to cover a wider class of possibilities than those already identified in section 51(3). If stock effluent does not fall within the first part of the definition, then it is definitively covered by the wider class component of this section. The clean up costs are for the removal of the stock effluent and can include any repairs necessary to the road. Clean up costs are imposed in addition to any

penalty under section 51(2). After the penalty is paid the clean up costs imposed must be paid by the Court, back to the Ministry of Transport or Transit New Zealand who incurred those costs.

The law defines a 'road' in the widest possible sense, including drains, ditches, road reserves, rest areas and lay-bys. The law puts the responsibility on the person driving the stock truck (Section 2) who is likely to be an employee and would therefore bear the brunt of the fine. This is the wrong person for enforcement purposes as the target should be the owner of the livestock truck.

4.3.1.2 Local Government Act (1974)

Part XXI of the Act applies to roads (other than regional roads) and states, in **S357(1)(f) Penalties for damage to roads** that it is an offence under the Act to place on any road any 'thing', wilfully or negligently cause or allow any oil or any harmful liquid to ... sealed or paved surfaces or likely to create a danger to vehicles on such surfaces, to escape on to any road having such a surface.

The information must be laid by the council (probably by the Chief Executive) or an officer of the council with the appropriate delegation. If stock effluent comes within the definition of 'thing', the offender is liable for a fine not exceeding $1,000 and $50 a day for a continuing offence (S357(1)(j)). This section gives the option of a further penalty for clean up undertaken by the council in removing the stock effluent. This option is the key difference between this Act and the Transit New Zealand Act.

The amount of the fines in both these sections are not punitive and could easily be built into the operating costs by stock truck companies. For these two sections to be effective, a fine not less than $10,000 should be considered. The Local Government Act is twenty-five years old and is in desperate need of an increase of the penalty to bring it into line with the current financial climate. In comparison to the 1995 amendment of the Transit New Zealand Act, the

$500 increase fails to modernise the legislation to a limit that prevents stock effluent being spilled on the road.

4.3.1.3 Crimes Act (1961)

Section 145 Criminal nuisance

(1) *Every one commits criminal nuisance who does any unlawful act or omits to discharge any legal duty, such as act or omission being one which he knew would endanger the lives, safety, or health of the public, or the life, safety or health of any individual.*

(2) *Every one who commits criminal nuisance is liable to imprisonment for a term not exceeding one year.*

In 1992, a member of the general public, Kevin Le Gros, lost his life after his motorbike went out of control caused by stock effluent spillage on Tar Hill in Tokoroa. This case could clearly fall within the ambit of section 145. Endangering lives is the requirement combined with criminal nuisance as defined in this section. This law imposes a severe penalty of not more than one year in prison.

4.3.2 Restricted applications of the law

4.3.2.1 Resource Management Act (1991)

The Resource Management Act is the principal statute for the management of land, water, soil, the coast, air and for the control of pollution. It sets out the rights and functions of Government, Regional Councils, Territorial Authorities and individuals for resource management (Bell et al., 1994). The Act specifies new responsibilities for central, regional and territorial government. Regional authorities are responsible for the management of water, soil, air and pollution control, whereas district authorities are responsible for the control of land use, subdivision and noise.

Each of the sixteen Regional Councils enacts legislation in four areas: (1) Resource Management, (2) Land Transport, (3) Biosecurities, and (4) Civil Defence. These four areas are underpinned by national policies. A Regional Council has no legislative mandate to control spillage of effluent onto roads, rather its role is one of education and coordination.

Some Regional Councils have recently added the issue of stock truck effluent to their Regional Land Transport Strategy (RLTS). For example, the RLTS of Environment Waikato (1994) contains six policies relating to stock effluent spillage:

2.5.1 *Support the investigation and development of stock truck and campervan effluent disposal facilities.*

2.5.2 *Investigate, in conjunction with district/city councils and Transit New Zealand, how bylaws and bypasses can be used to remove stock trucks from certain roads and town centres.*

2.5.3 *Encourage farmers, transport operators and stock agents to develop a code of practice relating to the transport of livestock.*

The Resource Management Act prohibits the dumping of offensive materials on roads and section 15 of the Resource Management Act pertains to the discharge of contaminants into the environment. "*Discharge*" is defined within the Act as *"... emit, deposit or allow to escape."* 'Contaminant' includes "*any substance ... that either by itself or in combination with the same, similar or other substances, energy or heat - ... b) when discharged onto or into land or into air, changes or is likely to change the physical, chemical or biological condition of the land or air onto or into it is discharged."*

Under this section, no person may discharge such contaminants unless allowed by a rule in a regional plan, a resource consent or regulations. It obliges councils, through their plans and other planning instruments, to ensure that the

adverse effects of activities on the roading network are mitigated, remedied or avoided (Heffernan, 1997).

Primary enforcement tools are enforcement orders, interim enforcement orders, abatement notices, emergency works and prosecution. The problem is that there is no explicit power under the Resource Management Act (RMA) for enforcement officers to stop vehicles on the road. Major difficulties would arise in legally stopping a truck in order to serve an abatement notice or to undertake an inspection in order to determinate compliance with a plan or consent. The use of the usual enforcement is therefore limited.

However, the RMA processes and provisions can assist in four ways (Rae, 1999):

(1) Regional plans can include rules to control discharge of effluent from stock trucks at farms.
(2) District plans can include provisions to require installation of stock effluent disposal facilities and to encourage good practices to avoid/minimise uncontrolled discharges.
(3) Section 17 of the RMA may enable enforcement action to be taken in relation to uncontrolled discharges.
(4) Resource consents can be granted for disposal of stock effluent at farms and at new facilities.

The enforcement mechanism currently available prohibits success of any of these proposals.

4.3.2.2 Transport Act (1962)

Section 70 imposes strict liability for offences involving insecure loads and loads falling from heavy vehicles. Strict liability means an operator is liable under this legislation unless he can prove the defence on the balance of probabilities that there is no negligence by them.

S70(1) *The operator of every heavy motor vehicle shall ensure that any load carried in or on the vehicle or may the vehicle being towed by a heavy vehicle operated by him, is secured or contained in such a manner that it cannot fall or escape from the vehicle.*

S70(2) *Every operator of a heavy motor vehicle who fails to comply with subsection (1) of this section commits an offence and is liable on conviction to a fine not exceeding $2,000. And if that person was the driver of that vehicle or any vehicle towing that vehicle, the Court may order that he be disqualified from holding or obtaining a licence to drive a motor vehicle for such period as the Court thinks fit.*

The definitions of operator and load are important to the proper application of this law. The term operator is defined sufficiently widely to allow a prosecution. The problem appears in S70 (7)(a) that defines the term 'load' as not including animal wastes discharged from animals being carried on the vehicle at the time. Even if this section could be used it would still hit the wrong target. The driver of the vehicle being disqualified from driving is absolutely no help to control the issue of stock effluent on the road.

This section of the Transport Act cannot be used for prosecution in this issue unless the wording is amended from 'operator' to 'owner' and load includes 'animal waste'.

4.3.2.3 Litter Act (1979)

Every person who deposits any '**litter**' in or on any public place and leaves it there, commits an offence. Particular emphasis is accorded to 'litter' which is of a nature to endanger any person or cause physical injury or diseases or infection to any person coming into contact with it (Section 8).

'Public place' includes every motorway, road or street. 'Litter' includes any waste matter. Animal waste is not necessary waste, as it can be reused for example as a fertiliser product.

Every public authority may appoint Litter Control Officers who may already be employees, and the Police are automatically empowered as Litter Control officers. These appointed officers are authorised to enforce the provisions of the Act and may intervene to prevent the deposit (or attempted deposit) of 'litter' in any public place (Sections 6 & 7). Any territorial authority, having appointed any such officer, may adopt the provisions of Sections 13 and 14 of the Act, which apply in respect of infringements. An infringement notice must be served to any person committing any such offence.

Every local authority, whether alone or in conjunction with any other public authority or authorities can make bylaws to give effect to the provisions of the Act.

4.3.2.4 Health Act (1956)

Because of the nature of the discharge, the Health Act may also apply if the discharge could be considered to be a statutory nuisance (section 29). Determining the existence of a nuisance would depend on the circumstances of a particular discharge and the evidence available to pursue the issues of offensiveness or likelihood of injury to health (Ministry of Health, 1996). Health risks have been identified by Environment Waikato as

- Cowpox
- Tetanus
- Tuberculosis
- Salmonellosis
- Leptospirosis
- Johnes Disease
- Beef Tapeworm
- Endoparasites
- Clostridial Diseases
- Camplobacterosis

The degree of transmission is acknowledged by Environment Waikato to be difficult to assess (Environment Waikato, 1994). Given the uncertainties, it seems more appropriate to use the provisions of the other, more recent, Acts that appear to relate more specifically to the issue of stock effluent spillage or discharges onto roads.

4.3.2.5 Transport Regulations (1976)

Section 26 deals with dangerous substances on roads.

(1) If any slippery, piercing or dangerous substance, ... or any other substance of any kind whatsoever that by reason of its size or nature constitutes or could constitute a danger to users of the road, falls or escapes from any vehicle upon any road, ...

(a) If removal of the substance or glass can be achieved quickly and safely, it shall be the duty of the driver of any vehicle involved to remove it or cause it to be removed forthwith; or

(b) If removal of the substance or glass cannot be achieved quickly and safely and there is a likelihood of harm being caused to the public or to any person, it shall be the duty of the driver of any vehicle involved to warn the public or to report the occurrence forthwith to the nearest police station or to a police officer or to a traffic officer or to any office of the Road Transport Division of the Ministry of Transport.

(2) If all the drivers specified in subclause (1) of this regulation are physically incapacitated and unable to carry out any duties imposed on them, the duty described in subclause (1) (a) of this regulation shall devolve on any person removing the vehicle or vehicles from the scene.

An information would have to be laid by the New Zealand police and the fines would be maintained at the same level as the Transport Act 1962. The key

point of difference with all previous sections considered, is that a duty is placed in the regulations on the driver to remove the stock effluent or to organise with the local police the removal. One has to ponder just how many stock truck drivers would have any idea that this duty exists. This regulation could never work unless the drivers are educated about this duty.

4.4 Overseas Regulations

This section considers overseas legislation associated with livestock transport. Most regulations or directives deal directly with animal welfare issues. Within the European Communities, animal transport is regulated, however only as a directive, not to exceed 8 hours. For longer trips, animals need to be unloaded, fed, watered and rested for 24 hours (Lorenz, 1996; EEC, 1991; EEC, 1995). However, if the livestock truck fulfils certain criteria, a trip exceeding 8 hours is allowed. The truck needs for example to have direct access from outside to the animals, carry sufficient feed and water for the journey, dispose of adequate ventilation for the crate and water dispensers that cannot be tipped over. The allowed transport time for these special trucks depends on the animal species. Pigs need to have access to water (water dispenser in the stock crate) during the journey and their trip cannot exceed 24 hours. Calves and piglets need a rest after 9 hours whereas other animals need to be rested for a minimum of 1 hour after 14 hours transport. After this feeding and watering stop, the truck can move on for another 14 hours (EEC, 1995). These European 'rules' are only Directives laying down the principles governing the organisation of veterinary checks on animal transport. This is similar to the NZ code of recommendations and minimum standards for animal transportation.

Germany was in 1996 in the process of transforming these Directives into legislation and the author was hoping that domestic transports would be limited to 8 hours, as the Communities allow each country member to have stricter regulations in their own country (Lorenz, 1996).

None of the regulations or directives deals directly with the problem of stock effluent. Lorenz (1996) who describes all technical details required for German livestock trucks only mentions that the doors and each potential gap need to be sealed to avoid spillage on the road. This allows for a prosecution under the country's law. For each trip the transport operator must provide a carpet layer of sawdust and sand. The layer needs to be cleaned out after each trip. The transport operator needs to carry a high pressure cleaner on board and use the engine for access to high pressure. It has not been mentioned in the reviewed literature what happens to the contaminated mixture of sawdust and sand. The answers obtained in 1997, from visiting a few plants in Europe, ranged from dumping at the abattoir to taking it back to the depot.

Lenehan (1999) from an Irish Agricultural Research Centre mentions in a personal communication that in Ireland all trucks need to be equipped with effluent tanks to avoid spillage on the road. Unfortunately spillage of effluent on the road occurs in some cases. This is not dealt with by legislation.

Tyndall (1999) from McMillan College in Australia has an office less than 100 metres from the region's livestock saleyards and acknowledges that his car receives 'spats of cow crap' on sale days. The 'Litter Acts' of the various Australian states are supposed to control the manure escaping from a truck onto the road.

None of the American literature reviewed deals specifically with this problem, and a search through the Internet revealed nothing. Some American farmers communicated with by email answered that they were not aware of the problem at all due to little stock density in the region (Carlson, 1999). An alternative response was stock effluent is not seen as a big issue because the geography of the region produces flat roads. Others simply replied that if it was happening and the police could monitor the spilling truck, unfortunately the driver is prosecuted. Therefore the target is missed for effective law even overseas.

4.5 Conclusion

The New Zealand legislation that could deal with the problem of stock effluent spillage from trucks is currently weak. As the rural industry and transport lobbies have always been high in New Zealand, none of the attempts to deal with this issue has gone further than establishing a new *Code of Practice*. Unfortunately, the breach of any code is not an offence and has no legal status in New Zealand.

The *Transit New Zealand Act 1989* and the *Local Government Act 1974* are probably two pieces of legislation that could be used for prosecution. However, unless the fines are increased from $1,000 to $10,000, nobody will be able to use these laws efficiently. The *Crimes Act 1961* could also be used, as effluent spillage has already endangered the life of a motorcyclist and can include other road users.

The *Resource Management Act 1991* has no efficient enforcement mechanism and is limited to actions. The *Transport Act 1962* would be useful, if amended with the word 'load' including animal waste and the word 'operator' associated with the truck owner and not the driver. There is difficulty with enforcement under the *Transport Regulations 1976*, with the duty being placed on the driver and not the real target, the owner. Most of these pieces of legislation hit the wrong target. The *Litter Act 1979* is weak, as stock effluent may not be regarded as 'litter' or 'waste'. A prosecution under the *Health Act 1956* is unlikely to be successful, as it will be difficult to find evidence for a prosecution.

This review shows clearly that the current legislation is weak or unfair. An amendment to the existing legislation including an adjustment of the fines (i.e. from $1,000 to $10,000) and targeting the truck owner would be a step in the right direction. However, unless a reasonable network of in-transit dump sites is established throughout New Zealand, competent legal advisers will find ways to defend a prosecution. The combination of the new Industry Code of Practice, an efficient educational communication strategy, and the pressure to

achieve a high quality end product in New Zealand and overseas will contribute towards a self-policing process. The amendments in the legislation or the writing of a new statute dealing specially with the issue of stock effluent spillage from trucks should be part of the overall process to reinforce the voluntary side of the Industry Code of Practice. There is still a long way to go, before "*the bull is taken by the horns*".

5 COMPLEXITY OF THE PROBLEM

5.1 Introduction

The purpose of this chapter is to identify the stakeholders, their responsibilities, the way everybody is linked in this complex problem, and to explore the reasons for effluent spillage. It also deals with the various factors that influence the volume of effluent produced by livestock in-transit.

5.2 Responsibility

There have been previous attempts to address this problem, however, these have not been successful. This is largely because of the lack of ownership of the problem, conflicts with the existing legislation, and inadequate facilities to either hold or dispose of effluent collected. The issue relates to the entire industry, from the farm to the saleyard or meat processing plant. The success of any improvement can only be assured if it is owned by all parties within this chain. The stakeholders are identified as being farmers, livestock carriers, stock and station agents, meat processors (management and drafters), saleyard owners and authorities (Kissling, 1997; Thull, 1997).

Is it the fault of the farmer who has not stood his stock prior to transport? Or was the transport operator too early for pick-up? Or did the livestock carrier ring the farmer at nine o'clock at night to ask him to have the stock ready at seven o'clock in the morning? Or did the carrier use a truck and trailer without holding tanks or leave the tanks open while driving to the destination? Or did the stock agents draft stock while the livestock carrier was waiting in front of the gate to pick-up the stock? There are many possible scenarios and combinations.

It is clear that a combination of full livestock (especially cattle) and a livestock truck and trailer unit without a holding tank fitted or used (running with open taps), will result in effluent discharge onto the road. But is it necessarily the

fault of the farmer and the livestock carrier? For a long time only the transport operator was seen as responsible. Through the work done by various working parties it became apparent that far more people were involved in the problem. All players identified above are implicated in the responsibility. The next section deals with the involvement of the different players to demonstrate the difficulties and constraints in the supply chain management from farm to table.

5.3 Reasons for effluent spillage

The problem has escalated over the last fifteen years as transport needs, farming and the whole industry have changed. Unfortunately, few stakeholder groups were prepared to contribute to reducing or to eliminating the stock truck effluent problem, as most saw it adding to their costs and inconvenience without clearly identified benefits for them. Some reasons are due to general industry facts, whereas the remaining reasons are specific to the individual stakeholder groups.

5.3.1 General industry facts and issues

Cattle herd sizes and total cattle numbers are increasing. 13.9% increase of cattle (1,128,000) from 1992 to 1995 (Statistics New Zealand, 1996 & Statistics New Zealand, 1998).

The travel distances from farm to meat processing plants have increased, as many local processing plants have closed down due to industry rationalisation. In the South Island of New Zealand the two main meat processing companies, Alliance and PPCS (Primary Producers Cooperative Society), have their plants located along the East Coast only. Due to potential weather conditions (drought) and seasonal factors (the lamb season starts in the northern part of the South Island), in most years livestock need to be shifted long distances due to the slaughter capacities in the different plants. Inter-island traffic has also grown through a competitive pricing system that involves procurement from anywhere in New Zealand.

Rail is not used to transport livestock. As a general rule, rail is the cheaper method when hauls exceed 800km (Tarrant, 1990). Despite higher freight costs, road transport is mostly preferred, as it is quicker, more convenient and stock are handled less. Transport by rail involves further loading and unloading processes that contribute additionally to animal stress.

No in-transit effluent disposal sites exist in the South Island. Two pilot sites are located in the North Island. Many destinations have unsuitable facilities to receive effluent (i.e. meat processing plants) or no facilities at all (saleyards). Even recently built saleyards such as the new Christchurch saleyard (Canterbury Agricultural Park) did not have this requirement in the resource consent.

5.3.2 Farmers and livestock producers

Most farmers do not 'empty out' or 'stand' their stock for four to six hours before transport for various reasons.

Farmers need timely notification by the stock agent or drafter and the livestock carrier in order to prepare their stock for transport. They usually need to 'stand' them off pasture in the holding yards for at least four hours or to prepare them on dry feed (hay or grain) for several days. Presently it often happens that the farmer has to muster the stock twice, once for the drafting process and once for the transport. If the livestock carrier is not on time, the livestock will 'stand' far longer in the yards than originally scheduled by the farmer, which can increase animal stress and potential liveweight losses, and is likely to affect meat quality. Some farmers have had bad experiences, knowing that their stock were processed 48 hours later at the meat plant. This fact makes it understandable that farmers are reluctant to 'stand' their animals in the yards to allow emptying out. Farmers really need the confidence that each stakeholder group further down in the supply chain will adopt best practice. This issue has been acknowledged by a meat company representative who maintains that a

labelling system that notes slaughter day and time may solve this concern quickly.

For shipments to saleyards farmers tend not to 'stand' the stock in the belief that they look better when 'full' (full of grass) and will command a better price. Unfortunately, too many farmers turn a blind eye to the unloading of trucks of 'full' stock. These animals usually look dirty as they emptied their guts in the truck. This problem may be overcome in the future through further education on animal welfare and promotion of meat quality issues.

Any of these mismanagement scenarios may lead to weight or quality losses and thus to a reduced cheque the farmer will receive. Consequently everybody along the chain needs to be aware of these factors and to understand the concerns of the others.

A small number of farmers still use their own trucks to transport their livestock to abattoirs and saleyards. These trucks, usually being quite old, do not have any containment capacity to collect effluent.

5.3.3 Livestock transport operators

The percentage of truck and trailer livestock cartage units in the South Island fitted with holding tanks is under fifty percent (survey 1997/98). These tanks have an average effluent storage capacity of approximately 150-200 litres. Currently most of the livestock carriers with holding tanks do not use them. The reasons for running with open taps are easy to understand:

- There is no in-transit discharge facility available in the South Island.

- The dumping facilities at the meat plants are combined with the truck wash and are not especially designed for discharge of stock truck effluent. These truck-washing facilities are provided to enable a quick wash of the crates to meet the hygiene requirements for the next load. Unfortunately, many

transport operators do not provide adequate truck washing facilities at their own yards. Therefore, they tend to use the facilities of the meat plants. A normal truck wash takes around three hours and blocks the access for any trucks that want a quick wash or to dump the effluent collected en-route. Ideally, a cattle stop with a receptor outside the truck wash is required at each point of destination (meat plants, local abattoirs and saleyards) to allow a quick discharge of effluent without wasting time.

- Most of the current fitted taps do not work properly. Either they have never been maintained or they do not close properly for many reasons (e.g. small stones, corrosion, broken materials). The most common taps or valves are made of Polyvinylchlorid (PVC). PVC is not designed to be exposed constantly to UV radiation and big temperature fluctuations. The researcher encouraged two main South Island trailer manufacturers to use stainless steel ball valves of a large diameter (100 mm). Ball valves are supposed to be self-cleaning and are used a lot in the sewage treatment industry. The company managers realised the quality advantage and started to equip their new gear with those valves. The original concern about higher costs was overcome when a New Zealand product was found at an even better price than the PVC valves (Currie, 1999). Exchanging all current valves with ball valves would greatly benefit the stock truck drivers. These ball valves are easy to operate through their long stainless steel handle. It needs to be clear that nobody can expect a stock truck driver to get covered in 'effluent' each time he is operating a valve that jams. As most trucks are company owned, a truck driver will not have much influence, unless the legislation is changed and his company is prosecuted for spilling effluent. It would be desirable, in the future, to see the requirement of a perfect operating valve system added to the New Zealand Warrant Of Fitness (WOF) standard.

- As nobody has yet been successfully prosecuted, some transport operators continue to leave the taps open. This allows their truck-load to decrease in

weight as they travel along the road. Using this practice the risk of getting caught with an over weight load reduces as the journey progresses.

- The time factor is a relevant issue, as the truck drivers often have to queue at the meat processing plants before unloading but still must abide by the driving hours recorded in the driver logbooks. Waiting at a truck wash facility to empty tanks is added time penalty.

- Transport operators are loading full stock, as they cannot afford to upset and loose clients in this competitive market.

- Many truck and trailers are only thoroughly washed once a week. This means that towards the middle of the week, the trucks may be quite dirty, especially on the outside. Some companies are discovering that a clean truck provides a better image to their clients and the general public and has marketing value.

It may be easy for the general public to blame the highly visible transport companies, but most of the reasons outlined above, show clearly that the current system in itself needs to be reviewed and that just fitting and using holding tanks will not in itself solve the problem.

5.3.4 Stock agents or meat company drafters

Stock agents often do not give sufficient advance notice to farmers or livestock carriers to allow them to do their task properly. They appear generally to be unaware or unconcerned about the impact of timing on meat quality and the benefits to be obtained from farmers delivering low stressed and clean stock. Stock agents and some company drafters do not communicate enough with the farmers and do not encourage farmers to prepare their stock prior to transport. They do not liaise sufficiently with farmers to build better levels of confidence. Many farmers refuse to 'stand' the stock, as they are worried their stock may stand too long at the meat plant before slaughter.

5.3.5 Meat processing companies

Some meat plants are not giving sufficient feedback to the farmers on the conditions of delivered livestock. 'Not stood' or 'full' stock will always be far more dirty than 'stood' animals as they produce more effluent in transit. Some meat companies have only started to focus on the condition of delivered livestock as quality issues have become increasingly important.

The travel distance for livestock cartage destined to the two larger meat companies in the South Island (Alliance and PPCS) can be longer in early and late season, due to the capacities of the different plants. These companies may be forced to re-direct carriers to bypass the closest processing plants to plants further afield.

It can also happen that meat processors run short of stock and need to procure urgently livestock to keep the plant running. The reasons for that can be caused by weather conditions (i.e. drought, frost) or simply bad management. This stock will often be drafted directly on the paddock with a waiting truck at the farmer's gate. There will not be time to 'stand' the stock prior to transport.

It can happen that a meat processor does not have the killing schedule available for the stock agents and drafters in time. Ideally, the planning should be ready at least one week in advance. The result of a short notice is transferred to the notice time given to farmers and livestock carriers that will be too short to prepare the stock properly for transportation.

None of the meat processors in the South Island has a separate location for stock carriers to allow a quick emptying of their effluent holding tanks. The meat plants are even reluctant to allow a truck wash or the discharge of effluent tanks, given the constraints of their resource consents from local authorities. Consequently many carriers run with open taps. The truck wash is a separate issue that needs further attention in the future. The attitude of meat processors regarding their truck wash facility is understandable as they are currently used

for extensive truck washing and not just for a quick hose down to ensure a clean crate for the next load. Stock effluent needs to be collected and treated differently from the wash water, as its BOD and concentration of solids and other organic materials are far higher, however the volumes are far lower.

5.3.6 Authorities

None of the Councils, except Waikato in the North Island, has so far provided conveniently located discharge facilities in-transit or has been seeking partnerships with other business organisations to fill the need.

Councils who give resource consents for facilities that involve the transport of livestock (i.e. saleyards, showgrounds, meat processing plants) have not to date used the New Zealand Resource Management Act to require the provision of adequate stock truck effluent discharge facilities. This is an urgent issue that needs addressing immediately.

5.4 Network of involvement

The lack of *communication*, *coordination, logistics*, and *confidence* all along the chain is contributing to effluent spillage. Players in the chain are aware of what others do and how they may impact others through their own behaviour. Systemwide efficiencies may not be obtainable while players look only to their own interests unless the reward system or the fear of sustainability being jeopardised encourages behaviour that is cooperative rather than conflicting. Knowing what others in the logistical chain face, is a necessary precursor for better communication. Better communications means in this context timely communication. Each stakeholder in the chain needs to be aware or informed in time to deliver his or her piece of the action at the right time, in a quality manner. It is time to search for a win-win solution and encourage the whole industry to act in an environmentally responsible manner whilst aiming to maximise the economic returns to those involved in this partnership.

Only when all players in the logistical chain seek to work in a partnership, assume full responsibility for their tasks, respect others' constraints, share the costs fairly and proudly own the system, will the problem of effluent spillage be minimised in the future.

5.5 Factors influencing the production of faeces and urination of livestock in transit

5.5.1 Introduction

Much literature is available about transport and slaughter of livestock (National Agricultural Library, 1998). A lot is devoted to technical and economic aspects of slaughtering as transport of livestock is often seen as an economic necessity. However, from the animals' point of view, it is an unnatural activity that inevitably exposes them to a variety of hazards. Animal welfare, meat quality and yield are important issues in the transportation of livestock from the farm to the final destination. Although this study was focussed on stock effluent produced in transit, it quickly became obvious that there is a relation between stock effluent, animal stress and meat quality issues. In order to understand better the influence of those parameters upon the whole transportation process, and the reasons, why farmers are reluctant to 'stand' their stock prior to transport, it became relevant at this stage to highlight the factor 'animal stress'. The whole transportation process involves assembly of stock, loading, transport, and unloading at destination. The pre-slaughter process from unloading at destination to slaughter may also involve a certain amount of stress but it is not part of the following literature review.

Tarrant et al. (1993) are among the few authors mentioning the factors of effluent excretion. They said that a higher frequency of urination was associated with fear. Fear is a strong stressor. Excretion of faeces and urine are usually mentioned in association with weight loss (Dantzer, 1982; Phillips et al., 1991; Shorthose, 1965). None of the scientific papers reviewed measured

the direct correlation between excretion of faeces and urine and fear, animal stress, fasting or feeding prior to transport.

5.5.2 Animal stress

Transportation by its nature is unfamiliar and threatening to an animal that has come from a relatively tranquil and undisturbed environment. Animal stress associated with transportation can be divided into two categories: Psychological or emotional stress (restraint, handling or novelty) and physical stress (hunger, thirst, weather conditions, fatigue and injury) (Stephens, 1982 and Grandin, 1997). In general, cattle are regarded as being more resistant to transport stress than pigs. Kilgour et al. (1973) recommended to feed dry material instead of grass before transportation, as this will add to the comfort of livestock in transit and will help maintain better standards of cleanliness throughout the journey.

5.5.2.1 Psychological or emotional stress

It is relevant to remember that cattle and sheep are herd animals that are used to their social order within the herd. Separation from the flock or herd or mixing with other groups (in the truck) will cause stress until the social order is restored. The fact that animals break the bond with the herd as they leave their farm of origin causes emotional stress and is often overlooked (Stephens, 1982). The drafting of one or two animals out of a mob, such as practised often in the late season, and mixed up with others in the same pen in the truck can have severe effects on meat quality. Numerous studies have shown how important it is to yard the livestock prior to transport in order to calm down, and to allow sufficient time for them to familiarise with other animals and to get used to the new restraint environment (Eldridge, 1988; Fikuart et al., 1995; Grandin, 1993; Gonyou, 1993; Kenny et al., 1982; Kraus, 1989; Lorenz, 1996; MIRINZ, 1997; Stephens, 1982; Tarrant et al., 1992; Waehaus, 1982). Some authors mention that the yarding time should not be too long and not exceed 24 hours, as animals become fatigued and less able to cope with the transport (Eldridge,

1988). Cattle that have been trained and used to a specific handling procedure (i.e. several transports by truck) may be calm and thus have a low stress level, whereas not habituated cattle with an excitable disposition (genetic factor) may become extremely agitated (Grandin, 1997).

Loading and unloading ramps can be a major stress factor for animals, especially if badly designed (Mickwitz von et al., 1993; Grandin, 1993). Augustini et al. (1982) states that the greatest stress reaction is to loading and unloading. Lorenz (1996) mentions that a ramp inclination should not exceed 20%. An ideal unloading facility to minimise stress allows animals to walk out of the truck onto a flat surface (Mickwitz von et al., 1993). This is only possible if the truck delivering area has an inclined ramp. The loading and unloading procedure are a novelty for animals which cause stress, unless they have been trained and shifted before (Grandin, 1997). It is vital that farmers and stock truck drivers become more aware that many handling events can cause stress in animals. Over use of electric prods, grabbing a sheep by its fleece, crowded transport conditions, stirring up sheep with a dog, mustering stock too quickly, ignorance of handling livestock properly, forcing animals from day-light into a dark truck are only a few examples (Grandin, 1993; MIRINZ, 1997; Meat New Zealand, 1998).

On the transportation site itself, most scientists dealing with animal stress, highlight the importance of the density of animals in each pen in order to minimise falls, trampling and consequently bruising. Grandin (1993), Holleben von (1998), Lorenz (1996), MIRINZ (1997) and Tarrant et al. (1992), just to mention a few researchers, recommend to avoid extremes of density (too cramped or too loose), as this can result in stressful difficulties while driving, loading and unloading and animal bruising or overheating. Animals tend to stand perpendicularly to the direction of motion (Tarrant et al., 1992; Kenny et al., 1982). Von Holleben (1998), Eldridge (1988) and Fikuart et al. (1995) stress how important stock truck drivers' education on animal welfare and meat quality issues has become. They need to understand that cattle are particularly

exposed to centrifugal forces during a journey full of bends, as their centre of gravity is high. Keeping upright is a constant struggle for cattle, due to their great body weight and their thin and feeble legs. Notable braking manoeuvres and gear changing and frequent stops add to losses of balance. Von Holleben (1998) mentions that it is possible to recognise particularly ruthless truck drivers through measurement of the pH factor one hour after slaughter. She compares it to a marathon runner, whose muscles are full of lactic acid after a marathon. High body temperatures and excess Lactaid acid damage the membranes of the muscle cells, thus considerably reduce the 'water retention power' of the meat. Through an efficient monitoring (i.e. Certification Card) at the meat processing plant and an improved feedback system, this stress factor could be minimised in the future. The travel distance in itself does not affect the psychological stress level, as animals tend to calm down after a while (Eldridge, 1988; Honkavaara et al., 1994).

5.5.2.2 Physical stress

Physical stress involves hunger, thirst, weather conditions, fatigue and injury. due to treatment they have probably never experienced in their lives (Grandin, 1997; Knowles et al. 1996; Tarrant et al., 1993). They are also exposed to environmental stresses such as temperature, humidity, noise and motion.

Hutcheson et al. (1986) clearly states that feed and water deprivation are major stressors that have nutritional consequences. The dehydration factor is detrimental to body functions (Hutcheson et al., 1986; Knowles et al., 1996; Wythes et al., 1984). Jacobson et al. (1997a) found that fasting 2 year old bulls for 22-23 hours did not show an increased breakdown of structural muscle proteins, however had a detrimental effect on carcass weight. Wenzlawowicz (1994) recommends for pigs a fasting time of 24 hours in order to prevent blood circulation problems and respiratory troubles. There was no carcass weight loss within 24 hours, but some after 2 days. Monin (1982) reports on fasting double-muscling cattle (DM) for two days. Double muscling cattle are genetically modified breeds of cattle that reach a high level of muscles

development. Although DM cattle are reputed to be more sensitive to stress than normal animals, there was no noticeable difference in the biochemical parameters analysed. Raikes et al. (1979) and MIRINZ (1997) recommend access to water to prevent dehydration. Water access should be available throughout all holding periods and at least every 12 hours. None of the authors mentions the difference between feeding grass from the paddock, grains or hay. The observation of New Zealand stock carriers (personal information) gives a clear indication that stock taken directly from the paddock have the tendency of travelling badly, going down in the truck and producing a lot of effluent. The literature also shows (see section on carcass weight) that feeding animals prior to transport on grain or hay can be beneficial to the carcass weight.

Rapidly changing weather conditions, such as temperature and relative humidity contribute to animal stress (Augustini et al., 1982; Dantzer, 1982; Fikuart et al., 1995; Hutcheson et al., 1986; Knowles et al., 1996; Stephens, 1982). Dantzer (1982) shows that the weight loss increases linearly with rising temperatures. He found also a relationship between weight losses and relative humidity for pigs: the higher the humidity, the lower the weight loss. Hedrick (1982) recommends to prevent cattle from heat and high humidity, as these factors are high stressors. He suggests to provide protection against wind, rain or snow in order to avoid dark-cutting meat conditions. Trucks in some foreign countries (i.e. European Communities) are required by legislation to be equipped with a special ventilation system.

Long journeys, bad road conditions (Eldridge, 1988), and physical agitation due to motion and noise of the vehicle, combined with psychological stress increase the risk of fatigue and injuries. The skill of the driver and the quality of the road appear to be more relevant than the distance travelled (Tarrant et al., 1993). They recommend to fit pneumatic suspensions to truck and trailer unit to reduce the vibrations and consequently stress. Stevens et al. (1979) (cited in Tarrant et al., 1993) advise not to over-inflate tyres as it increases vibrations.

5.5.2.3 Measurement of stress

Behavioural, physiological and pathological indicators are used to measure stress (Tarrant, 1990; Tarrant et al., 1993). It is difficult to quantify behavioural stress, although it would be useful information to enable modifications on the design of equipment or facilities. Tarrant et al. (1992) installed video cameras in trucks to analyse the effects of motion.

Physiological stress is measured through indicators such as changes in heart rate, blood composition and liveweight. Plasma cortisol and glucose levels give a good indication of stress level, as high stress activities such as climbing up steep loading ramps, nervous stock truck drivers or a journey full of bends use up the sugar reserves of the animals and increase their adrenaline production. The direct consequence of this means dark, firm and dry meat (DFD) that is difficult to preserve on the shelves, especially as a chilled product. The pH level rises from an ideal value of 5.5 to 5.8-6.2 (Holleben von, 1998; MRDC, 1994; Tarrant, 1990).

Pathological indicators are for example the yield of the body components, the chemical composition of tissues and organs (Tarrant, 1990; Tarrant et al., 1992). Muscles are of economic concern and related to meat quality and yield. Many scientific studies refer carcass bruising and injuries as good pathological indicators for stress and bad management. Both, psychological stress and physical stress can lead before slaughter to a higher microbiological contamination of the meat, due to intestinal bacteria (Fikuart et al., 1995).

5.5.3 Weight loss issues

5.5.3.1 Factors influencing weight loss

The loss of liveweight during long journeys and its effect on carcass yield is of a concern to the livestock producer and the meat industry. The liveweight of an animal is made up of the weight of the body tissues, the contents of the gut and the bladder. The gut contents can reach 12 to 22 percent of the liveweight of

an adult cattle (Wythes et al., 1984; Hughes, 1976 cited in Warriss et al., 1995). The pasture type and the season affect the percentage of gut fill. Cattle grazing on high-roughage pasture have a greater percentage of gut fill than those on a grain diet (Hedrick et al., 1983 and McIntyre and Ryan, 1982; cited in Wythes, 1990; Warriss, 1990). Loss of liveweight results from excretion, evaporation and respiratory exchange (Dantzer, 1982). The carcass is composed of muscle, fat and bone. Any losses of tissue substances or moisture will lessen carcass weight. Deprivation of water leads to dehydration of muscle and fat tissues, withholding of feed changes the catabolism of muscle and fat tissues. The result is that cattle need to draw on their body tissue to supply their water and energy needs (Wythes et al., 1984). Whether water is provided during food deprivation is therefore an important consideration.

5.5.3.2 Literature review on liveweight loss

Wythes (1990) reported in her literature review that the most comprehensive research on liveweight loss was compiled by Ward (1913) in the United States and Salerno (1949) in Italy using a total of approximately 18,000 cattle.
Some liveweight loss is inevitable while travelling as the animals are deprived from water and feed. Many parameters such as age, breed, grain-fed, pasture-fed become relevant (Wythes et al.; 1984). Even when feed and water are available, the cattle will still loose weight (Wythes et al. (1984). Transit time affects weight loss more than the distance travelled (Henning et al., 1962; Holmes et al., 1982; van den Heever et al., 1967; and Wythes et al., 1981 cited in Wythes et al., 1984).

Wythes (1990) gives an overview of liveweight losses for cattle having been off feed and water. The average losses are about 2.5, 4.0, 6.0 and 12.0% after respectively 6, 12, 24, 48 and 72 hours (Figure 5.1).

The data on cattle liveweight loss given by Warriss et al. (1995) confirmed the results published by Wythes (1990). His results showed a liveweight loss of 4.6% after 5 hours, 6.5% after 10 hours and 7.0% after 15 hours. He

acknowledged a recovery time of 5 days. Phillips et al. (1983 & 1991) reported that the liveweight loss of calves of 220kg was approximately 8.25% after 48 hours fasting (feed and water). The liveweight loss of cattle (600kg) found by Tarrant et al. (1992) reached an average of 8.4% for 24 hours off feed and water. They had not been fed prior to transport, but had access to water. Kirton et al. (1971) used dairy and beef cattle of an average of 317kg liveweight for a fasting experience. They stood in a concrete yard for four days and had only access to water. Liveweight loss reached 10% after the four days of starvation. Warris (1990) referred to a paper written by Wythes et al. (1981) that cattle were also subjected to transport and tend to loose weight through the transportation process itself, however, this was not found universally. Knowles (1996) analysed lambs being transported from the UK to France and found a liveweight loss of 6.4% after 15 hours and 7.3% after 24 hours, broken by two hours of feed, water and rest.

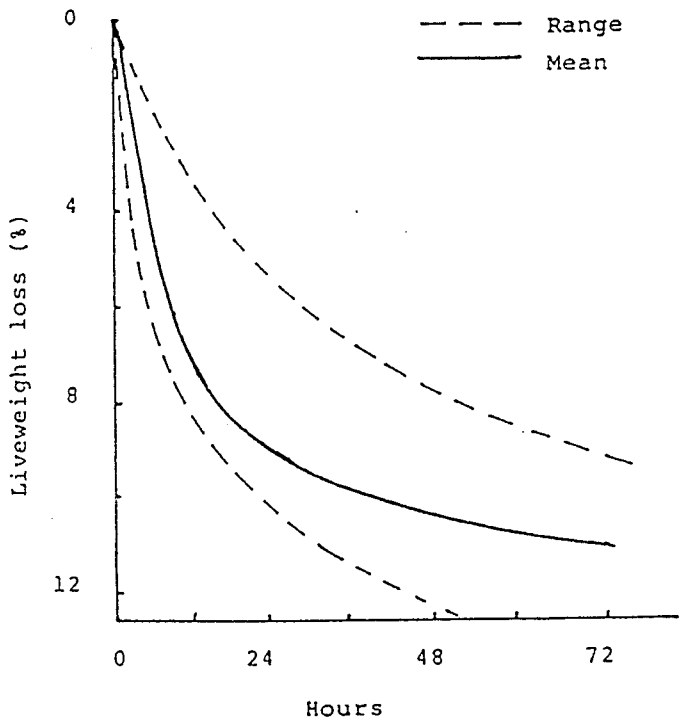


Figure 5.1 Liveweight loss over time, as a percentage of initial liveweight, in cattle deprived of feed and water (with or without transportation) (Wythes, 1990)

5.5.3.3 Literature review on carcass weight loss

Wythes et al. (1984) and Wythes (1990) state that it is difficult to measure carcass weight losses over time correctly, as it is impossible to estimate the precise initial carcass weight. It is difficult to choose similar live animals beforehand for such an experiment. Wythes (1990) summarised in her literature review that the average daily carcass weight loss was estimated as 1.3% for unfed cattle for periods of 2 to 11 days after mustering but with access to water. On the other hand, she acknowledged a loss of carcass weight of 0.66% for cattle having access to feed and water for the same period. Figure 5.2 summarises the relation between the numbers of days off feed and the percentage of carcass weight losses.

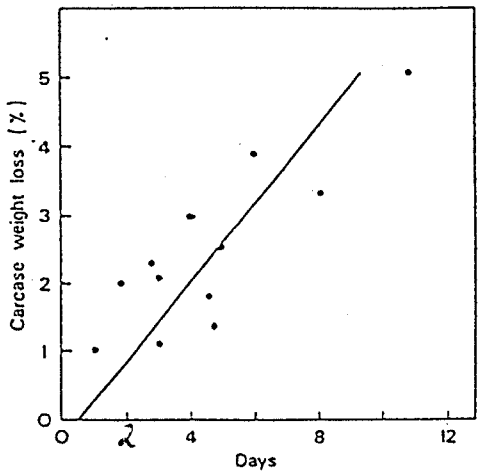


Figure 5.2 Carcass weight losses of cattle under Australian conditions, deprived of feed with water access for up to 12 days (Wythes, 1990)

Dehydrated cattle have much lighter carcasses than those who had access to water (Chambers, 1974; Price, 1981; van den Heever et al., 1967; Wythes et al., 1980; and Wythes et al., 1983; cited in Wythes et al., 1984). Bass and Duganzich (1980) reported about a carcass weight loss of about 3% after 24 hours off feed. Jacobson et al. (1997a & b) did two trials in New Zealand by

holding bulls of approximately 550kg in the yards with access to water for 20 hours before transport (2 hours) to the next abattoir. The first experiment in which the bulls were fasted for 20 hours prior to transport, was detrimental to carcass weight. In the second trial, the bulls received silage (approximately 2.3 times maintenance energy requirements) over the holding time period that lead to an optimised carcass yield. In both trials the stress response was low. Shorthose (1965) found that losses in carcass weight in ruminants begin only after the first day and may average 0.75% thereafter. Kirton et al. (1971) mentioned in his New Zealand experiment discussed in the section on liveweight losses (cattle starved for four days with access to water) that there was no evidence of carcass loss over the first three days. Callaghan and Thompson (1940) cited in Kirton et al. (1965 & 1968) concluded through their experiments that lambs being transported by rail, and fasted for 24 hours with access to water did not loose carcass weight. Raikes et al. (1979) affirmed that withholding feed and water before slaughter will affect the carcass weight. Wyhtes et al. (1984) clearly stated that the trials implemented by Carr et al. (1971), Kauflin et al. (1969) and Kirton et al. (1971) did not show any carcass weight losses for cattle that had been without feed for 24 hours.

Wright (1994) concluded in his report after discussions with Dr Royal from MRDC, Dr Devine from the Meat Industry Research Institute of New Zealand, Dr Kirton and Dr Bass from AgResearch in Ruakura and Mr Blandford from MAF Quality Management New Zealand, that all the trials had produced conflicting results. The purpose of the trials implemented so far in New Zealand or overseas had never had the objective of starving animals to reduce faecal excretions without causing carcass weight loss. Further as each trial used different experimental conditions, divergences in results were not unexpected. Nevertheless, Wright (1994) was convinced that cattle being taken 12 hours off feed were unlikely to loose significant carcass weight. He added that grazing was largely confined to daylight for cattle with the onset of active grazing correlated with the time of sunrise. Thus fasting overnight (i.e. 12 hours) in the holding yards was unlikely to seriously affect cattle nutrition and penalise carcass weight (Wright, 1994). The MRDC recommendation of

letting animals empty out for at least fours hours before loading was associated with the prevention of animals becoming dirty during trucking.

5.5.4 Faecal and urinary losses

Stress caused by psychological or physical factors give rise to fear (Tarrant et al., 1993). Fear responses are difficult to predict as they depend on the animal's perception upon handling or previous trucking experience. The reactions of an animal are controlled by a complex interaction of genetic factors and previous experiences (Grandin, 1997). Bisschop (1961; cited in Kenny et al., 1982) described an example of 110 steers of different breeds that were loaded into one railway wagon. 1.5 hours elapsed between loading and departure and the animals became so nervous and restless that they started to defaecate and urinate so copiously that they stood in centimetre deep faecal slush. During the transport most defecation stopped. Probably the group had not had enough time to socialise and complete the formation of a social hierarchy before transport.

Only a few scientific papers deal with the amount of faeces and urine animals produced while being transported. It can be approximated by considering the losses in liveweight. Phillips et al. (1991) looked at the relation between fasting and transport plus fasting and its effects on weight losses for calves of approximately 220kg. Over a time period of 48 hours, he measured a liveweight loss of 8.25%, where 68.3% or 12.78kg were faeces and urine output.

Though animals in transit are deprived of feed and usually of water (EEC are an exception), they continue to defaecate and urinate, often more frequently than normal (Shorthose, 1965). As mentioned already by Bisschop (1961, cited in Kenny et al., 1982), Shorthose (1965) states that defaecation and urination usually occur at a maximal rate in the early stages of the transport and become less as the amount of feed and water remaining in the gut declines. However, faeces are produced during fasts of up to five days,

although towards the end the rates are reduced to 15%-20% of those prior to fasting (Blaxter and Wainman, 1966, cited in Warriss, 1990).

The literature research and various discussions with scientists involved in animal science, farm management and meat technology throughout New Zealand lead to the conclusion that more detailed information regarding the rates of effluent produced by cattle and sheep in-transit was required. The difference between livestock being prepared prior to transport by standing in the holding yards off pasture for four hours or more and animals coming straight off pasture needed to be assessed. It was relevant for the data input of the computer model to become aware about the 'defaecation rate' over time.

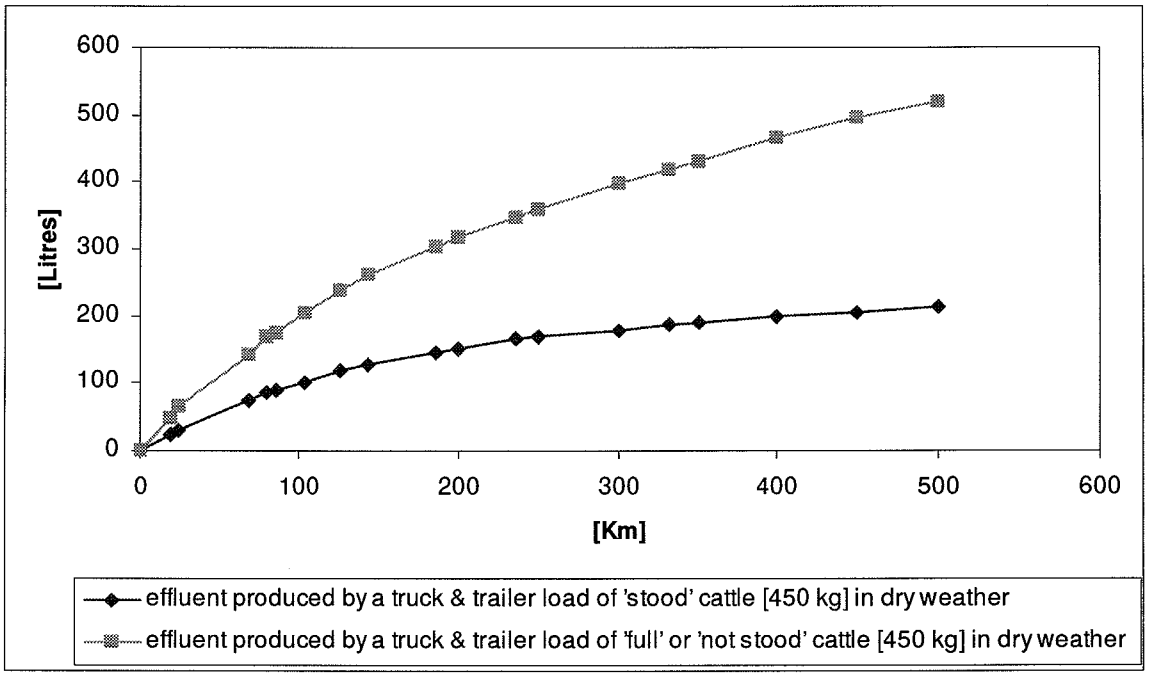


Figure 5.3 Relation between the volume of effluent produced by adult cattle, that were emptied out (fasted for approximately 4 hours) or full and the distance travelled

The graphs in figure 5.3 and 5.4 show the produced effluent collected over the travelled distance. It was difficult to get the cooperation of livestock carriers to

take a researcher on different journeys as they were all wary about the outcome of the project. The measurement of effluent was done approximately every 20-30 minutes in the first 2 hours, and then around 45-60 minutes, depending on the amount measured. Unfortunately, the truck drivers were always in a hurry which did not make this job an easy task. Blocking or leaking holding tank valves were common and did not help speed up the measurements or to make them highly accurate. The curves represented in the figures 5.3 and 5.4 can only be seen as an indication. They have been interpreted in a conservative way and represent a mixture of different animal types (i.e. dairy cows, bulls, heifers, steers), different pastures types and different fasting times (i.e. most farmers were reluctant to talk about the 'standing' time and often gave different answers each time you asked them how long their stock had been off feed), changing drivers, and different seasons.

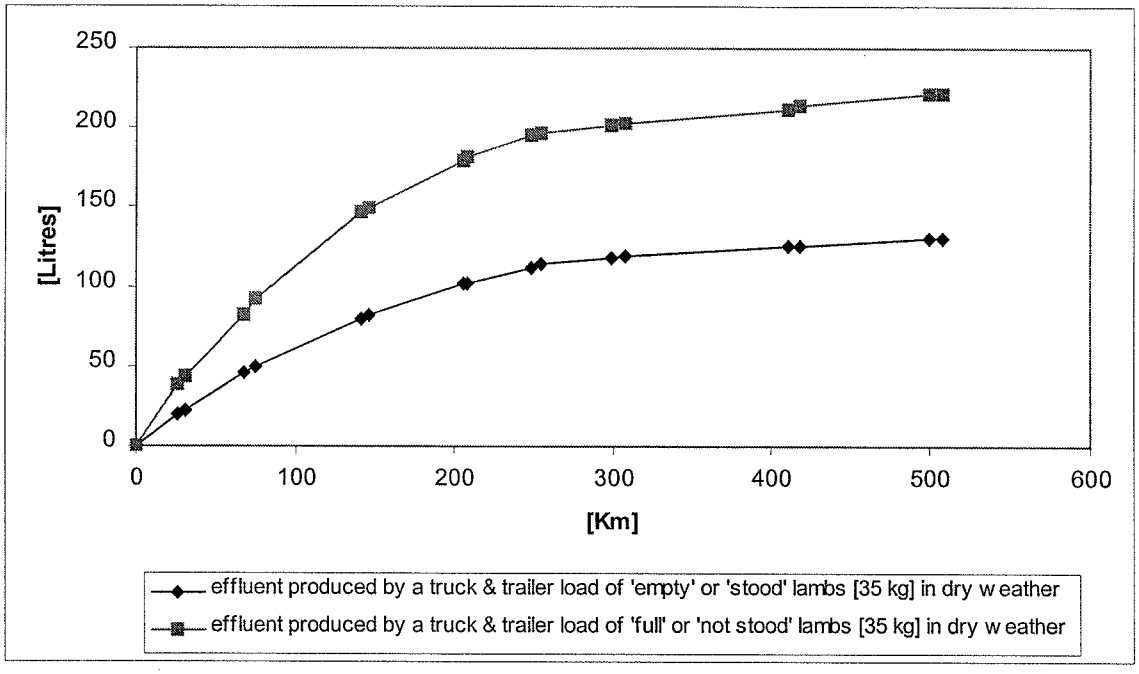


Figure 5.4 Relation between the volume of effluent produced by lambs, that were emptied out (fasted for approximately 8 hours) or full and the distance travelled

Although we were aware that the first few hours of transport were crucial for the results, it was not always possible to get exact details, as in general there were many pick-ups at different locations. As the model was using data associated with distances, the researcher discovered that the overall time in minutes was on each long distance trip (400-500km) correlated exactly with the distance (kilometres). This fact does not tally with short distance trips under 100 km, as the collection of livestock may take quite a while depending on the locations of pick-up. The observation was that the number of pick-up locations increased with the advancement of the killing season. Further details are mentioned in chapter 9.

These graphs show clearly that livestock stood off feed produce far less effluent on the truck. However, the next section on meat quality issues shows a correlation between animal stress and meat quality. The longer animals are off feed, the higher the risk of a high ultimate pH. It also needs to be considered that pasture feed is different from dry feed (i.e. hay or grain). Many stock truck operators told me that there was a huge difference on the behaviour of animals (disturbance in the truck, volume of effluent, bruising) by comparing what feed the stock had been on prior to transport. Feeding animals on hay or grain in a reasonable way with access to water seemed to be beneficial for animal behaviour during the transport. The literature reviewed on animal stress gives a similar view. There is a need for further research to assess and compare different feed types in association with minimising stock effluent and stress and optimising meat quality. In the meanwhile, the recommendation is to advise farmers to stand their stock in the yards prior to transport with access to water and without access to pasture for approximately four hours, and feed them dry hay if they go on a long journey (National Stock Effluent Working Group, 1999a).

5.5.5 Meat quality issues

When steaks on the plate are too chewy, it is often pointless arguing with the cook. The blame lies with those stakeholders involved in the supply chain from

farm to table, unless it is due to the breed. The genetic provenance of the animal and the environmental parameters (physiological and physical components) within the time frame of approximately 24 hours previous to slaughter, are the most relevant factors contributing to the meat quality (Kallweit, 1989; cited in Roeser, 1995). Buchenauer (1994) recommends not to feed or only moderately feed sheep prior to transportation to achieve a better end product. The most powerful stimulus towards improvement in care of stock from the farm to the end-destination comes from the need to avoid financial losses, because it explains the consumers' attitudes towards a product.
With regard to beef quality, Dumont (1981) stated that the consumer was judging quality on *display* (hygiene aspect; freshness; general appearance such as colour, lean/fat ratio, texture; and shelf-life), on *cooking* (drip on cooking, weight loss) and on *tasting* meat on the plate, (texture and tenderness, flavour, juiciness and colour).

Any of the stress factors described in this chapter that may occur prior to slaughter will increase ultimate pH in the meat and will be unacceptable for the consumers. The ultimate pH is an indicator for many factors (MRDC, 1994):

- Colour

The darker the meat colour, the higher the ultimate pH. Some overseas countries such as Japan, have set beef colour standards and do not accept dark coloured meat. Figure 5.5 gives an overview of some effects associated with the meat colour.

- Keeping ability

The keeping ability is reduced in meat with high pH. This is particularly negative for the New Zealand meat industry, as they cannot provide some overseas markets with chilled products (i.e. shipping time to Europe takes approximately six weeks).

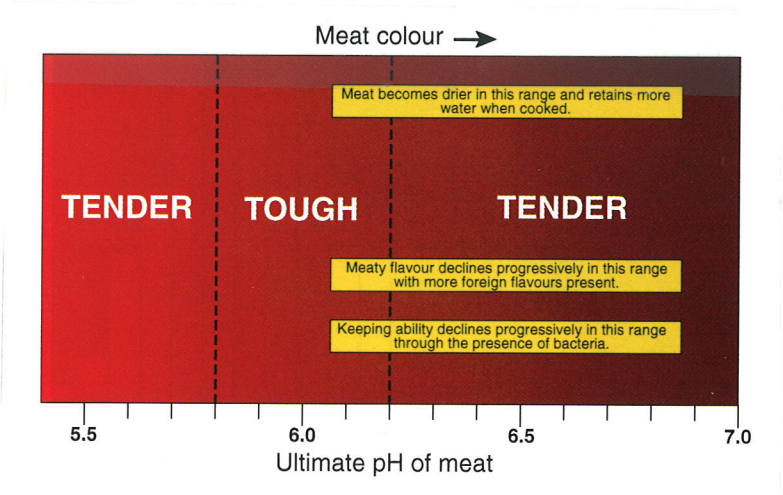


Figure 5.5 Relation of ultimate pH and further effects on the meat colour (MRDC, 1994)

- Texture

Rubbery meat that holds water, making it too juicy when cooked is likely to have a high ultimate pH.

- Flavour

Meat flavour drops as the ultimate pH increases. The meaty flavour becomes less noticeable, as foreign flavours resulting from the cooking process change the taste.

- Tenderness

Meat of low or high pH is tender. However meat with a low pH (5.5 – 5.8) is preferred as meat of high pH is dark, can be rubbery and cannot be preserved for a long period. Tenderness can be measured with the MIRINZ Tenderometer, an instrument that shows a highly significant correlation with the tenderness judged by the general public (Bickerstaffe, 1998). Tenderness is probably the most important criterion for beef judgement, as only tender meat

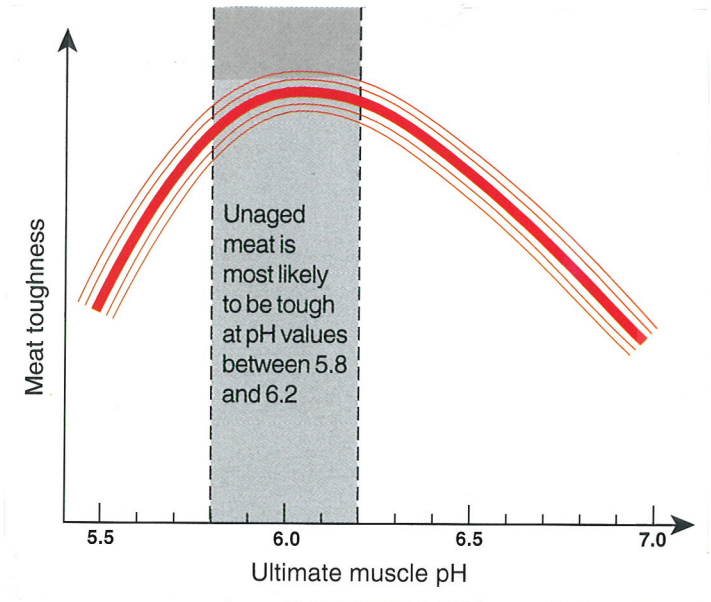


Figure 5.6 Relation between ultimate pH and meat toughness (MRDC, 1994)

In addition to welfare concerns, animal stress can in the pre-slaughter period affect the meat quality seriously and jeopardise the sustainability of a whole industry.

5.5.6 Conclusion

The first few sections give an overview on how the different stakeholders in the supply chain are involved. It has become clear that it is not the responsibility of one single group, as each stakeholder is contributing to the spillage problem. Everybody involved will need to change behaviour, accept responsibility and adopt a cooperative attitude. It needs to become clear that efficient and timely communication will allow the other partners in the supply chain to fulfil their tasks properly and so reduce the problem.

The original goal of this project was to find ways to reduce the production of effluent during transport of livestock. The amount of faeces and urine produced

dry feed), (3) the time they had access to it prior to transport, (4) the level of stress they have been exposed before and during transportation, and (5) the type of animals (dairy cows, bulls, sheep, pigs, deer).

This chapter gave an overview of the different aspects involved with the management of stock truck effluent. The literature review on animal stress, meat quality and weight losses showed that the effect of fasting cattle and sheep prior to slaughter result in a loss of liveweight. The majority of the liveweight loss in the first 12 hours of fasting prior to transport is due to gut emptying. Consequently, animals fasting for 12 hours prior to transport will reduce the production of effluent in-transit dramatically. The carcass weight is not likely to be affected within 24 hours of fasting. However, fasting an animal for 24 hours prior to slaughter will increase the risk of dehydration and the depletion of muscle glycogen and other body energy stores, vital in metabolic buffering of stress responses and determinants of meat quality (Jacobson, 1998). Good quality beef needs to have a final pH value close to 5.5. At pH values of 5.8 and above, both the tenderness and keeping quality of the fresh chilled meat are adversely affected. Stress can be reduced by handling animals well prior to slaughter. A standing time of 4 hours off feed is recommended, and an overall time off feed prior to slaughter should ideally not exceed 24 hours. More research is needed regarding the optimal standing time in association with different feed types.

The question of 'Minimising stock effluent during transport' needs to be rephrased into 'Management of stock truck effluent through optimising animal welfare, producing meat quality of high standards and achieving the protection of the environment' (Thull, 1998a).

6 WHICH METHODOLOGY AND TOOLS WILL LEAD TO A FEASIBLE SOLUTION?

6.1 Introduction

The objective of this chapter is to show how a multi-disciplinary problem can be approached. A classical decision-making model, as described below, is a static process that is not suitable in the case study. It is however an excellent base to which additional features can be added. Social psychology is one of the disciplines (Morrison, 1999).

Social psychology has little by way of tools to offer the study of decision making. But social psychology can contribute as an approach to the study of the decision-making process that specifies in a particular way the social conditions under which decisions are made. The role of social psychology is to provide some insight into factors, needs, and concerns that affect the particular decisions, people make (Hammond et al., 1980). This project, as described in the previous chapter, involves a number of stakeholder groups with different attitudes and perceptions of the problem itself. Multi-stakeholder processes have evolved as a means of ensuring wide public participation in decision making, particularly in rural areas (Pomeroy, 1998). Subsequently to the decision-making process, the innovation or decision needs to be communicated amongst all the members of each stakeholder group (Rogers, 1983).

6.2 Management decision making systems

The next section deals with the more classical system, which can be seen as the basic approach.

6.2.1 Classical decision development

6.2.1.1 Introduction

"*There is a world of difference between making a decision alone and making a group decision*" (Hirokawa et al., 1986). The unique 'chemistry' of social interaction can distil the best that each member has to offer, creating a resonance of ideas and a synthesis of viewpoints. A different 'chemistry' can stop the reaction and contaminate the product with low commitment. Communication is the medium for the coordination and control of group activities and conflict management, to name just a few of its functions. The essence of group decision-making is interaction. "*An adequate theory must incorporate complex, multilevel descriptions of group activities with multiple cycles and discontinuities in the development path*" (Hirokawa et al., 1986). There is also a need to recognise "*the force of unique critical events that can shift the direction of development*" (Fisher et al., 1984). A central feature of this type of interaction is its developmental nature, since all interactions are extended over time, and since its content, flow, and the course change as it develops.

The classical and theoretical framework suggests that group decision-making can best be conceptualised as a series of five or six steps leading to a final group choice. This five step model can be listed as: (1) define the problem, (2) identify alternatives available for solving the problem, (3) the objectives to be met by the solution, (4) the assessment of positive and negative consequences associated with various alternatives, and (5) the decision (Scheerhorn et al., 1986). The six-step model of Hill (1986) inserted a quantifying step after the identification of alternatives and drops the objective step. Hill included the objectives within the definition of the problem. (6) The sixth step is the last step and is called implementation of the decision.

The Scheerhorn and Hirokawa model, seen as schema in figure 6.1, seems to be more a 'learning' model and therefore will be seen as the most appropriate because of its cyclical attributes. The following section illustrates as an

example the general structure of a classical group decision-making model, such as described by Scheerhorn et al. (1986). This model does not allow for feedback to the 'information base' from the 'assessment of situation' or from the 'assessment of positive/negative consequences'. It is also deficient in allowing for interaction between the inner and outer loops. These matters are addressed in the soft systems approach (see section 6.2.2).

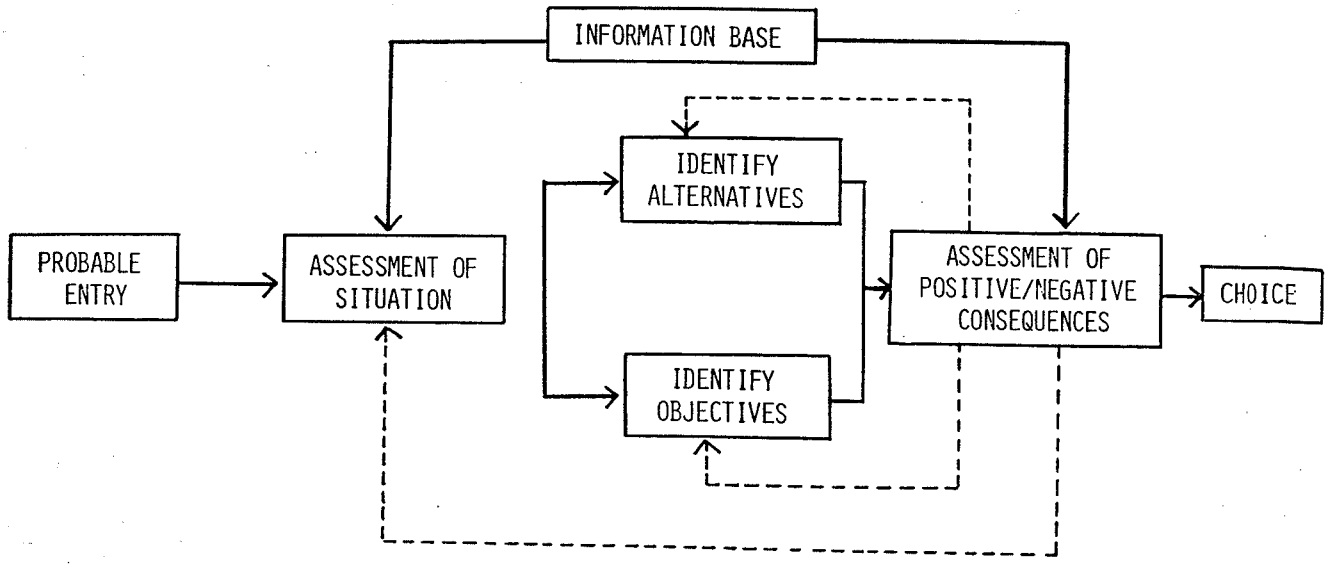


Figure 6.1 General model of the Group Decision-Making Process (Scheerhorn et al., 1986)

6.2.1.2 Definition of the problem

The process begins with the assessment of a problematic situation. To ensure adequate definition of any problem, one should first gather background information in the general area. This general assessment involves an attempt to clarify and/or understand the relevant contingencies and circumstances of the choice-making situation. In attempting to understand the nature of its problematic situation, the group relies on its information base, which consists of data that have been presented to the group by outside sources or its own members. Depending on the problem, the gathering of information can take the form of a literature research, a survey, a scrutiny of data, a visit to the competition, the advice of paid consultants, or an examination of case histories.

There are many ways of becoming informed about a subject. It is relevant to note that not all of the information presented to a group will be included in its information base. On the contrary, some of this information may be rejected by the group on the grounds that it seems invalid or unreliable. It is important to understand that the group's information base essentially consists of data that have been ostensibly accepted by the group.

6.2.1.3 Identification of alternatives

Once the group is satisfied with its understanding of the situation, it will need to decide which course of action to take. It will generally proceed in one or two directions, depending on the general preferences and perceived needs of the group:

- First, the group may **identify alternative courses of action** and examine the set of given choices.

- Alternatively, the group may proceed to **identify relevant** goals or **objectives** that it wishes to achieve through its choice making. The objectives need to be summarised in the terms of reference.

The working group will then try to obtain a general consensus regarding the specific end-states desired as a result of its choice-making process. Additionally, the group may attempt to reach a general consensus regarding the specific negative outcomes that it seeks to avoid as a result of its decision-making procedure. In each case, the identified objectives will be influenced by the group's perception of the issue and/or by the inherent beliefs that group members bring into it. The next step will be determined by the nature of the group's second step. If this involves the identification process of available alternatives, the third step will involve a discussion of the objectives that they are seeking. Alternatively, if the group's second step was to find out the objectives, then the third step will examine alternatives.

Scheidel et al. (1979) defined the step described above also as divergent thinking. The diverging process is described as an activity of searching for and generating ideas. In this mode ideas are developed, analysed, examined, explored, expanded and unfolded. Divergent thinking is a brainstorming and cumulative process with little need to reject or eliminate (Scheidel et al., 1979). Overall, the diverging mode is an arena for creativity.

6.2.1.4 Objectives to be met

The next step is to identify and to assess the positive and negative consequences associated with various alternative choices. Ultimately the workgroup will compare the positive and negative qualities of various alternatives to determine which option offers the best combination of acceptable consequences. Scheidel et al. (1979) called this the converging process that entails a different pattern of thought. It is an activity of comparing and evaluating ideas.

The model also suggests that a workgroup will also rely on its information source and base to assess the effects associated with various alternative choices. The knowledge of previous similar projects may help to determine which positive and negative consequences are likely to occur (Simon, 1976).

6.2.1.5 Assessment of positive and negative consequences associated with various alternatives

In this step, the model suggests that a decision or solution, based on the most acceptable combination of positive and negative qualities, can be achieved. However, the model also indicates that the working group, if not totally satisfied, can go back and try to identify new alternatives or reconsider its objectives, or even may attempt to put those objectives into a particular hierarchy of priorities.

This conceptual basic decision-making model shows the different steps leading eventually to an appropriate final decision. At any point in this process,

misunderstandings can be introduced. These represent potential sources of faulty group decision-making, do not occur by chance or accident. The five most important factors leading to potential low-quality decisions include:

(1) The improper assessment of a choice-making situation:

The clearest example of this type of error is the group that fails to recognise the existence of a potentially problematic situation. Another example is to not identify properly the cause of the problem.

(2) The establishment of inappropriate goals and objectives:

This can happen through neglect in identifying specific objectives that need to be achieved in order to improve substantially or correct the problematic situation. A further example is the selection of unnecessary objectives that may not contribute to any improvement.

(3) The improper assessment of positive and negative qualities associated with various alternatives:

This may occur if the members of the working party underestimate or overestimate the problems or benefits that could result from the selection of such an alternative.

(4) The establishment of a flawed information base

It was indicated above that a group's information base is directly or indirectly tied to all phases of the decision-making process. Therefore, any inaccurate information, whether deliberately or distorted by accident, will contribute to a poor or ineffective decision. This can happen through discarding certain facts, accepting invalid data or collecting too little information to assess the situation properly.

(5) A faulty reasoning based on the group's information base

This may happen through wrong interpretation and utilisation of the information, although the data source may be essentially correct. A group member of high status or authority can, for example on purpose, facilitate the occurrence of

errors by directly convincing the group to accept a faulty belief, perception, or conclusion. Clearly the persuasive influence of one or two group members are able to persuade others to reject a correct assessment of either positive or negative consequences.

6.2.1.6 Decision

Regardless of the problem, the alternatives, or the consequences to follow, once a decision is made, things begin to happen. Decisions trigger action, movement and change. Although the purpose of the stepwise decision-making process is to guide a decision-maker to the best choice, there is no reason why this choice cannot be reversed. If consequences run contrary to the decision-maker's analysis and expectations, the decision itself may be cancelled and the process needs to be restarted.

It needs to be reminded that the process of decision-making is cyclical by nature (Checkland, 1981). Although the workgroup may always wish to press on in a linear stepwise manner, feedback loops and repetition are often necessary. By iterating the sequence of steps in the basic procedure described in the section above, there is a high likelihood that the best decision will be made (Keen et al., 1978).

In order to assure success, the processes need to ensure that all interests within a community have an opportunity to contribute to their long-term development. This whole process is often called soft systems methodology and is described in the following section.

6.2.2 Soft Systems Methodology (SSM)

6.2.2.1 Introduction and definitions

The classical methodology, whose aim is optimising, shown above, fails to address three key issues (Brown, 1997):

- "*First, democracy requires a democratic consciousness*" (Brown, 1997); for instance, the voting system in New Zealand is not just a structure. Rather "*it is built on people's right to participate in decision-making. Democratic consciousness as a right to be involved, is not addressed in the classical methodology*" (Brown, 1997).

- "*Second, the issue of a democratically conscious facilitator is not directly addressed. A structure cannot ensure democracy. A structure also requires the building in of democratic processes and consciousness"* (Brown, 1997).

- *"Third, the issue of evaluating the impact"* of a classical model "*should not be measured solely in terms of productive effectiveness"* (Brown, 1997).

In summary, a classical model eventually meets the structural requirements of a democratic organisation, however it does not ensure a democratic consciousness, as all real-world 'management' problem situations have at least one thing in common: they embody people trying to take purposeful action. Often the word cooperacy is used to describe the "*technology of collective or consensus decision-making as distinct from democracy and autocracy. For democracy to work there needs to be a widespread belief that the best decisions for social organisation are made by the majority. For cooperacy to work there needs to be widespread belief that the best decisions are made by involving everyone affected by the decision* " (Hunter et al., 1997). Cooperacy is of course not new, but not yet an integrated system of thought or a coherent philosophy.

In order to better understand SSM, it is relevant to give first an overview on soft systems thinking (Checkland et al., 1990):

(1) Systems thinking takes the idea of a whole entity (holistic view) that may show properties as a single whole.

(2) Within systems thinking there are two complementary practices. The 'hard' tradition takes the world to be systemic; the 'soft' tradition creates the process of enquiry as a system.

(3) SSM is a systemic and constant cyclic learning process of enquiry.

(4) SSM uses a particular kind of holon, namely a so-called 'human activity system' (i.e. processes of communication and control).

(5) In examining real-world situations characterised by purposeful action, there will never be only one holon, given the human ability to interpret the world in different ways. It is necessary to create several models of human activity systems and to debate and so learn their relevance to real life.

Von Bulow (1989) defined SSM "*as a methodology that aims to bring about improvement in areas of social concern by activating, in the people involved in the situation, a learning cycle which is ideally never ending. The learning takes place through the iterative process of using system concepts to reflect upon and debate perceptions of the real world, taking action in the real world, and again reflecting on the happenings using system concepts. The reflection and debate is structured by a number of systemic models. These are conceived as holistic ideal types of certain aspects of the problem situation rather than as accounts of it. It is taken as given that no objective and complete account of a problem situation can be provided*".

SSM has also been classified as a methodology for debating organisational change, directly impacting on organisational culture as attitudes change in the process of debate (Flood, 1995). SSM is composed of two streams of inquiry, the *"logic driven stream"* or 'hard' system stream, based on institutional arrangements and mental processes, and the *'cultural stream'*, based on organisational culture and politics. Both aim to cover pragmatic real-world thinking and the theoretical systems thinking world (Checkland et al., 1990).

SSM is not just simply a consensus-seeking process. It has started as a basic stream of thinking and debate that was logic-driven (stream of logic-based enquiry). It used the purposeful holons as logical machines that could be used to question the real world. SSM evolved in a way to pay more attention to the cultural aspects of human situations, the aspects that make them specifically human. This new stream was called the 'cultural stream', which interacts with the logic-driven stream. Both are described in more details in the next section.

6.2.2.2 Structure and process of participation

Given that the aim of SSM is to encourage debate, the role of the facilitator is surely important. However, it is not well defined. It could be learning to interact in a skilled manner with other stakeholders or learning to resolve the problem situation. Each statement emphasises different priorities that again require different forms of facilitation, skill and style. One approach is people centred, requiring high levels of *social* skills, the other is issue or system centred, requesting *technical* skills. Although participation is a core principle of the soft systems methodology, there is little guidance on how participation is to be achieved. In summary, because of the lack of principles and guidelines within SSM, the principle of participation is likely to be shaped by the facilitating chairman and organisational body.

The logic-based inquiry begins with pragmatic real world thinking, via discussion of the problem area with those chosen to be involved in the methodology. The process in itself incorporated all the stakeholders involved

in the supply management chain. Right at the start of the project, a Canterbury Stock Truck Effluent workgroup was created (November 1996). The members in this project included Regional and Local authorities, the Meat Industry Association New Zealand, the Road Transport Forum (representing the livestock carriers), the NZ Stock & Station Agents Association, Federated Farmers, NZ Police (Commercial Vehicle Investigation Unit), Transit New Zealand (responsible for State Highways), Ministry of Agriculture and Forestry (MAF quality management), NZ Game Industry Board (quality assurance programme) and finally Lincoln University. The working party was chaired by the Canterbury Regional Council. This workgroup was followed six months later (June 1997) by a national workgroup, including similar members, however at a higher managerial level. This group was chaired by Transit New Zealand. The mutual acceptance of the members within this working group was important as each member needed to feel a certain amount of personal belonging above and beyond the basic need for inclusion (McGrath, 1984).

First, the problem of effluent spillage was analysed through the stream of logic-based enquiry. This process dealt with the problem situation and issues such as the acceptance of responsibility by each stakeholder, possible actions that could be taken (i.e. establishment of effluent discharge facilities, prosecution by the Police of each stock truck spilling effluent on the road). This procedure took place twice, regionally and nationally. However, it was a big advantage to have started on a regional level (area of Canterbury Regional Council) as each stakeholder group seemed more relaxed and open to the analysis of the issue of effluent spillage. It became a steep learning curve for all stakeholders involved, as nobody was really aware of what the other stakeholders were doing and why specific stakeholders reacted in a certain way. This situation of unawareness was a surprise for some stakeholders. Therefore, an unanimous decision was taken (December 1996) to organise a workshop and invite all key regional people involved to listen to the views of others and discuss what actions might be taken. This workshop was held in Mid-Canterbury, in Ashburton in April 1997, just six months after the start of the project. The

workshop was designed to provide information in the form of paper presentations (Heffernan, 1997), (Kissling, 1997) & (Thull, 1997) in the morning. The afternoon was reserved for small group discussions. This workshop proved to be an effective means of exploring the issues to deeper and broader sensitivity.

After an initial investigation of the problem, SSM switches to development of root definitions, which identify and describe the human activity systems, followed by the building of conceptual models. Debate occurs through comparison of the ideal system and action with the actual situation. Participants then negotiate the issue by using a certain decision-making system of comparing 'desirable changes' with 'feasible changes' (Figure 6.2) to decide on further actions to take.

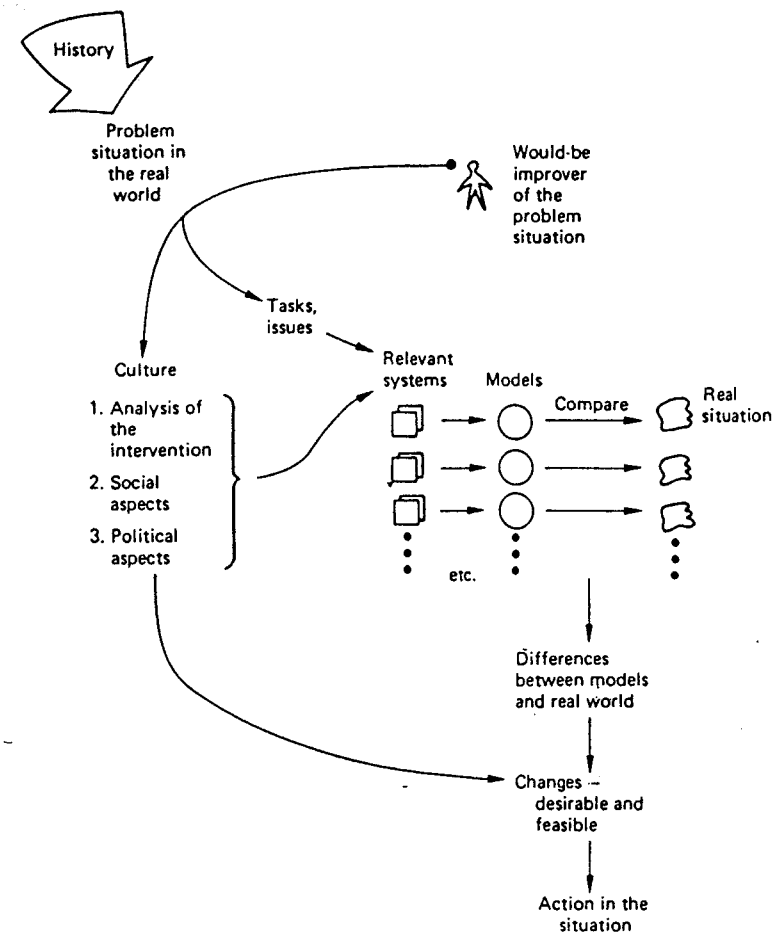


Figure 6.2 Process steps of soft systems methodology (Checkland et al., 1990)

Figure 6.2 helps to understand what is going on in the study and to define further sensible work. Experienced users of SSM are more problem-situation oriented than are beginners. The experienced do not start from the methodology, thinking about it and how to 'apply' it. They start from and stay immersed in the problem itself, using SSM to facilitate the process. SSM is not used to drive the study but to make sense of the emerging experience.

The message from the Ashburton workshop was clear: Everybody admitted that effluent spillage was definitively a problem. More investigation was needed. Lincoln University was encouraged to seek for feasible solutions to minimise the problem. Nobody wanted a heavy-handed approach. Education and the provision of a minimal network of effluent discharge sites were seen as the key means to tackle the problem. The media, such as National television and several South Island newspapers, reported on this event.

The financial factor, being part of the logic stream, emerged as an important issue. The notion of 'standing' stock prior to transport, was associated with advantages for some (meat processors, livestock carriers) and possible disadvantages for others (farmers). Financial disincentives perceived by one party could cause hesitation or even collapse of the whole idea. It became important to seek satisfactory cost solutions and compromises that would gain the confidence of each stakeholder to buy into the process. Governmental institutions were not about to provide an effluent discharge site at each major State Highway intersection, as the capital costs would be unacceptable. Education alone would only reduce, not eliminate the problem.

A combination of education (i.e. better communication and coordination) and a small number of effluent dump sites (assuming each truck and trailer livestock cartage unit will be fitted with effluent holding tanks of 300 to 400 litres within a few years time and those tanks properly used), might lead to an acceptable solution. It is clear that all the changes examined involve costs as well as benefits. Some of these are obvious and easily monitored: fitting storage tanks, and constructing dump sites for example. Others are less quantifiable,

such as the time and commitment of managers, and some are hidden, such as the psychological cost of change and the disruption of an organisation's pattern of behaviour (Keen et al., 1978). These 'soft' costs are not easily converted into hard dollars but it may be highly misleading to ignore them.

Within the **stream of logical inquiry**, all participants may identify possible changes believing that an open and fair debate on all relevant issues has occurred.

The **cultural inquiry stream** runs concurrently with the logic stream. It incorporates three different parts:

(1) The analysis of the intervention in relation to roles

This role analysis, also known in SSM as 'Analysis One' is dealing with the problem owners. There are many possibilities of who is 'problem owner' and who is 'problem solver'. It is worthwhile knowing why certain stakeholders want things to change or why the perception of one stakeholder is totally opposed to a specific intervention. This question of 'problem owner' and 'problem solver' was discussed on a regional level at the Ashburton 'stock effluent' workshop and a second time on a national level, at the first meeting of the National Stock Effluent Workgroup (NSEW) in Wellington.

(2) The social stream considers organisational culture

The analysis of the organisation as a social system studies continual interaction between three elements: (a) roles, (b) norms, and (c) values. Each element defines, and is defined by the others.

(a) *Roles*, which represent social positions

Such a position may be institutionally defined (i.e. CEO of Road Transport Forum NZ; Policy Manager of Federated Farmers; Representative Spokesperson of Meat Industry Association NZ) or behaviourally defined (strong-minded farmer).

(b) *Norms,* which are our expected standards of behaviour.

(c) *Values*, under which performance will be judged.
The values are beliefs of what is humanly 'good' or 'bad'.

All three elements are constantly interacting and changing. There is always the risk of differing values. A certain meaningful perception to a particular culture may not be feasible for another culture. Such a statement implies the potential of a single worldview or culture within an organisation. It is not explained in Checkland et al. (1990) whether this view is assessed by identifying a majority view, or a dominant view related to power.

New Zealand has a long history of land use change, associated with the cessation of government subsidies for agriculture in the eighties and a shift from traditional sheep farming to more dairy farming and forestry. Generally speaking, the whole philosophy has moved towards the export industry and how to provide best services to attract more overseas visitors to New Zealand. This cultural shift is not yet complete in the farming community. The traditionally strong unions have lost power and many associations (i.e. Federated Farmers, Road Transport Forum NZ, Meat Industry related associations) have declining membership. This has happened for many reasons: some farmers became more entrepreneurial and sold their livestock directly to overseas markets. Others found that these producer organisations were not covering their particular needs any more. It took several years for those organisations to readjust their internal management systems and respond to the needs of their members. There are many examples that could demonstrate the social stream influencing enormously a problem such as effluent spilled onto roads. It can never be stressed enough that the listening process is a key tool to loosen tension in a multi-stakeholder process.

The outcome of the cultural inquiry is the identification of culturally feasible changes.

(3) The political analysis

The political analysis considers power to be exchanged within the system. Checkland et al. (1990) state that accommodation of interests ultimately resides with the disposition of power. The question of obtaining, exercising and passing on power is seen as crucial to the choice of root definitions. Checkland said in 1981 that "*power in the process shapes the choice of relevant ways forward*". This means that the dialogical process could be constrained in relation to these inter-subjective problems. So politics can be seen as a power-related activity able to influence managing relations between different interests.

This empowering attitude of specific stakeholders (i.e. representatives of the farming community and livestock carriers) occurred throughout the whole project, however mostly in the first two years and only amongst the national workgroup.

There were two main strategies of intimidation:

- **First**, the stakeholder groups tried to minimise the issue itself or to disapprove a proposed course of action by producing something that was both obviously deducible from it and obviously contrary to common sense. Euclid often used this method, as a proof by assuming the contrary of the thing to be proved, and then showing that it led to an obvious absurdity. Further, they used to shift the responsibilities towards somebody else in the supply-chain or just did not agree to specific actions. Finally, the members of the National Workgroup agreed that the discharge of stock effluent from trucks on roads was *not* 'someone else's problem' but the responsibility of everybody involved.

- **The second tactic** was to postpone actions or just not to complete discussed tasks in time. Adair (1985) mentioned under his section 'the no decision/ no action argument' that often actions get postponed or committees/working parties created to escape the necessity of action

because there are other problems behind the first that will merit attention as well.

In many cases, it was more successful to raise a controversial issue at one meeting without coming to a decision, and then to take a decision the next time.

By accepting the fact that the two streams of logic and cultural inquiry run concurrently as Checkland et al. (1990) propound, the cultural stream, if dominant, could constrain issues being addressed in the logic stream. It is important that political constraints as part of the cultural inquiry stream are included throughout the whole process, in order not to jeopardise the outcome of a feasible decision.

The purpose of a comparison stage, when it comes to implementation of 'feasible and desirable' changes, is to generate debate about perceived possible changes. In practice, debate at this stage frequently draws attention to inadequacies overloaded in the initial analysis of root definitions (i.e. similar to the classical model), that will lead to further work. Much iteration may be necessary to arrive finally at an agreement regarding possible changes. Checkland (1981) notes that in 'hard' systems, the 'change' envisaged, is the creation and implementation of a system. It may also happen for the case of 'soft' systems. Sometimes, appropriate action might entail, such as the implementation of a planning system. In these more nebulous problem situations, the eventual action is generally likely to be less than the implementation of a whole new system.

It took approximately one and a half years to bring the National Stock Effluent Workgroup (NSEW) to agree to an Industry Code of Practice. The Industry involved agreed to accept a self-regulating solution. This comprised the adoption of best practice with sign-in from the stakeholder organisations. These organisations were Federated Farmers, Road Transport Forum NZ, NZ Stock and Station Association and Meat Industry Association NZ. The agreed common code of practice, would, if put into effect, largely eliminate the problem

in New Zealand, if backed by the establishment of a strategic network of in-transit dump sites. This Code of Practice (Appendix 2) is voluntary. Its purpose is to encourage best practice by the different groups involved in the handling and transportation of livestock. This was the second step (after the video) towards a solution.

Checkland (1981) mentioned that there are three kinds of change possible:

(1) Structure

Structural changes (i.e. organisational groupings) are made to those parts of reality which in the short term, do not change.

(2) Procedure

Procedural changes are changes to the dynamic elements: the processes of reporting and informing (e.g. more advanced notice to all stakeholders in the supply chain), verbally or on paper (i.e. 'Stock standing' Certification Card such as described in the Code of Practice). Changes of both these kinds are easy to specify and relatively easy to implement, at least by those having authority or influence. Once made, other not anticipated effects may result from these changes, but at least the act of implementation itself is definite.

(3) Attitudes

Changes in attitude include changes in influence and in the expectations which people have of the behaviour appropriate to various roles. As described earlier on, the hostile attitude of the stakeholders changed as soon as they realised that nobody agreed to a quick fix solution. Politically this was not possible. They agreed that the adoption of modern technology (holding tanks on livestock truck and trailer units) is necessary, as is the encouragement of farmers and meat processors to adopt best practice. Quality management issues have become important for the industry to be sustainable.

Further details are explained in chapter 8 that deals with the evaluation of the pilot educational programme run by Lincoln University. It outlines that such changes will occur steadily as a result of shared experiences lived through people in human groups. They will also be affected by deliberate changes made to structures and procedures. It is necessary to keep monitoring 'attitudes' in order to evaluate 'change' in problematic areas. 'Improvements', if seen, help reinforce positive change.

A study of Oelander et al. (1995) shows that all participants in a waste separation programme tended to become more positive towards active participation, as soon as they had gained experience. This 'experience effect' could have several reasons. The most obvious one is that beforehand, some stakeholders overestimated the trouble that waste separation causes. As one acquires personal experience with an innovation, prejudice and scepticism are replaced by knowledge and acceptance. Attitudes change. An alternative explanation is that once change is implemented, in due course it appears less troublesome to comply. These two explanations are both practical for the adoption of best practice in the stock effluent project.

The two authors above also refer to studies done by Ajzen et al. (1980), Bagozzi et al. (1990), stating that a consistency between attitudes and behaviour can be expected only if the behaviour is self-directed or in other words depends solely on the actor's free choice. The actor needs to command the necessary and sufficient will-power, abilities, resources, and technical means to perform the behaviour.

Checkland (1981) wonders how deeply a stakeholder can understand through debate another stakeholder's view as both will always try to interpret it in relation to their own abstract perceptions and experiences. Therefore, achieving potential change relies on the willingness of participants to modify their views. Such an alteration process is dependent on quality communication.

6.2.3 Implementation

Once a decision has been made, appropriate action must be taken to ensure that the decision is carried out as planned. Implementation needs to be seen as the management of social change, emphasising the dynamics of a process, resistance to change and the need to institutionalise a change-programme (Keen, 1977).

All too often, even the best decisions fail to be implemented due to lack of resources, such as necessary funds, staff, or inadequate supervision of subordinates and employees. Furthermore, regular reports of progress need to be provided to the chairman of the steering group in order to monitor the progress towards the ultimate goal.

It is important to realise that the implementation process is as important as the decision-making system itself. Figure 6.3 shows a six-phase view of an implementation process (Kwon et al., 1987).

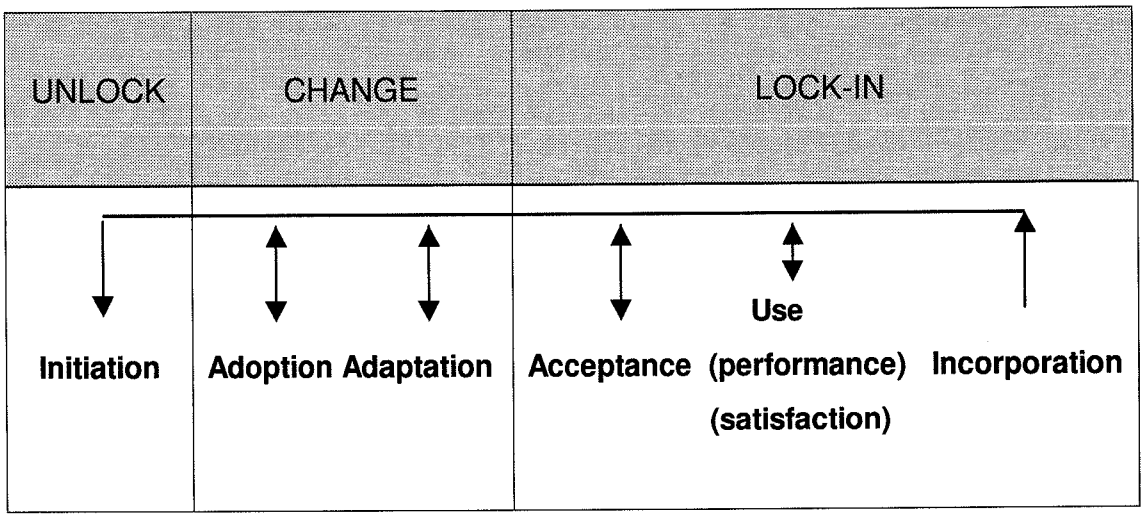


Figure 6.3 A six phase view of an implementation process (after Kwon et al., 1987)

Feedback loops are part of the structure that may act in a positive or negative manner. In extreme cases, positive feedback would result in the full incorporation of a new system, while negative feedback would demonstrate that a wrong decision was taken and further work is required. Often incorporation occurs when the innovation becomes embedded within one or several organisations' routine and when the innovation is applied to its full potential and extent within these organisations.

The working groups, especially the National Stock Effluent working party, endeavoured over thirty months to meet the demands for action, as some politicians and the general public become impatient. On the educational side, an educational video was produced (Chapter 7), a pilot educational programme was tested and evaluated in Canterbury (Chapter 8) and an Industry Code of Practice was agreed by developed the different stakeholder groups (Appendix 2). The evaluation of the pilot educational programme, as described in chapter 8, informs the need for a long-term perspective. The computer simulation model (described in chapters 9 and 10) was designed, tested and applied during a 28 month period to isolate a recommended network of effluent discharge facilities in the South Island. The establishment of such a minimum set of dump sites is vital if stakeholders are to adopt best practice procedures.

The relative success of the first stages of the project (effluent storage tanks on livestock cartage units, dump sites for effluent, introduction of best practice) can realistically only be measured over the next few years. This will require willing and continuing participation by all stakeholder groups, especially the monitoring functions of Regional and District Councils. Evaluation of the pilot educational programme revealed that all participants recognised identifying the vision, the obstacles to achieving that vision and solutions to those obstacles was in itself insufficient.

The next stage involves more collaboration and coordination between the National Stock Effluent Workgroup and various extension agencies to select appropriate decisions. The Working Party needs access to information about

the economic, social and environmental factors relevant to changes (i.e. financial situation of farmers before and after the Code of Practice or practicalities for livestock drivers to empty their tanks in-transit or at destination). The Working Party needs to liaise with suitable extension agencies, and seek for appropriate ways to diffuse efficiently and effectively the recommendations of the Industry Code of Practice. These agencies need experience and good access to rural communities, as community networking is relevant. Potential extension agencies for the agricultural sector are MAF or Agriculture New Zealand. It is recommended to select in each region a certain number of key stakeholders prepared to adopt best practice and to encourage them to participate with the implementation process.

Duncan (1974) identified four major forces that represent the constituent elements contributing to successful introduction of innovations into organisations: (1) individual factors, (2) structural factors, (3) technical factors, and (4) task related factors. Oelander et al. (1995) and Frey (1993) perceive economic incentives as a further instrument for effecting change.

(1) Individual factors

Kimberley et al. (1981) identified that attitude or receptivity towards changes was highly correlated with (a) job tenure, (b) cosmopolitanism, (c) education and (d) role involvement.

(a) Job tenure

A positive attitude to innovations is expected through increased knowledge, while a negative can occur through an individual's bounded capacity. As New Zealand has gone through tough periods (removal of subsidies) over the last fifteen years, the technical knowledge of most stakeholders is at a high level.

(b) Cosmopolitanism

Cosmopolitanism is generally associated with the adoption of innovations due to increased outside contacts and broader perspectives. The widespread access to multi-media (Email and Internet) has increased rapidly over the last

three years in New Zealand (Bridgeman, 1997). This can be seen as a favourable trend encouraging dispersion and adoption of innovations.

(c) Education

Education is related to receptivity toward change. REAPs (Rural Educational Activities Programmes) in New Zealand provide a wide range of educational activities and programmes that play a significant role in addressing the diverse education needs of the communities in which they operate (Anderson, 1997).

(d) Role involvement

Broader involvement in managerial activities and full commitment have been reported to be positively related to adoption of changes (Kimberley et al., 1981).

(2) Structural factors

Structural arrangements influence the introduction of technological innovations (Davis, 1974). A high degree of networking through multi-media and traditional structures (i.e. farmers' meetings such as offered through Federated Farmers) will help an implementation process. In the early days, farmers would come to town on market days and meet in the local pub when business was done. Pubs were tremendously successful places, because they allowed highly meaningful discourse to take place in a convivial atmosphere, which could be called agricultural communication. Bridgeman (1997) states in his PhD thesis on the application of information technology to rural communities that there is a growing interest among New Zealand farmers to access virtual agricultural groups. This kind of information transfer, is more focussed on the exchange of farmers' experiential information rather than just scientific information. This demonstrates clearly how relevant it becomes to integrate the tool of the 'Internet' in a communication and implementation strategy towards best practice in the rural community.

The psychological approach and research of Fazio (1986) illustrates that attitudes based on direct, behavioural experience have been shown to predict

later behaviour adoption to a greater extent than attitudes based on indirect, non-behavioural experience.

(3) Technical factors

Tornatzky et al. (1982) identified three innovation characteristics that were associated with innovating behaviour: (a) compatibility, (b) relative advantage, and (c) complexity.

(a) Compatibility

The degree to which an innovation is perceived as being consistent with existing values and past experiences. The adoption of an innovation is dependent of its compatibility towards the norms of the system. The size of holding tanks on a truck and trailer unit can be given as an example. The limitation of space for fitting effluent storage tanks on a stock truck led to a recommended minimum tank size of around 150 litres (Currie, 1998). This tank size needs to be practical and compatible with the common truck design.

(b) Relative advantage

The relative advantage reflects the degree to which an innovation is perceived as providing greater benefits than the status quo. The meat processing companies saw an advantage in receiving 'stood' and thus clean livestock, as the achievable meat quality may be maintained at a constant high level. Livestock carriers may have less dirty crates to deal with and they will save time and money in the long run.

(c) Complexity

Complexity is related to the degree of difficulty, potential users may experience in understanding or using an innovation. Innovations that are easier to understand will be adopted faster than those that are difficult to understand. Lack of skill and knowledge are probably factors contributing to a resistance towards innovations. Unless a high demand for growth and achievement is required, complexity is likely to be associated negatively to innovations.

(4) Task related factors (social factors)

Task related factors such as (a) task uncertainty or variety, (b) autonomy, (c) responsibility, (d) identity and (e) feedback can stimulate change as well as provide a challenge and meaning to a specific job.

(a) Task uncertainty or variety

It reflects the degree of routine in accomplishing a task. It is believed that simplified and routine tasks are not likely to lead to higher performance and employees are divorced from change and tend to resist change.

(b) Autonomy

A higher degree of autonomy may increase the motivation of staff, idea generation, satisfaction and performance. A positive association to change is linked to growth and satisfaction.

(c) Responsibility

Tasks with high responsibility will create more motivation for staff to accept and to seek work system changes, as they are responsible for sustainability.

(d) Identity

Increased identification with and belief in work may lead to the potential for more innovative behaviours.

(e) Feedback

Feedback is a mechanism to inform individuals on their work performance. Based on reinforcement and learning theory, positive associations are expected between the feedback and the attitude towards innovations (Kwon et al., 1987).

(5) Economic incentives

Within the consumer psychology, several scholars have argued that financial rewards for behaving in a pro-environmental way may destroy the actor's moral or intrinsic motivation, and hence may be counter-productive (Oelander et al., 1995). When the attitude towards a change is based on a moral obligation (i.e. the clean green image of New Zealand or the provision of high quality products for overseas markets), private side-benefits are irrelevant to the attitude. However, incentives schemes (i.e. meat processors introducing a reward for clean stock or a levy on dirty stock) that reward proper and punishes improper behaviour, may reduce the feeling of obligation. Before introducing an incentive scheme, the cooperative, environmentally beneficial behaviour is perceived to be the most successful. The incentive scheme could be dangerous as in the mind of the actor the economic incentive may lead to a re-framing of the behaviour from 'the domain of morality' to 'the domain of economy'. This interpretation would set different goals. On the other hand, it is important to reward an actor to a degree that will acknowledge the adoption to best practice. The reward may strengthen the intrinsic motivation of the actor. However, the crucial point is to remember that an incentive needs to be perceived as a token of approval which will strengthen and not as a payment that will weaken the intrinsic motivation (Frey, 1993).

6.2.4 Time

Bridgeman (1997) and Rogers (1983) identified the 'time' factor as an important element in diffusion of innovation procedures. The innovation-decision period is the length of time required to pass from first knowledge of an innovation, to forming an attitude, to a decision to adopt or reject, to implementation of a new idea, and to confirmation of this decision. The rate of awareness-knowledge of an innovation is faster than its rate of adoption.

The adoption process (cf. further details in chapter 8) may take three to five years (Greer et al., 1997).

6.2.5 Conclusion

Soft system methodology in comparison to the classic scientific method, is an attempt to cope with the kind of complexity associated with natural, human or social phenomena. The way of working in this multi-disciplinary research involving the rural community, was to start with classical 'hard' systems methodology and modify it as it would have failed in situations in which the problems were 'soft' or related to human or social behaviour and traditions.

In summary, any debate about 'change', carried out in the real world, aims at defining modifications that need to meet basically two criteria: They must *systematically be desirable* as a result of the insights gained from selection of root definitions and conceptual model building, and they need to be *culturally feasible* given the characteristics of the situation, and the people in it with their shared experiences and their prejudices. Changes need to be flexible rather than prescriptive to allow full community participation. For this reason, the definition of community needs to be made carefully to ensure that all stakeholders have the opportunity to be included.

In practice, Soft Systems Methodology (SSM) can be used in a light-footed way by having simultaneous action in stages 1, 2 and 3 of figure 6.4, which should always be thought of as an iterative self-generating learning cycle, rather than a prescribed sequence.

The main characteristics are not to see SSM as a formula to be followed but as a sense-making mechanism that may assist the process of creating recoverable and defensible understandings of a complex socio-political-economic situation that can lead to action. This is important as changes, which are both arguable desirable and at the same time culturally feasible, are seldom the result of simple logic.

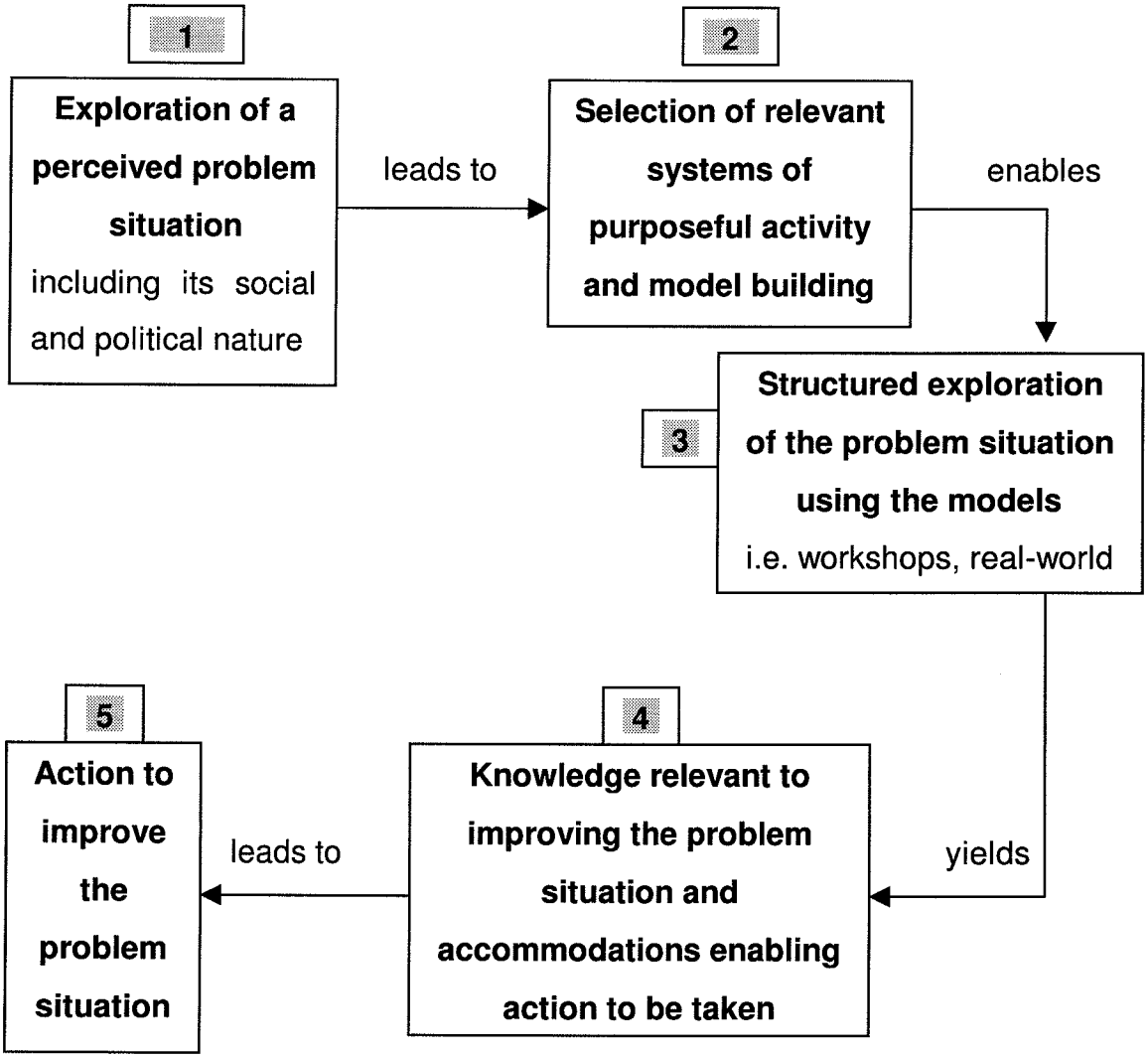


Figure 6.4 The formalised structure of soft systems methodology as a learning system (Checkland et al., 1998)

In order to make a co-operative system work, there is a need for an underlying commitment to reach agreement. It requires listening, really listening – from the heart to the gut. It involves understanding one another's world and validating their perceptions without invalidating your own, which is not always easy. No matter how different are the circumstances, the skills, the education or social backgrounds of the stakeholder groups, it will require honesty and non-manipulative processes. Such processes involve commitment and hard work will never be over. It is a journey, a learning curve, and an exploration without a final destination.

It is important to emphasise that SSM, as a methodology, needs to be adapted by its users both to the demands of the situation they face and to their own mental modes and casts of minds. Every user will have to learn their way of approach with which they will be comfortable. There will not be two users applying it in exactly the same way.

Soft system methodology (SSM) is a relatively new technology of decision-making that can be applied in many management areas at each stage (from the definition of a problem to the implementation process) seeking for positive opportunities to enhance human growth and consciousness. Soft systems methodology will not appeal to dictators. It will appeal to all those people in any discipline, who are knowledgeable enough to know that there is much they do not know, and that learning and re-learning is worthwhile.

7 EDUCATIONAL PROGRAMME

7.1 Introduction

The analysis of the problem on stock effluent spillage from trucks had two clear outcomes at the Ashburton workshop in April 1997 and its requirements were:

- An educational programme encouraging best practice among all stakeholders involved.
- A minimum network of effluent discharge facilities throughout the South Island.

The basics of the educational programme are discussed in this chapter while the evaluation of a pilot test educational campaign is the topic of chapter eight. It is important, at this stage, for the reader and perhaps potential initiator or facilitator of similar projects to be aware that it is crucial at each step within an educational process involving the desire for human behavioural change, not to be in any way prescriptive. A facilitator or person in charge of 'pushing' towards systems change can propose feasible ideas. Unless those ideas become the suggestions of the relevant stakeholders themselves, they will hardly ever be promoted or adopted.

7.2 Methodology

Sarason (1991) mentioned that no 'educational enterprise' will ever work if one of the major stakeholders is absent or banished to a secondary role. It is important to achieve an 'active partnership with the community' and 'celebrate change but affirm tradition'. These two mission statements fit well with the definition of soft systems thinking. He also brought up a novel allegation that affirmed that a further goal is to engender and sustain in communities a desire "*to continue individual growth, pursue knowledge, develop aesthetic sensibilities....by providing challenging programmes*". Soft systems

methodology (SMM), as discussed in the previous chapter, permeates much of the thinking in this project, even if not mentioned explicitly at every stage.

7.2.1 Scoping phase

As a preliminary to setting in place an educational programme for this research, similar projects within the rural community in New Zealand were assessed. The Ministry of Agriculture and Forestry (MAF), the NZ Game Board Industry, the Injury Prevention section of ACC (Accident Rehabilitation & Compensation Insurance Corporation New Zealand) and the New Zealand Dairy Board, just to list a few examples, have run educational projects. Compared to written material, videos had been found to be rather successful in the farming community (Kelly; Tacon, 1997). It is however, a difficult and expensive task to measure the degree of impact of any programme with precision. Whilst a video may be seen by many stakeholders (i.e. farmers, stock agents, livestock carriers...), it takes a long time, probably several years, to have them change behaviour and adopt better practice.

7.2.2 Quality of the message and medium

The next step was to watch and assess some of these videos to perceive the quality of the messages portrayed. A quality video production including a companion brochure was seen by all stakeholder representatives as an excellent tool to encourage best practice. For this to occur, a draft script was needed. The members of the National Stock Effluent Workgroup (NSEW) all agreed to a high professional quality standard, which required some research up front, especially regarding new multi-media technology and the benefits of digitised equipment.

NSEW accorded highest priority to an educational programme from whatever funds could be secured. With NSEW support, Transfund provided the funds to commission a 13-minute high quality educational video. Transfund is a main New Zealand funding agency for R&D projects associated with roading.

7.2.3 Role and aim of the educational campaign

If current practice in the transport of livestock is to continue without modification of attitudes and behaviour, the number of discharge sites required to reduce spillage on the roads is greater than most authorities will countenance for capital funding and on-going operating costs. For this reason, much store was placed in an educational programme to encourage best practice throughout the whole supply chain to minimise the problem. It was also made clear by the stakeholder representatives that the message in the video needed to be absolutely positive, else it would not capture the attention of the target audiences.

Both, the National and the Canterbury Stock Effluent workgroups agreed on presenting the video and its associated brochure to various stakeholder groups in the Canterbury area over a limited time (June 98- October 98) as a pilot project to assess its impact. If the reaction was positive, the educational campaign could be taken nationwide.

It was clear to all members of the working parties that the problem was not going to be solved overnight. Resources are required to run this programme over the next few years, otherwise the effort expended so far, is likely to be wasted.

The following case could be seen as a bad example: A few years ago, New Zealand was running an extensive educational programme on advising people of the danger of UV radiation. However, over the last twelve months, only a few people talked about this issue. Does that mean, New Zealand is no longer facing the problem of an ozone hole in the atmosphere?

A good example of an efficient educational extension programme was the HIV awareness programme in Europe encouraging people to practice safer sex. This campaign started around 1985 in a rather scary and unpopular way as a threat to the general public. This educational programme was intensified in a

positive and explicative way over the years, so that none could escape being confronted at one or another stage with the fatal problem. The message was wrapped in many ways and adapted to many circumstances, such as cartoons or plays to access schools teaching at different age levels. This excellent example demonstrates how important it is to run such programmes in educational institutions themselves. This way, students will learn and adopt best practice from the outset.

As described in the previous chapter on soft systems thinking, new details will have to be dealt with in a learning curve during the implementation of the programme. As long as this progress towards best practice is continuing, the prospect of achieving around 75 percent of farmers to 'stand' their livestock off feed in the holding yards for at least four hours, is promising. But along the way, there will be new, not yet identified, problems that will need solutions derived from further stakeholder working parties. These groups need not necessarily to have the same members as the original groups. They will more likely be composed of specialists in the implementation of rural extension programmes.

7.2.4 Industry Code of Practice

The members of the National Stock Effluent Workgroup (NSEW) worked on a combined voluntary Industry Code of Practice (Appendix 2) for nearly two years. The process started with the draft script for the video film and its associated brochure. The pamphlet (Appendix 2) was designed as a handy take home summary of the message in the video. The move towards adoption of best practice along the whole supply chain required quality communications in order to build up confidence relationships with and within each stakeholder group. The final version of the code sets out a positive way to convey the message that the problem of effluent spillage is *not* 'someone else's problem', but it is the responsibility of everybody involved. The Code contains two different sections: the first gives an overview of its purpose, the responsible parties, and the benefits of being involved in best practice. The second section

outlines the responsibilities of each stakeholder group (i.e. farmer, livestock carrier, meat processors, saleyard operators, stock and station agents, and territorial authorities) and seeks to assist those stakeholders better understand the purpose of this educational programme. The Code has also been designed to increase the confidence building process for all stakeholders.

The NSEW is hoping that this voluntary code of practice including a new 'livestock standing' Certification Card or Declaration Card will be in place for the start of the new livestock season in 1999. The role and format of this new Declaration Card has been discussed by the Meat Industry Standards Council involving Meat Companies, the Stock and Station Industry, Federated Farmers, MAF, the Animal Health Board, the Meat Board, and animal Remedies Companies since the release of the new code. The main focus of the new declaration card will be the time factor (i.e. time taken off pasture/feed, time arranged for stock pick-up, actual time of pick-up, time arriving at destination) to improve better coordination, communication and also animal welfare.

7.3 Video production

The total time involved was about nine months (October 1997-June 1998). The process could be split into the following steps:

7.3.1 Development of the video script (Oct 97-Feb 98)

The development of a draft video script and its presentation to the working parties and regional and local authorities for further discussion started in October 1997. In the early stage, only a few stakeholders were prepared to collaborate while others still appeared to hope that Lincoln University (LU) would not find the funding resources in time. As the video was originally destined as a pilot video for Canterbury, it was important to reach an agreement first with the Canterbury Stock Effluent Workgroup (CSEW). In a subsequent step, the national workgroup was consulted. Some members (i.e. Federated Farmers and Road Transport Forum) were concerned that their

industry would be seen in a negative light and refused to collaborate on the development of the video script. To solve this disagreement, LU offered the responsible leaders of the industry the opportunity to comment themselves in the video and to give their view of their industry on the problem of stock effluent spillage. This allowed each stakeholder group to express their individual feelings and perceived constraints. LU agreed not to film or mention any of the current bad practices, in order to produce a positive video, aiming for a win-win solution. This process took a few months and the video was in jeopardy at each meeting or exchange of ideas. This was probably the most testing time of the whole project. The reaction of the Industry leaders was nevertheless totally understandable. They were representing their members. They were wary of any outcomes that might increase the costs or interfere with the work practices of their members. Even so they realised that a behaviour change could contribute towards the sustainability of the supply chain management system for the New Zealand meat industry. Accordingly they agreed to play their part and self-script their sections of the video. Such a process was not the norm for the professional video production unit contracted to produce the video.

7.3.2 Choice of a video production company

From the outset, a select number of nationwide video and film production companies experienced in educational matters were contacted and consulted if they were interested in quoting on the video project. Before the specification for the video was completed, Lincoln University (LU) received agreement on a research grant from Transfund, specifically aimed at the educational component of this research. It covered the video production. One of the funding conditions was that the chairman of the NSEW (Mr. Robin Odams, Regional State Highway Manager of Transit New Zealand) had to be involved at each stage of the project. His critical assistance and management experience contributed towards the success of the whole project. Transit New Zealand also helped with the evaluation of quotes. Two companies were invited to elaborate and discuss details. Finally, the Christchurch based film

company '*Orly*' was chosen to produce the video (Christmas 1997). From then on, *Orly* productions became fully integrated in the script elaboration process.

7.3.3 Difficulties around the video production

The process to have each stakeholder willingly participate in the video script and brochure layout, needed far more time than originally planned. It was not an easy task to find appropriate locations and stakeholders (i.e. farmers, stock cartage firms, and stock truck drivers) for the video. Each individual had to be informed personally and made comfortable with the idea of becoming an active player in the video.

This personalised integration in the process was time consuming but necessary. It was frustrating when people, still confident the night before, rang up at 6:00 am to inform me that they were not prepared to cooperate anymore. These withdrawal situations made the video production schedule difficult and required frequent and quick reactions. The communication network that had been nurtured since the start of the project (approx. sixteen months) became useful in such cases.

Before releasing the final version, the representatives of each stakeholder group had the opportunity of viewing the video and commenting on the various statements and scenes. This participation increased the work for everybody involved. However, it guaranteed the full acceptance of the final product. The possibility of some participants requiring last minute changes to the video, influenced the choice of a video company to one using the latest digital equipment.

After completion of the video shooting, we had progressed to the stage of having a strong commitment to change from leaders of stakeholder groups. The video was a start to the educational process. Its production helped leaders converge on the theme of coordination and cooperation for mutual benefit. It

meant those same leaders became advocates for the cause. Without their positive participation, the project would have died.

7.3.4 Video: role and various statements

"*The Answer*" to the problem of effluent spillage from stock trucks is in fact a video of that name, and accompanying pamphlet (Appendix 2), produced by Lincoln University's Transport Studies Group in association with the National Stock Effluent Workgroup (NSEW). The 13-minute video was supposed to heighten the awareness of the problems, to promote solutions and self-regulation; to encourage cooperation, coordination and confidence building among stakeholders; and to promote quality management throughout the supply chain from farm to table.

The video starts with a voice over acknowledging that there was no coordinated system in place and no one who owned the problem. Those speaking on the video, included farmers (**Peter Roberts** & **Mark Houston**), a farmers' association representative (**Tom Lambie**), transport operators (**Frews** & **Woodley's Transport**), stock truck drivers (**Brendan Smart** & **Gordon Phimister**), a transport operators' representative (**Tony Friedlander**), a NZ Meat Board director (**Alan Grant**), a Stock and Station Agent representative (**Denis Hazlett**), scientists (**Professor Roy Bickerstaffe** & **Jean-Paul Thull**), Local Government representatives (**Ian McChesney** & **Robin Odams**), and a restaurateur, farmer, meat exporter and previous NZ Meat Board director (**Brent Rawstron**).

Ian McChesney from the Canterbury Regional Council was the lead speaker: "*Stock truck effluent problem first came to our attention through the Regional Land Transport Strategy (RLTS) process. We received a number of submissions from the public and from interested parties, for us to do something about it. In looking at what was appropriate, it was quite clear that a heavy handed approach was not warranted at this time because there simply is not a system set up in place to deal with the problem.*"

Robin Odams, as a representative of Transit New Zealand and the convenor of the National Stock Effluent Workgroup (NSEW), gave the following comments among others: "*As a road controlling authority, we are very concerned about the safety and environmental aspects. Accidents have occurred as a result of effluent on the road, safety is paramount. Also the environmental effects are a concern on arterial roads and in urban areas.*"

The spirit of the approach to the problem was expressed by North Canterbury farmer *Peter Roberts* - "*We know that this effluent is a bit of a problem but I feel that we don't need legislation to remedy that. I think that we need education and cooperation, especially among the stock firms, the drafters, the freight companies and the farmers.*"

Crucial to the 'standing' and 'emptying out' of stock is careful attention to time-tabling from the on-farm presentation, selection and collection of animals to their off-loading at destinations.

Tom Lambie, the current National Vice-President of Federated Farmers said much the same: "*The result, we would like to see from the farming community's point of view is a 'win-win' situation for everyone in the industry and the general public. We see that with a good, well coordinated planning regime we will be able to confidently stand stock in order to prepare the animals properly for transportation to their final destination. The 'win-win' situation comes with us being able to minimise the amount of effluent that needs to be captured by the transport industry on the trucks and also reducing the possibility of any spillage from those trucks on to the roads. We also see that there is a real advantage in supplying an animal which has a minimal stress level and therefore we are supplying a better product, particularly to our end users in the form of the meat processing companies.*"

Denis Hazlett is the president of the New Zealand Stock and Station Agents Association. He said: "*Stock agents such as we know them in New Zealand, play an important part in the communication, helping farmers, transport*

operators, meat companies understand the need to be prepared or preparing animals for transport, to have them empty prior to transport by being given plenty of notice to ensure that when on the road this problem, we are confronted with, is minimised."

Temuka farmer *Mark Houston* said: "*Success is really dependent on stock companies and stock agents giving farmers plenty of notice. There is nothing worse than being rung up at the last minute to get stock in, especially at night.*"

NZ Meat Board and Canterbury Meat Packers director *Alan Grant* made the same point: "*Timing and confidence are central to the matter. It is up to the sections along the processing chain to arrange the timing so that the farmer can have the confidence to put his stock into his yards, empty them out for the required time and be sure that carcass weight loss doesn't occur so that the product is of optimum quality when it is processed.*"

Starting with the problem of effluent on the road, it had been looked at a way to come up with something that would benefit everyone, right down to the consumer of meat. Indeed it just might be that in the end, the consumer will provide the ultimate leverage in ensuring a solution to the problem.

As beef exporter and restaurateur *Brent Rawstron* of Rossendale Wines, Christchurch, said on the video – "*Consumers are demanding quality, particularly in terms of tenderness and palatability. If they are not satisfied with the quality they are getting they can easily choose pork, pasta or poultry as alternatives. A major determinant in creating the pH or creating an animal with a pH level is how farmers handle their livestock in the last 48 hours before they are slaughtered. A lot of reasons and a lot of the ways that farmers can lower the stress level on those animals, is to truck and handle those animals carefully and therefore getting a lower level of pH.*"

Through the work of scientists such as *Dr Roy Bickerstaffe*, Professor of Food Technology at Lincoln University, it is now known that low-stress handling of stock in the 48 hours prior to slaughtering is a major determinant in creating an animal with the right pH level to optimise tenderness. He said: " *Best practices*

do indicate that four hours off the paddock prior to transport is a minimum time, six hours to nine hours transport is probably a maximum time, and an overnight fast of around twelve to fifteen hours is the normal practice. An overall time of twenty-four hours is ideal. If you start exceeding that time, you will have an effect on the quality of the meat that comes from the carcass."

The researcher mentioned in the video that Lincoln University (LU) was participating actively to this study and that LU was in charge of creating a computer simulation model to find an ideal network of dump sites for stock trucks in transit on State Highways. Some initial information on the volume of effluent produced in transit by full or empty cattle was given as an indication.

The view of the transport industry was represented by **Merv Frews** (company director) and two livestock truck drivers (**Brendan Smart** and **Gordon Phimister**).

Merv Frews gave his concerns regarding effluent spillage: "*We as an industry have nowhere to dump our effluent once we have saved it. Unfortunately, this is where you see the case where it can spill out of trucks as they go along the highway.*"

Bredan Smart (Frews Transport) described the problem similarly: " *Loading full stock on the truck leaves me with the problem of effluent. Once my tanks are full, I have a problem of getting rid of it. I either dump it on the side of the road which looks really - not too flash - or the other option is, leaving my tanks open.*"

Gordon Phimister from Woodley's Transport talked about his advantages of carting empty stock: "*The emptying out of stock is quite beneficial to us in the fact that we end up with crates that are kept a lot cleaner and don't have to look for stop-offs for emptying effluent so often. It also means that we can get the stock off to the works in a lot more tidy conditions and much more presentable.*"

The final part of the video was reserved for concluding statements to emphasise the fact that all the stakeholders had to assume their part in the overall responsibility. If one link in the chain between the meat processing companies, the stock agents, the transport companies and the farmer was broken, no significant change would ever take place.

These allegations were made by **Tony Friedlander** (Chief Executive Officer of the Road Transport Forum New Zealand), **Tom Lambie** (Vice-President of Federated Farmers), **Alan Grant** (Director of Meat New Zealand) and **Ian McChesney** (Manager for Transport and Environment at the Canterbury Regional Council).

Tony Friedlander said clearly: "*As an Industry, the livestock carriers undertake to operate clean trucks with effluent tanks fitted and used. We undertake to collect livestock on time at the agreed time and we undertake to exercise professional care of those livestock in transit. But on the other hand, we want cooperation from other sectors of the industry. We want farmers to ensure that livestock are stood and emptied out, before they are transported. We want reasonable notice of livestock cartage requirements. We want the livestock to be available on time. But most important, we want all people to understand that the stock effluent will be delivered with the livestock. In other words, there must be effluent disposal facilities at the point of destination of livestock.*"

Tom Lambie encouraged the viewers by adding: "*We have a real interest in making sure that the communications within the industry allows farmers sufficient time to prepare their stock for transportation to the final destination*".

Alan Grant gave a summarising view on the role of this video: "*The aim of this video, is to ensure that all members of the production chain are aware of the problems and constraints that the others face. Because what we all want to achieve, is a high quality product which is marketable on world markets.*"

Ian McChesney finalised by saying: "*We are very supportive of the cooperative approach being taken by all stakeholders in the industry. But clearly, we also have some expectations that within a short space of time, there will be some solid solutions emerge from this process. We also expect that through this process, all stakeholders will understand the nature of the problem and understand their responsibilities to be part of the solution. What we are looking for of the industry from this process, is a system that is essentially self-regulating and self-policing.*"

The final voice over concluded with the following words: "*Environmentally, we can avoid, remedy or mitigate stock effluent from stock transport vehicles spilling on roads through clearer communications and better logistics, resulting in an improved animal welfare, consistent high quality, and enhanced customer satisfaction.* ***It's time to make a choice and the time is now.***"

7.4 Conclusion

This chapter dealt with the practical approach of getting the educational programme started. It gave an overview on the proceedings and the difficulties involved. The inclusion of each stakeholder group in this process was relevant for the success of the project. It was not an easy task to encourage the relevant people to become and remain active in this process aiming for changes in the rural environment.

The video explained that every member along the supply chain had an opportunity to influence the others towards better practice. The message was clear: effluent spillage was no longer tolerated and every stakeholder needed to become aware that this self-policing concept was an opportunity to avoid legislators hitting everyone over the head with various enforcements.

Figure 7.1 Video cover picture

While the educational programme, spearheaded by the video and the pamphlet, would encourage all stakeholders to reduce the overall volume of effluent collected, there remained an acceptance that some effluent would still have to be delivered with the livestock at the point of destination or discharged in transit.

The video, the brochure and the Industry Code of Practice taken together are the right step towards a self-regulating solution. It is up to other stakeholders to join and make the system work. Funds will be required to facilitate a nationwide educational campaign, run in a professional way. Nevertheless, there was still the requirement to assess this pilot educational programme to analyse potential concerns in order to avoid them in the future. The next chapter deals with the evaluation of a test programme, run in Canterbury. The

picture shown above in figure 7.1 is taken out of the video and was used for the cover of the video box.

8 EVALUATION OF PILOT EDUCATIONAL PROGRAMME

8.1 Introduction

The primary purpose of this pilot educational campaign was to assess the attitudes of relevant stakeholder groups regarding livestock preparation prior to transportation and the likelihood of future behavioural change. The target stakeholder groups were:

- Farming community (cattle & sheep farmers)
- Stock & station agents (independent & meat processing company employees)
- Meat processing companies (management)
- Sale-yard operators
- Stock cartage firms
- Road Controlling Authorities

8.2 Background

Prior to any nationwide educational campaign being implemented based upon the Lincoln educational video, it was important to evaluate first the current attitudes and behaviour of stakeholders in a restricted test area. This would allow open dialogue and honest feedback. It would enable any problems to be corrected prior to any national campaign. Mid-Canterbury was chosen for the following reasons:

- The specific area had already been surveyed regarding stock preparation before transportation in a six month period in 1997 (cf. section 8.5.1, tables 8.1 & 8.2).

- Mid-Canterbury has a range of different farming systems (i.e. cattle & sheep farming, mix crop/stock farming).

- The researcher had established a network of contacts, which could help initiate meetings with specific stakeholder groups to present the educational pilot programme.

- The subregion has an extended variety of stock cartage destinations:

  - Several export meat processing plants represented by three plants of PPCS (Primary Producers Cooperative Society), one Alliance and one Canterbury Meat Packers plant
  - Two domestic abattoirs (i.e. Ashburton & Malvern Abattoir)
  - Two big sale-yards (Christchurch & Ashburton/ Tinwald)
  - Farm to farm movement for store stock

- A Workshop on 'Stock Effluent Spillage from Trucks' was held in Mid-Canterbury (Ashburton) in April 1997.

- The regional media were supporting the project by updating the general public on a regular base.

- Involvement of the Canterbury Regional Council.

- Involvement of the National Stock Effluent Working Party (NSEW).

- Lincoln University is located in Mid-Canterbury, which enabled short travel distances to meetings.

Although Mid-Canterbury was originally thought as being a restricted pilot investigation area, the video was presented at one meeting of the Road Transport Forum in the North Island. Such an exposure was considered unlikely to influence stakeholder groups in the test area.

8.3 Objectives of the educational campaign

The purpose of this educational campaign was to focus on the issue of stock effluent spillage on New Zealand roads; the impact on the concerned parties (i.e. general public, regulators and Road Controlling Authorities) and on their current and possible future response.

The Lincoln video on Stock Effluent from Trucks, was aimed to:

- Heighten awareness of problems and constraints faced by each stakeholder group.
- Promote industry led solutions and self-regulation.
- Encourage all stakeholders to interact through

  - Communication
  - Cooperation
  - Coordination
  - Confidence building
  - Acceptance of responsibility

- Encourage Quality Management throughout the Supply Chain (from Farm to Table)
- Capitalise on the experience of industry leaders as agents of change.

8.4 Role of stakeholder groups

As described in a former chapter, the issue of stock effluent spillage is such a complex problem that individuals cannot solve it on their own. The stakeholders had to be recruited to act as active and responsible participants becoming part of a team that owned this issue as a team project, similar to the following statement: "*The success of the New Zealand America's Cup campaign in 1995 was attributed to the sailors' involvement in the design of the boat and in operational decisions. This enabled the crew to feel they were sailing their 'own' boat*" (Hunter et al., 1997).

To achieve all these goals, a structure was required. All team members or stakeholder groups had to be willing to co-operate, to have a chance for input into a clear collective action plan and finally to agree to it. The team needed to be in constant communication all the way through the pilot educational campaign. It was important to ensure that the Lincoln video was presented to all stakeholders' groups, as their expertise needed to be captured. As a pilot programme, it was crucial that each participating group was able to express and share honestly its concerns and to encourage a universal commitment to communication.

The stakeholders involved could be split into two groups; the self-employed individuals such as farmers, sale-yard owners and owner-drivers and the employees working for companies, such as Stock & Station agents, Meat plant employees, and Stock Truck drivers.

Most stakeholders were grouped in associations. This enabled relatively easy access to their members, as the leaders of these associations had earlier become involved in the National or Regional Stock Effluent Workgroups. Some associations issued invitations to the researcher for the Lincoln video to be presented at their annual meetings, others organised special venues. In order to gain acceptance by a specific group (i.e. Federated Farmers), it was crucial that the exercise was introduced by a respected representative of that organisation acting as a facilitator. This was possible since cooperation was assured from earlier networking, as described in earlier chapters.

The stakeholder groups invited to assist at this stage, needed to be approached in similar fashion to the set up for the first workshop in Ashburton. The process of change may lead to chaos and conflict situations. They are a necessary part of the change process and movement towards agreement. Therefore it was important to create an atmosphere of shared responsibility and relationship building at these presentations. As these meetings were held at any one time with only one specific stakeholder group (i.e. livestock carrier group), the issue on stock effluent spillage needed to be explained carefully in

order not to lose the attention of the group, as some may see it only as another group's problem.

The purpose of these initial educational meetings had two specific goals:

- To establish contact with the stakeholders themselves to encourage collaboration, a basis for resolving conflicts. Communication and openness were essential to gain their confidence. It was necessary to listen to explanations of their work procedures and operational constraints before proposing a strategic plan that could benefit them.

- To assess the current operational behaviour and willingness to change behaviour after viewing the win-win solution for supply chain management as seen in the video.

8.5 Evaluation process

The evaluation process was split into two separate phases by assessing the current behaviour and the stakeholders' attitudes before and after the video presentation.

Questionnaires were used to evaluate these two phases. As each stakeholder group was linked at a different part of the supply chain, the design of the questionnaires had to be developed carefully in order not to upset the different parties involved. These precautions resulted in specific questionnaires customised for each stakeholder group. The expected outcome focussed on the evaluation of two specific ideas: on the one hand the surveyed stakeholders were asked to answer by 'yes – no –no comment' to obtain data that could be analysed in a statistical way. On the other hand, they were challenged by free line space to comment in their own words how they felt about the issue and how they saw themselves contributing in a productive way to the improvement of the situation. This stakeholders' input was relevant for a successful assessment of the educational programme. This was important, as

behaviour change does not necessarily correlate with knowledge. All constraints stakeholders saw arising from potential changes need to be analysed.

8.5.1 Current behaviour practice and attitudes before the video

To obtain a realistic picture of the status quo situation, it was necessary to establish to what extent livestock were currently 'emptied out' prior to transport. An initial approach to the farming community clarified that it was not possible to obtain an accurate assessment of 'standing' or 'emptying out' stock. The livestock carriers however, dealing on a day to day basis with the carting of cattle and sheep, were in an ideal position to monitor the situation. The livestock carriers realised that this project, driven by an independent party, such as a university, was likely to have a more objective outcome compared to previous attempts to deal with the issue of effluent spillage.

By considering the Kolb-Frohman 'model of change' (Kolb et al., 1970), which indicates that if personal, professional or political trust, mutual understanding and respect for each other's needs and realistic, mutual expectations can be established, the resistance to cooperation will be low.

Lucas et al. (1972) provided a case study of how the entry stage for tackling this kind of problem was relevant to ultimate success. He described 'entry' as requiring subtle skills and, in many instances, far more time and effort than any other aspect of implementation. Far too often, analysts responded to the pressure for visible results and focussed on formalising the system, leaving 'people' issues to be sorted out later. However, most critical decisions need to be made at entry, particularly in complex projects, such as the one of stock effluent spillage, that involve an innovative DSS (decision support system) with many inputs, stakeholders and goals. As the client's expectations are set at entry, the relevant tool of success lies in the management of expectations. To avoid failures, a careful approach had to be taken to involve the livestock carriers in the survey. The survey was restricted to livestock transport

companies based in Canterbury. The main reasons for this were cost and travel factors (Lincoln University being located in Mid-Canterbury). A personal approach to each rural transport company was inevitable, as a successful implementation of this survey could only occur if the researcher and the company manager engaged in a relationship of trust and understanding that could lead to joint goal setting, cooperation and mutual appreciation (Argyris, 1970).

The five largest livestock transport companies in Canterbury were approached in June 1997 to assist in collecting data on the stock preparation status prior to transport. Many personal meetings with the company managers were required to discuss the project and explain to them what information was required. It was at that stage important to challenge their interest and demonstrate ultimate benefits for them in order not to lose their cooperation. The researcher needed to clarify any potential problems (i.e. offence against the privacy act) and assess to what extent the company managers and their drivers were prepared to fill in a questionnaire (table) regarding the number of livestock being emptied out prior to transport. The strategy taken did not assume that this kind of approach would be free of conflict. The behaviour of the parties involved in an implementation process can either erode or build on this support. The outcome is determined by the project leader's ability to identify the key constraints and to work with the stakeholders involved. Keen et al. (1978) see such an implementation as a complex process for which very few rules can be confidently applied.

All transport company managers agreed to assist with this survey and advised their drivers to fill in the questionnaires over a period up to six months. Appendix 3 shows a questionnaire form as an example. Approximately 40 ring binders, A4 size, containing about 50 questionnaire forms were distributed to five transport companies. In the follow up process over the next few months, it became clear that it would be difficult to achieve a high score of returned ring binders. This had the following reasons:

- The drivers did not use the same truck every day and the ring binder was left in the truck they used the previous day.

- There was insufficient interaction with the drivers in the beginning, as the company managers did not pass enough information to them. The managers were themselves sceptical about the whole process. They asked their staff to fill in the forms on a voluntary and casual basis. Clearly, the implementation process required more initial confidence building. Unfortunately this was only the start of the programme. Pushing too hard at that stage could have jeopardised the whole survey. This all happened before any pilot educational campaign had even been mentioned. However, if the data had been collected later, the outcome of the survey could have been different.

Specific truck driver	number of surveyed days	number of surveyed cattle, sheep & pig farmers	farms surveyed regarding "emptied out" cattle		farms surveyed regarding "full" cattle		number of surveyed cattle farmer
			number	%	number	%	
A	22	81	5	23%	17	**77%**	22
B	16	41	1	6%	15	**94%**	16
C	9	30	1	25%	3	**75%**	4
D	2	4	0	0%	3	**100%**	3
E	7	26	4	29%	10	**71%**	14
F	5	21	4	80%	1	**20%**	5
G	11	47	6	26%	17	**74%**	23
H	8	42	2	13%	14	**88%**	16
I	20	59	1	3%	29	**97%**	30
J	16	92	2	9%	21	**91%**	23
K	6	14	0	0%	7	**100%**	7
L	5	22	0	0%	12	**100%**	12
M	10	34	3	30%	7	**70%**	10
N	14	48	4	21%	15	**79%**	19
O	4	10	2	40%	3	**60%**	5
P	8	27	1	50%	1	**50%**	2
Total	**163**	**598**	**36**	**17%**	**175**	**83%**	**211**

Table 8.1 Survey regarding cattle preparation prior to transport

- The farmers of Mid-Canterbury would have been warned about the survey and they might have encouraged the stock drivers at each pick-up to confirm best practice.

The outcome of this survey over a period of six months is summarised in the tables 8.1 and 8.2. It shows that 83 percent of the surveyed farmers did not 'stand' their cattle for a few hours in the yards to let them 'empty out' (Table 8.1). It was obvious to the truck drivers which cattle were emptied out, as their guts look different, they move far better and faster and produce less effluent while loading into the truck. Livestock that 'stood' in the yards for a few hours are adapted to close confinement and are therefore less stressed, when loaded onto a truck.

Specific truck driver	Total number of surveyed days	number of surveyed cattle, sheep & pig farmers	farms surveyed regarding "emptied out" sheep		farms surveyed regarding "full" sheep		number of surveyed sheep farmer
			number	%	number	%	
A	22	81	29	53%	26	**47%**	55
B	16	41	7	32%	15	**68%**	22
C	9	30	19	73%	7	**27%**	26
D	2	4	1	100%	0	**0%**	1
E	7	26	3	38%	5	**63%**	8
F	5	21	6	67%	3	**33%**	9
G	11	47	5	33%	10	**67%**	15
H	8	42	16	62%	10	**38%**	26
I	20	59	7	28%	18	**72%**	25
J	16	92	39	70%	17	**30%**	56
K	6	14	1	14%	6	**86%**	7
L	5	22	0	0%	6	**100%**	6
M	10	34	11	46%	13	**54%**	24
N	14	48	9	31%	20	**69%**	29
O	4	10	2	50%	2	**50%**	4
P	8	27	9	36%	16	**64%**	25
Total	**163**	**598**	**164**	**49%**	**174**	**51%**	**338**

Table 8.2 Survey regarding sheep preparation prior to transport

Looking at the percentage of 'empty' sheep (Table 8.2), the drivers noticed only 51 percent not being stood. It is more difficult to see how full are the guts of sheep compared to cattle, as the woollen body may give a wrong impression. Sheep seem to be easier to handle once they are in the yards. By opening a gate in the holding yards, they will run into a truck as long as no obstacle is in the way. However, it needs to be mentioned that the metabolism of sheep is different to that of cattle and it may take up to two or three days for a sheep to totally empty out (Elvidge, 1998).

A further check on the current behaviour of farmers and other stakeholders was provided through the pilot educational programme run from May to October 1998. The stakeholders were asked to fill in a questionnaire before the video presentation. This information was evaluated and summarised into tables to allow better comparisons. The tables indicate current practice of farmers, stock and station agents and meat companies' drafters, meat company managers and livestock carriers. One of these tables is in the main document, whereas all other tables are included in Appendix 3. The percentages are statistically not significant, as only a small number of stakeholders had been surveyed. The purpose of this survey was never oriented to large numbers of stakeholders but more towards representation from many different groups at different types of meetings.

Each stakeholder group was analysed separately. The overview tables regarding attitudes before the video presentations are in Appendix 3. They are divided into tables outlining the average values in one column and also individual details (Appendix 3.1/**A-D**). The overview tables representing the attitudes after the video presentation are included in Appendix 3.2/**A-D** as they are discussed in section 8.5.2. A summarising table comparing the attitudes of the various stakeholders after the video presentation can be consulted in Appendix 3.2/**E**. This table can be unfolded in a way that enables both to read the text and consult the tables. The average values in the tables are always calculated in relation to the number of participants attending these meetings.

8.5.1.1 Farmers

The reason for the relatively high percentage of cattle in this table stems from the fact that two of the six farmer meetings were attended exclusively by dairy farmers (Appendix 3.1/A).

1	**Farming type**	**Cattle**	**52.3%**
	percentage of farmers preparing cattle prior to transport by "standing"	farm to **meat processing plant**	**58.1%**
		farm to **sale yard**	**55.1%**
		farm to **farm**	**48.6%**
		average percentage	**51.5%**
2	**Farming type**	**Sheep**	**47.7%**
	percentage of farmers preparing sheep prior to transport by "standing"	farm to **meat processing plant**	**93.7%**
		farm to **sale yard**	**84.2%**
		farm to **farm**	**100.0%**
		average percentage	**91.9%**
3	**General attitude of stock preparation**		
	percentage of farmers preparing their stock by "standing" prior to transport	only **yes/ no** answers were possible	**65.8%**
	"standing" periods: percentage of farmers standing their stock for	less than 1 hour	**13.7%**
		1 -3 hours	**35.0%**
		4 - 6 hours	**23.4%**
		over 6 hours	**27.9%**
4	**Subsidiary information**		
	age group	20 - 39	**40.0%**
		40 - 49	**24.4%**
		50 - 59	**23.4%**
		> 60	**12.2%**
	number of questionnaires		**48**
	number of meetings		**6**

Table 8.3 Attitude of surveyed farmers before the video presentation

Current behaviour attitude and future perspectives

The percentage of 'stood' livestock was lower for cattle (51.6 percent) than for sheep (91.9 percent). This accorded with the survey conducted by the livestock carriers (Appendix 3.1/A)

When comparing the 'standing' behaviour for different destinations, cattle involved in 'farm to farm' transport were 'emptied out' less often prior to transport.

Another question focussing on general behaviour regarding stock preparation revealed that 65.8 percent of all livestock (cattle and sheep) were 'stood' (Table 8.3 or Appendix 3.1/A). Of those farmers 'standing' the stock, only 51.3 percent (23.4% + 27.9%) of the 65.8 percent applied best practice, by standing them off grass in their yards for at least 4 hours. Thus the percentage of farmers who had already adopted best practice was reduced from 65.8 percent to 33.8 percent. It needs to be highlighted that most of the farmers who attended the meetings were dairy farmers. Most dairy farmers are able to use the concrete based waiting yard in front of the milking shed to 'stand' the stock off grass prior to transport. As a beef farmer does not necessarily have such facilities, it is likely that the 'standing' rate of 33.8 percent may drop further. None of the groups appeared to know much about an ideal standing time.

8.5.1.2 Stock & stations agents and company drafters

This group dealt with a higher percentage of sheep (67.8 percent) resulting from the fact that the stock agents and drafters were not just based in Canterbury but came from all over the South Island (Appendix 3.1/B).

Current behaviour attitude and future perspectives

One hundred percent of the company drafters and 50 percent of the independent stock agents were currently advising farmers on best practice. However only 68.9 percent of drafters were explaining the importance of stock preparation to farmers.

Thirty point three percent of stock agents, mainly company drafters gave less than 24 hours advance notice to farmers for drafting stock. The percentage of stock agents not commenting was 13.6 percent. Assuming that people not commenting are wary of admitting bad practice, the number giving a notice time of less than 24 hours could be as high as 43.9 percent. The independent stock agents seemed better organised as 59 percent (42% + 17%) allowed between one and three days; their 'no comment' percentage was 25 percent.

The question on the time gap given between drafting and livestock pick-up did not show any specific tendency but could be interpreted as not coordinated. The stock agents and company drafters did not give much advance notice time to the livestock carriers: 41.2 percent gave less than 24 hours, although they admitted in 84.1 percent of the time to have been given more than three days notice from the meat processing plant. These figures demonstrate a lack of coordination. This is probably due to unawareness of the issue. Education is one of the main keys to solve this problem.

Looking at the responsibility factor of this problem the stock agents commented as follows: the farmer was seen as the most responsible (55 percent), followed by the livestock carrier (27 percent), the stock agent or meat company drafter (9 percent), and the meat processor (9 percent).

The company drafters explained how they perceived meat processors could contribute towards best practice. The ideas started with education (69 percent), followed by setting financial signals (14.5 percent) and increasing the feedback procedure to farmers on the stock arrival conditions (14.4 percent). The opinion of a small percentage (2.1 percent) was to contract only stock carriers that operated with certified stockcrates.

8.5.1.3 Meat company managers

Current behaviour attitude and future perspectives (Appendix 3.1/C)

The meat company managers indicated they were aware of the impact of the importance of coordination and planning. Their policy was to have their drafters pre-draft (30 percent) a few days prior to transport or just before transport to reduce the time between drafting and livestock pick-up to a minimum (<6 hours) (45 percent). This second method is far more difficult to achieve as a lot of coordination is required. The killing schedule is supposed to be organised 90 percent of the time one-week in advance. Ninety percent of the surveyed meat processing plant managers were aware of or knew about the feedback report to farmers on stock arrival presentation.

Farmers were seen by the meat company managers as the most responsible stakeholder group regarding stock effluent spillage (31 percent). They were followed by livestock carriers (27 percent), meat processor (23 percent), stock agents or meat company drafters (11.5 percent), sale yard owners (3.8 percent) and finally authorities (3.8 percent).

The meat company managers thought they could contribute towards best practice by providing improved information (education) to farmers and other stakeholders on the benefits of 'emptying out' stock prior to transport (34.3 percent). A further 24.3 percent favoured compulsory 'stand down' periods and the sending of signals via a specific payment formula, whereas 17.2 percent thought pre-drafting could help. A further 17.2 percent saw as beneficial increasing feedback on the assessment procedure covering stock arrival conditions by providing details on the kill-sheets. Some 7.2 percent agreed with the idea to contract only livestock carriers with certified stockcrates and associated equipment (i.e. 400 litre effluent storage capacity).

8.5.1.4 Livestock carriers Current behaviour attitude and future perspectives

The livestock carriers provided the most detailed information of any group before the video presentation (Appendix 3.1/D). This probably results from the fact that they are constantly blamed for spilling effluent onto roads.

Some 25.6 percent admitted that the situation had improved in the last 12 months, following increased awareness amongst farmers from information and education driven by media and organisations such as Federated Farmers (14.5 percent). Other contributing factors (10.1 percent) were improved responsibilities taken by farmers, enhanced communications, meat processors becoming tougher regarding dirty stock and increases in pre-drafting. Nevertheless, of the 71.7 percent who did not see any improvement, some 28.9 percent believed that the educational programmes are insufficient. Further 13.2 percent thought that the general attitude of stakeholders regarding this issue showed a lack of awareness and 4.4 percent perceived stock agents and drafters were poorly organised. Their suggestions involved a higher focus on education (34.4 percent), better communication and coordination (10.9 percent) and more pre-drafting (8.8 percent). They also mentioned legislation (8.7 percent) and penalties for dirty stock (6.6 percent). A small number (3.9 percent) believed that a network of dump sites throughout the country could help fix the problem.

Livestock carriers reported that 45 percent of the time, they did receive sufficient advance notice time from the stock agents. They had observed around 30.9 percent improvement in the last 12 months, but only 7.1 percent were seen as due to better coordination and communication. The main reasons given for continuation of the status quo (64 percent) were, first, a high demand by the meat processors for stock, and second, the perception that the general public and authorities did not seem to be concerned about or even still tolerated effluent spillage. About half of the carriers (30.3 percent) did not comment or could not give a reason.

On being asked how to improve the current situation, the carriers expected:

- Pre-drafting to become compulsory (13.7 percent)
- Better coordination through better communication and increased personal responsibility (13.7 percent)
- Education amongst all stakeholders (9.1 percent)
- Industry requirements to become more stringent (9 percent)
- Increased effluent storage capacity on truck and trailer units (6.6 percent)
- Sufficient dump sites throughout the country (6.6 percent)
- 39 percent did not comment.

Their perception of responsibility put the farmer at the top (40.6 percent), followed by the meat processors (21.5 percent), the stock agents and drafters (15.6 percent), the transport operator (13.9 percent), authorities (2.2 percent) and 6.2 percent did not comment.

8.5.1.5 Conclusion

Farmers

The length of 'standing' time for livestock in yards off feed prior to transport, was equally distributed between one and six hours for farmers who said they followed this practice. This showed that they were probably not aware of the ideal standing time of approximately four hours. They were all concerned that stock would loose weight and would not look their best when arriving at the sale yards. In reality, most farmers did not know what happened after the stock left the farm. As some sale yards require the stock to arrive the day/night before, buyers did not know if they were fed or not. For this reason, many farmers simply kept them on the paddock until the last moment, as feeding out hay is a time consuming and costly process. Much information exchange and confidence building seems to be required on these issues. Cattle were far less likely to be stood compared to sheep, probably due to the fact that sheep are more difficult to yard, and the farmers seldom knew exactly when the carrier was arriving. They therefore yarded sheep early rather than at the last moment.

Stock and station agents and meat company drafters

Most meat company drafters were more aware of industry related issues, such as consumers' demands for high quality products and the importance of delivery of clean livestock. Some company drafters knew about the resource consent issues, as their processing plant would have to deal with extra stock effluent from trucks if discharge took place at their truck washing facilities. Many plants already operate at or close to the discharge limits of their existing resource consents and conditions therein. This is one reason why they see that authorities should have a prime responsibility.

The independent stock and station agents probably are motivated to maximise profits by comparing prices at the different meat companies. They appeared to be unaware of the quality issues involved, as 50 percent admitted not advising farmers of the benefits of standing stock. Both, company drafters and independent stock agents, tended not to give sufficient advance notice time to the livestock carriers. It clearly was not perceived as an industry norm that such communication and coordination is highly desirable.

Meat company managers

The meat company managers were aware of the issue and their statements indicated that some work regarding quality management systems involving supply chain management had commenced a few years ago. However, as best practice would involve dealing with more stock effluent discharged from trucks, they were concerned about the potential volumes, which might eventually jeopardise their current resource consents. They did advise their staff and drafters to encourage contracted livestock suppliers to empty out the stock prior to transport for reasons of quality (i.e. pH, tenderness of meat, microbiological contamination of chilled food). They all perceived the benefits this programme could have for them, but were still concerned that livestock carriers might start closing their tank taps and fit all their truck and trailer units with 400 litre effluent storage capacity. They all agreed they were able to assist in improving the current situation by providing education and better

coordination and logistics at their end, as it would ultimately benefit their industry and help keep them sustainable.

Livestock carriers

The livestock carriers see themselves as 'the burger in the bun' blamed by all other stakeholders for this messy situation. They tried to solve the problem by everybody else becoming better organised (i.e. compulsory pre-drafting, higher focus on education, penalties for dirty stock). Some of them wanted penalties and legislation aimed at farmers but did not realise that it could also affect them. Few operators were aware of the volume of effluent collected in-transit in their tanks or of the exact size of the effluent storage tanks fitted to their truck and trailer units. Only a small percentage were prepared to accept further responsibility to, for example, fit bigger effluent storage tanks on their vehicles. Again, few thought that a network of discharge sites around the country, if used, could minimise the problem. Their perception of responsibility with respect to this problem seemed to be to shift responsibility to everybody else except themselves.

Responsibility

A summary of the perceived responsibility is shown in the following table 8.4. The left column represents the stakeholder groups surveyed.

Responsibility as seen by surveyed stakeholders before the video presentation	Farmers	Livestock Carriers	Stock & Station agents and Drafters	Meat Processors	Sale Yard Owners	Road Controlling Authorities	Did Not Know or No Comment	SUM
Livestock Carriers	41%	14%	16%	22%	-	2%	6%	**100%**
Stock & Station agents and Drafters	53%	24%	14%	6%	-	2%	-	**100%**
Meat Processors	31%	27%	12%	23%	4%	4%	-	**100%**
OVERALL	**42%**	**22%**	**14%**	**17%**	**1%**	**3%**	**2%**	**100%**

Table 8.4 Perception of responsibility seen amongst the stakeholder groups

8.5.2 Behaviour attitudes after the video presentation

It is important to caution here that this analysis only represents a small-scale pilot study looking at attitudes of stakeholder groups. It is also important to note, that most questions were to be answered by 'yes – no – no comment'. A questionnaire sample is included in Appendix 3. Nevertheless, after each question, some space was provided for comments. These comments have been sorted and structured to enable the analysis of the specific stakeholder groups. This detailed analysis is attached as excel spreadsheets in Appendix 3 as Appendix 3.2/**A-D**. The following sections highlight the most relevant features.

8.5.2.1 Farmers

Some 47.6 percent of the farmers surveyed commented that the video was informative and well structured (Appendix 3.2/A). There were two possible reasons for this:

(1) They really found it informative, as they were not previously aware of the issue in all its complexity.
(2) They wanted to be polite and be seen to be helpful.

Whatever, none of the farmers agreed to take ownership. Of the farmers who found the video interesting, 46.2 percent did not provide additional comment on the question. Silence may indicate they could see they were going to be required to change behaviour and were not about to make that easy unless seeing others play their part. All other stakeholder groups acknowledged the fact that their industry leaders had taken a positive approach to ownership of the issue and were prepared collectively to assist in solving the problem of effluent spillage on the road.

Some 66.7 percent of the farmers admitted having learnt something new from the video. Only 6.7 percent perceived that the problem could be reduced

through education. Stakeholders may learn from the video but still not adopt best practice. Hence the farmers did not believe in the success of an educational programme. This low percentage indicates the fragility of the whole process. Many issues are raised from 'standing' stock. If farmers' concerns are not taken seriously, a change will never take place. The high figure of 66.7 percent showed how important a continuous educational programme will be to help raise awareness of the implications of stock effluent spillage, the benefits of pre-drafting and stock preparation prior to transport. But as farmers weigh costs and benefits, it is important to deal with those concerns. Their biggest concern appears to be the weight loss issue and their financial returns in the future. 85.3 percent were convinced that the industry was going to increase the quality control requirements. 50.1 percent of these 85.3 percent did not comment. This silence could be interpreted that they saw the problem of effluent spillage being shifted towards meat quality matters, to impose higher quality requirements on suppliers in order to keep their markets overseas. 6.1 percent acknowledged that stock effluent spillage on the road was no longer environmentally acceptable and 5.6 percent saw a need for in-transit dump sites.

Unfortunately, 14.8 percent of the surveyed farmers did not think that an increase in quality requirements would ever take place, unless incentives were paid. They thought that nothing would change because meat processors would accept any livestock, just to keep their plants running efficiently. They also could not imagine any livestock carrier, wanting to stay in business, refuse to cart a load of 'full' cattle.

However, 87.3 percent of the surveyed farmers were prepared to help make a coordinated supply system work. Only half of them were able to give practical suggestions to that end. 15.5 percent saw an urgent need for continuous education and improved communication amongst all stakeholders. 15.3 percent were seeking increased responsibility along the whole chain in order to improve the product quality, to restore the viability of farmers and keep a high

profile industry image overseas. Only 15.1 percent affirmed, that confidence of best practice needed to be assured all along the chain. This was probably one of the key issues for success. 39.5 percent did not comment at all, perhaps because they realised that education on its own would not be enough and did not want to criticise too much this educational approach. A small number admitted that they were not prepared to invest extra time for stock preparation (2.1 percent).

The question and value raised on a potential 'Stock Standing Certification Card' (CC) (cf. Industry Code of Practice included in Appendix 2) made farmers realise that the issue of stock effluent spillage was going much further than they originally had thought. Nevertheless, 67.3 percent of the surveyed farmers agreed a CC to be a fair approach to encourage compliance by all stakeholders. Of these 67.3 percent, more than half (35.9 percent) did not comment at all. They presumably realised the long-term benefits to the whole industry's development. However, they also recognised the requirements (more paperwork, less returns if not compliant), which could represent a potential conflict of interest for them. Only 14.6 percent saw in it a proof of stock preparation that could assist raising awareness and responsibility for their obligations by setting an overall standard. 9.2 percent realised that a CC scheme would assist the quality assurance programmes of meat processors that could end up with rewards or penalties for farmers. At this early pilot stage, farmers probably were not yet aware that a CC would help them to gain confidence with the other stakeholders as each record could be tracked. Assurance is one of the principles of quality!

8.5.2.2 Stock & stations agents and company drafters

While 96.9 percent of surveyed stock and station agents found the video interesting, only 22.1 percent described it as well structured and informative (Appendix 3.2/B). Only a small percentage (5.4 percent) acknowledged that all stakeholders had taken ownership in the video. However, 69.4 percent of the 96.9 percent did not add comments in their answers. 3.1 percent (the highest

figure amongst all groups) did not even find the video interesting. This raises the prospect that they did not see themselves as needing to take responsibility.

Some 62.5 percent learnt something new, close to the farmers' figure and far higher than the meat companies' managers and livestock carriers. Although the stock agents gave the impression to shift the responsibility to someone else, 19.3 percent of the 62.5 percent stressed that the video was an excellent tool to heighten the awareness of the problem and to show the benefits of pre-drafting and ideal stock preparation. The meat company drafters apparently learnt more about the in-transit dump sites than the independent stock agents did. Only 2.4 percent seemed to be surprised about the magnitude of the effluent spillage. This was probably new to them, as they had never been involved in those issues previously. Their main role was to choose livestock at the farms and achieve the best price for the farmer.

A small percentage (4.9%) acknowledged having learnt something new about the effect of stock preparation on meat quality. This indicated that many stock agents had some knowledge gaps concerning quality assurance issues. A coordinated approach by stakeholder groups, such as meat processors, MAF and other educational institutions is probably required in the future to run a targeted extension programme. 8 percent said, explicitly, that they learnt about the value and need for a minimum number of dump sites. 62.5 percent admitted that they had learnt something new from the video. This high percentage could be interpreted as most stock agents learnt something new about the value of dump sites. More than 50 percent (23.1% + 31.3%) did not comment at all. This could be explained by the fact that they were reluctant to admit that their current practice was not always adequate.

A full 100 percent of the stock agents were convinced that the industry would require quality controls in the future. They were all aware of the trend towards a quality driven industry demand and knew about the best practice for stock preparation. They gave the impression of not wanting to become too involved

in this issue as they might lose clients. The jobs of stock agents might be placed in jeopardy, as the tendency of meat processing companies over the last couple of years has been to contract directly with suppliers to try to obtain a higher quality product. This fact could be a reason why only 14.2 percent of the 100 percent expecting move stringent quality requirements agreed that encouraging farmers towards best practice through education was important. 40.1% of the comments presented mixed replies such as 'everybody need to take responsibility; quality requirements relevant to remain sustainable; higher expectations on animal welfare and hygiene; enforcement and control system required; stock effluent spillage no longer environmentally acceptable; and finally, the importance of providing dump sites'. The remaining 45.8 percent did not comment.

It was encouraging to see that 30.7 of the 87.5 percent were prepared to make the system work through better communication and continuous education. A further 29.4 percent thought that increased responsibility along the whole supply chain was essential. Only 5.9 percent believed that their personal organisation regarding pre-drafting and giving more advanced notice to farmers and livestock carriers could be useful. 3.1 percent did not regard themselves as responsible and shifted the responsibility to local or regional authorities.

Only 60.6 percent believed a Certification Card (CC) could help reduce the problem. This was the lowest percentage given by all stakeholder groups. This might be related to the fact that the implementation of such a card would need substantial additional work and responsibility on their part, which would not be rewarded in Dollars. 29.5 percent of the 60.6 percent did not comment at all. This indicates that less than a third were welcoming to the potential introduction of a stock standing Certification Card.

Stock and station agents listed a range of possibilities for each stakeholder group that could contribute towards a reduction of effluent spillage, as follows:

Livestock carriers

- Better coordination (advanced notice regarding livestock pick-up arrangements).
- Give priority to livestock carriers with QA (Quality Assurance) accredited equipment.

Farmers

- Better coordination (advanced notice regarding drafting and supply requirements) and increased personal responsibility.
- Continuous personal education or information to increase the awareness and better understanding of the issues involved.

Meat processing companies

- Better communication and coordination between stock agents, drafters and meat processing companies (advanced notice for drafting, supply demand, killing schedule)

Some 62.5 percent of the stock agents and drafters were hoping that the problem of effluent spillage could be solved in a self-regulating and self-policing way. Only 39.5 percent thought that the tools required were education, communication and shared responsibility. Nevertheless, 25 percent were not convinced, as in their opinion, farmers would not change attitude unless it was going to 'hit them in the pocket'.

8.5.2.3 Meat company managers

All surveyed meat company managers found the video interesting, while 35 percent commented the video as well structured and informative (Appendix 3.2/C). Eight point three percent were satisfied to see all stakeholders taking responsibility in the video, however 56.7 percent did not comment any further.

Fifty percent admitted having learnt something new from the video. Twelve percent of those 50 percent had not realised the magnitude of the issue before.

They acknowledged that a serious study was undertaken. Forty percent did not learn anything new, while 10 percent did not comment.

All meat company managers admitted that the industry was changing and had already started to require higher quality standards to meet overseas requirements. High quality products were seen as the one way to ensure sustainability for stock farming in New Zealand (46.7 percent). They agreed that encouraging (18.3 percent) all stakeholders to take more responsibility was the way to go, as they also expected higher requirements for animal welfare and hygiene (8.3 percent). Only a small percentage (18.3 percent) did not comment, which clearly showed a common interest in stock preparation.

All managers made assurances that they wanted to assist in making a coordinated supply system work. A third decided that the current feedback procedure on livestock presentation at arrival at the works needed to be reviewed. Another third wanted to focus on adoption of better practice overall: more pre-drafting through their drafters, more coordination of stock procurement, better personal organisation, more notice to farmers...). The rest saw education, communication and more responsibility of all stakeholders as essential.

Eighty percent agreed a 'stock standing' Certification Card was needed, which was the highest figure of any stakeholder group. This demonstrated the high degree of cooperation from surveyed meat processors. They could see that this educational programme would also benefit them. A few were concerned about inevitable increases in paperwork and were unsure whether the other stakeholders would all cooperate honestly.

The meat company managers also mentioned how they saw a possibility for minimising spillage through their interaction with:

Livestock carriers

- Better coordination and use of specific contracts for livestock supply.
- Contracting only carriers with QA certified equipment (i.e. 400 litre tanks).
- Reviewing of livestock presentation at arrival (including clean trucks).
- Improved logistics to allow better planning.
- Improved communication (education).

Farmers

- Better coordination (advanced notice).
- Improved communication to raise awareness.
- Improved logistics regarding stock supply.

Finally, 80 percent perceived that through continuous education, improved communication, better logistics and an increased feedback on the assessment procedure of stock conditions on arrival, a win-win solution could be achieved in a self-policing and self-regulating way. Only 10 percent were concerned about the 'she'll be right' attitude of other stakeholders and consequently they saw a need for legislation and penalties to take place in the future. Ten percent did not comment.

8.5.2.4 Livestock carriers

All the livestock carriers found the video interesting (Appendix 3.2/D). Nineteen percent were satisfied that everybody had been involved in the video (ownership) and seemed to be prepared to accept responsibility. The livestock carriers were the only group suggesting that the video needed to be circulated widely. Only 40.6 percent of the carriers acknowledged in a further question that they had learnt something new from the video. This clearly showed that many were aware of the issue. Nearly half of these 40.6 percent thought that it was a great achievement, that each stakeholder group had agreed to address the problem in the video. They were very satisfied to see responsibility being shared in the video, as their group members were usually the only ones blamed

by the general public for messy roads. Twenty seven percent were well aware of the situation and one third did not comment.

Eighty six point eight percent were expecting the industry to require quality controls in the future. However, only 20.5 percent perceived quality would soon become a driver to ensure sustainability for stock farming in New Zealand. Nineteen point four percent were hoping that each stakeholder group would accept responsibility and meet their obligations in the future, while 40.4 percent did not comment. It was interesting to see that a subgroup (13.1 percent) did not expect higher quality expectations by the industry at all. This answer was similar to that given by farmers.

A high 92.1 percent were prepared to help make a coordinated system work. Forty seven point eight percent (24.9% + 22.9%) of them thought communication, education and shared responsibility would be a good start. A further 7.7 percent were prepared to fit holding tanks to their truck and trailer and use them. The remaining 36.6 percent did not comment. A small number (7.9 percent) were reluctant to fit tanks on their truck and trailer units.

A 'stock standing' Certification Card was seen by 66.6 percent to be a good way to help solve the problem. They were all wary of the paperwork and the time they would take collecting these documents, as even the TB (Tuberculosis) card is still a problem. Even knowing that this card could be combined with the TB declaration, they were dubious about the honesty of all stakeholders involved when filling out these cards.

The livestock carriers also looked at direct improvements:

Stock agents and drafters

- Better coordination (pick-up arrangements).
- Personal education to increase awareness.
- Increased pre-drafting.

Farmers

- Better coordination (more notice to farmers).
- Personal education to increase awareness.
- Increased feedback on stock arrival conditions.
- Improved holding yards.

Meat processing plants

- Better communication & coordination (space allocation).
- Improved plant logistics (adequate unloading facilities, delivery hours).
- Personal education.
- Increased feedback on stock arrival conditions.

A minority of stock carriers (46.4 percent) believed that the problem could be solved in a self-policing and self-regulating way. Only 27.9 percent were convinced that communication, coordination and shared responsibility were enough to achieve a win-win solution. The rest (40.8 percent) were not persuaded or did not give any comment.

8.5.2.5 Summary

Farmers

Most farmers knew about the problem of stock effluent spillage and the issue of 'standing stock' in the yards for approximately four hours, as this message had been around for the last twenty years (Young et al., 1979). They were all curious as to how the key message and aim of this research programme was going to be different from previous failed attempts to fix it. The video presentation split the farmers into three groups:

(1) **The first group** who knew about the pros and cons was convinced that livestock preparation was an essential part of quality assurance programmes and knew well that it was promoted by the meat industry. They knew that international experience has shown that the major long term benefit for quality assured farmers was continued access to these

markets (Christie, 1997). Increasingly, buyers preferred product with quality assurance. There was not always a premium for that product but there would almost certainly be a discount for product without it – and the discount could be in the form of difficulty in having stock processed. Those farmers knowing that changes were certain to take place wanted to make sure that consequential issues would also be solved. The overriding issue was 'confidence building'. The farmers two specific concerns were:

Sale yards

Most stock in sale yards or fairs was auctioned on a live-weight base. Some of the sale yards required the stock to arrive the night before the sale. This means that in addition to the transport time and the overnight period in the sale yard, an additional time in the holding yards on the farm might add up to more than 24 hours, which is likely to affect live-weight. This could be avoided if livestock are fed properly upon arrival at the saleyard.

Meat processing plants

Some farmers realised that lack of coordination meant their stock could be waiting for one day in the processing plant without feed before being processed.

If these reliability issues, which are part of quality principles, can be solved and guaranteed in the future, adoption of best practice might take place through persuasion. Persuasion is the process by which individuals form their attitudes to the proposed practice or solution (Greer et al., 1996).

(2) **The second group of farmers** was not fully aware of the complexity of the associated issues related to the effluent spillage problem. They had never been concerned, as it had never affected them. Some of these farmers were in pursuit of knowledge. Knowledge is both, initial

awareness of the need to change and active gathering of information about practical solutions.

(3) **The remaining farmers** were aware of the situation, but were not prepared to contemplate behavioural changes, as no incentive or penalty was currently applied.

Stock and station agents and company drafters

Most stock agents found the video interesting, but more than two thirds did not offer any comments. While a large percentage said that they had learnt something new through the video, only a few commented that the video heightened the awareness of stakeholders and gave a general overview on in-transit discharge facilities. The independent stock agents' role had always been more focussed on the best deal for the farmer and less on quality control. They recognised that now the 'standing' requirements would be taken far more seriously than twenty years ago, as it involved quality requirements that are relevant for the sustainability of the industry. Therefore, most of them promised to help make the quality supply system work. Less than a third were looking forward to a stock Certification Card, as it would involve them in more work and responsibility.

They mentioned a range of possibilities that could contribute to making the system work. These were better coordination (towards farmers, livestock carriers and meat processors), and better personal communication to obtain better collaboration and coordination.

Meat company managers

All meat company managers found the video interesting. Half of them admitted having learnt something new. Some of those had not realised the magnitude of the issue before. As they were also seeking high quality products, they made assurances that it was in their interest to assist a common educational programme. They were prepared to put an effort into better coordination and

communication. They thought of reviewing the feedback assessment process for livestock presentation on arrival at the meat processing plants. A high percentage agreed with the benefits of a 'stock standing' Certification Card. They also agreed that a self-regulating system could work, if in addition to communication (education) and coordination, a shared system of responsibility was implemented. They would focus on issues such as better logistics within the plants, contracting only transport operators with QA certified equipment, pre-drafting whenever possible, extension of slaughter schedules, reviewing livestock presentation guidelines.

Livestock carriers

The livestock carriers admitted being pleased to see each stakeholder group in the video was prepared to take responsibility. Most of the rural carriers were aware of the issue but some might have learnt something new, especially concerning the magnitude of the problem and the way it could be minimised. They all appreciated that they were not seen as the main responsible group. Most of them were prepared to make a coordinated system work by taking more responsibility (i.e. better communication, coordination, fitting holding tanks and using them).

A Certification Card for 'standing' stock including the TB card was seen with certain scepticism, understandably, as it would involve more paper work for their drivers. Unfortunately, fewer than 50 percent believed that the problem could be solved in a self-regulating way through improved coordination, communication and shared responsibility.

8.5.3 Conclusion

Farmers have known for years about the benefits of 'standing' stock prior to transport (Young et al., 1979). The original reason was linked to meat hygiene regulations, which was a combination of 'emptying out' and 'rest period' for livestock prior to slaughter. Unfortunately, not many farmers complied with the

requirements (i.e. provision of under cover facilities with grates). The reason for this was a lack of communication and incentives.

The surveyed farmers did learn something from the video. Many had not been aware previously concerning the relationship between stock preparation on farm prior to transport and the magnitude of effluent arising therefrom. They realised through the video that effluent spillage onto roads had become an issue that was no longer acceptable. They all acknowledged the fact that the industry leaders of each stakeholder group stressed the necessity of taking responsibility quickly in order to avoid regulations and legislation being revised and applied rigorously.

However, the adoption of new practices is not a fast process. The process from awareness to adoption could be summarised in four clearly recognisable steps (Greer et al., 1996):

(1) *Knowledge* – both initial awareness of the need to change and the active gathering of information about a number of solutions.

(2) *Persuasion* – the process by which individuals form their attitudes to their practice or solution.

(3) *Decision* - – to adopt or not adopt a practice or solution.

(4) *Confirmation* – seeking information to confirm decision, continuing evaluation of practice, may result in a decision to discontinue using the practice.

Each stakeholder holds core beliefs which guide their decision making process (Appendix 3.2/E). Changes in those beliefs, and consequently in behaviour, can be triggered when a conflict arises between those beliefs and the evidence confronting the individual. Even where a person holds some beliefs that support a change in behaviour, it is their attitudes overall which will determine

how they act. Therefore, extension programmes have become a relevant tool to assist this process.

The rate of diffusion will be determined by the level of communication activity within the community. Typically it will take 3 to 5 years (Greer et al., 1996) for a practice to be adopted by 30 to 40 percent of the members of a target audience. The level of support given to the practice by opinion leaders within the community has a significant impact on its rate of adoption. Geographic barriers, such as rivers and mountains, act as communication barriers. The extension activity needs to be focussed widely to achieve quickly small cells of adoption. The diffusion of a new practice is influenced by its benefits, its visibility, its compatibility with existing systems, its complexity and the ease with which it can be trialled.

The video presentation in itself has been only a first step towards the process of behaviour change. This is probably the reason, why many stakeholders were reluctant to comment. They agreed on the need for better practice, however did not comment, as they all needed some time to think about it and become used to the idea.

Meat processing companies are becoming more interested in seeing that the stock they are processing, are well prepared and travel unstressed. This will alter pH levels affecting the tenderness and appearance of the final product. If the livestock require excessive washing on arrival because of effluent fouling, such action causes further stress on the animals. If the timing of arrival at the works is not carefully controlled, more time standing off feed will occur which may impact the final carcass weight and pay-out to the farmer. Therefore, information flows are as important as the physical transfer of stock is. More and more consumer interests are demanding certification of product related to its production which in turn is leading meat processors to set higher standards along the complete supply chain.

Meat company managers realised the benefit for their industry to help fix the problem. They declared before the video presentation that they already encouraged farmers to prepare the stock since introduction of their quality assurance programmes. After the video, they acknowledged that the system could be improved through better communication, coordination and improved logistics at the meat plants. They agreed to help make the system work. However, their main focus was on reviewing the feedback procedure on livestock arrival presentations. This could be achieved through better communications but also by adopting a penalty system for dirty and full stock. They unfortunately never acknowledged taking responsibility regarding the acceptance of effluent collected in the storage tanks of the livestock truck units. They were aware that they might have to deal in the future with more effluent and tougher resources consents investigations. The meat processors seemed to be prepared to play a role towards achieving higher quality products by altering their livestock presentation feedback system. Some farmers did not seem to be too worried as they knew that in case of shortage of stock, the meat processors would accept any stock. It is really important for future communication and extension strategies to endorse the 'pasture to plate' programme. An improvement of assessment reports passed back to livestock suppliers will help farmers understand that quality management is not just a farce to annoy them. The report could also include a health analysis of processed livestock. This invaluable information would help inform the farm's animal health programme. Some deer processors are already endorsing this procedure (Stevens, 1997).

The British supermarket chain Sainsbury set-up a Code of Practice of its own (New Zealand Game Industry Board, 1997). This chain is positioned right at the top of the market and is known for its quality products. The New Zealand deer farmers had to react quickly to meet the export requirements. None of them were then asking for incentives but struggled to meet the code of practice to remain sustainable. This British Code of Practice uses words that look more like a set of regulations.

As described in a previous chapter, the National Stock Effluent Working Party (NSEW) completed in June 1999 an Industry Code of Practice to reduce effluent spillage on New Zealand roads. This code supplements the Lincoln University video. The biggest difference to many other codes is the approach taken by the whole industry. The industry desire is for self-regulation through adoption of best practice with sign-in from each stakeholder organisation. They have all been exploring through the NSEW, a common code of practice, which will encourage better practice through better communication, coordination and sharing of responsibility. The Industry Code of Practice attached to Appendix 2 is designed to give assistance on how communication and coordination could be improved. However, it also focuses on the responsibility of each individual stakeholder group. This code is the result of a long consultation process between all stakeholder groups. All parties seek to avoid attracting prosecutions and wish to achieve an 'all-win' situation supported by education. It was a long process to find a sustainable solution that was acceptable to all concerned.

The livestock carriers recommended extensive educational programmes. They were unwilling to be seen as mainly responsible and to be the only stakeholder to have to pay for the mess. Therefore, they want everybody to focus on better communication to improve the general coordination and logistics, which are viewed as a low cost solution. Many carriers were still strongly opposed to fitting storage tanks to their multi-purpose truck and trailer units. Apart from the capital costs, multi-purpose units need more intensive clean-ups each time they have been used for carting livestock in order to meet general hygiene requirements. This is a time consuming factor and a cost factor that many carriers are currently not prepared to accept. Some carriers realised the benefits of having tanks fitted and used as they spend less time cleaning their gear. In fact, as no effluent dribbles underneath the truck or trailer, there is a substantial reduction in corrosion. As cleaning time and corrosion are two cost relevant factors, some livestock carriers realise the benefit of effluent storage tanks fitted and used (Swain, 1998 & Woodley, 1998). A further step towards

adoption of behaviour change is to elaborate a communication strategy by encouraging these few livestock carriers to demonstrate the benefits to their colleagues. Most livestock cartage units purchased over the last five years are equipped with effluent holding tanks. Generally a truck is replaced after eight years, a trailer may last a few years longer. It is quite realistic that within a time frame of three to five years, most units could be fitted with tanks. Unfortunately, compliance will not be high if better communication strategies and acceptance of responsibility by other stakeholder groups does not take place simultaneously.

The stock agents and company drafters were also confronted by the issue of 'standing' stock prior to transport, twenty years ago. In those times, they did not wish to put pressure on the farmers, as they were their clients. In the eighties, as farming in New Zealand changed cutting out subsidies, the problem of 'standing' stock was not seen as a relevant issue anymore. Stock and station agents also now see some of their jobs are in jeopardy, as more and more meat processors are contracting directly with their livestock suppliers. Therefore they will have enormous difficulties convincing farmers to 'stand' their stock if they are not prepared to do it. The very best that can be expected from independent stock and station agents is to improve their personal organisation. They need to take responsibility through pre-drafting and letting all other parties know in time about their arrival to allow farmers and livestock carrier sufficient time to do their jobs properly. The company drafters have an even bigger role as they need to procure the stock for their company, assure high quality products and follow the company line. In case all meat processing companies agree to adopt the Industry Code of Practice in a consistent way, they will advise their drafters to act towards best practice. The company drafters can contribute towards best practice by advising farmer groups on the benefits of 'standing' stock through personal communication and by showing best practice themselves and being well organised.

The 'stock standing' Certification Card (CC) which will be part of the new Industry Code of Practice will need some time to become established, as it will not be popular in the beginning. Its adoption time will probably be comparable to the TB card. As the CC will include the TB card, it may see the percentage of collected TB cards drop initially. On the other hand, the Certification Card is an excellent tool to ensure best practice along the whole supply chain and will so contribute towards confidence building among livestock suppliers.

It can be expected that there will always be some players who will not modify their behaviours in the collective interest. At the best the industry could expect around seventy five percent compliance with this new Industry Code of Practice. This perceived percentage of compliance (or twenty five percent livestock 'not stood') sets the limit to the benefits of education in the computer simulation model explained in the following chapters.

9 ASSEMBLY OF RELEVANT DATA FOR THE MODEL

9.1 Introduction

The purpose of this chapter is to describe the data collection. This includes many aspects such as the strategies applied to gain the cooperation of the industry, the data collection itself, the data control to allow the calibration of the model and the practical field work involved.

These data were required for the computer model (Chapter 10) to allow the simulation of various scenarios to seek for the most appropriate network of dump sites in the South Island of New Zealand.

9.2 Literature Review and Procedure

Farming and transport are industries both characterised by fragmented ownership. As a result, there is little comprehensive statistical information available on stock transport.

A Transport Survey of South Island Farmers done in 1975 quantified the volume and flow patterns of livestock and wool (Young et al., 1979). A transport Policy Study reported on the tonnage of livestock and wool moving between large sections of New Zealand in 1973 (Smith et al., 1973 cited in Young et al., 1979). These studies did not include details of livestock types nor seasonal patterns. Johnston's (1967) study on rural transport was limited to the particular geographical area of North Canterbury only.

In the last 20 years, many changes have occurred in the farming and transport industry, due for example to the rationalisation and the competition of meat processors, larger herd sizes and bigger stock trucks. As the data collected earlier on do not reflect the present situation, the researcher had to undertake the task of collecting comprehensive data on livestock movements for the South Island of New Zealand.

Section 9.3 describes the data collection, whereas section 9.5.3 gives an overview of the calibration process of these data. Section 9.3.3 outlines the cooperation process and efficiency of the investigation process. Section 9.4 shows the field work involved.

9.3 Data collection

9.3.1 Preliminary steps

As less and less farmers are transporting their livestock themselves, the most appropriate source of data collection was seen through surveying the transport companies and not the farmers. Unfortunately the quality of their records varied widely and the kind of information required, was commercially sensitive. As the problem of effluent spillage had been around for a long time without any significant change, the transport operators were reluctant to complete questionnaires as a new survey may contribute to some kind of future costs.

The New Zealand Road Transport Forum facilitated the first contacts and assisted throughout (December 1996 - June 1998) in the data collection. Around one hundred rural transport companies are operating in the South Island.

It was essential at this early stage to gain the confidence of the transport company managers to agree that a solution needed to be found that was going to satisfy all parties. The personal approach was important in order to learn more about the whole industry and the stakeholders. Some company managers or owner-drivers showed a great interest, as they realised that if successful, this study might benefit them. They needed to understand the worth and the future use of the data on flow patterns they were being asked for. These personal visits or meetings, facilitated by the Road Transport Forum NZ, allowed the transport companies to participate in seeking feasible solutions. The questionnaires were also seen as a first step towards the awareness

heightening process for the transport company managers and the stock truck drivers.

9.3.2 Livestock movements within the South Island

A mail survey was considered to be the best technique to survey a large number of widely dispersed transport companies economically and efficiently. However, at the start, a certain number of personal visits were essential to obtain a broader picture of the rural transport and farming industry. It was important to visit a number of transport companies in various regions to understand better the livestock movements in a specific area. These personal visits also helped refine the questionnaire destined to be sent to all rural transport companies in the South Island. The data on transport flows and patterns given by the industry were required as basic data for the computer simulation model.

A first pilot questionnaire was tested in the restricted area of Mid-Canterbury in early 1997. The sixteen page questionnaire form asked for far more information than the simulation model actually required. However, it helped to give an idea of the whole situation and some of the responses were useful to compare with the early oral comments made by the industry. Some of this initial information on livestock movements in Canterbury was used to prepare a presentation for the Ashburton Stock Effluent Workshop in April 1997 (Thull, 1997). The final questionnaire form sent to each livestock transport company was reduced to five pages. It was essential to keep the survey as small as possible to encourage the company managers to complete them. An example of the final questionnaire is included in Appendix 4. Each questionnaire was accompanied by an introductory letter from Lincoln University and from the Road Transport Forum NZ.

The survey dealt primarily with the livestock movements from (1) farm to meat processing plants, (2) farm to saleyards, (3) farm to ports and (4) farm to farm (i.e. for store and breeding purposes). The questionnaire excluded stock

movements from saleyards to farms or processing plants, as these trips were not relevant with regard to effluent spillage, as the animals were either empty or had only received small amounts of dry feed. Some questions were designed to allow a double-checking process on some of the answers. This was important, as the assignment of the flows needed to be a close approximation of the reality. For example, a company owning three trucks was not in a position to do five long distance trips in one single day! The questionnaires were finally posted out in June 1997.

9.3.3 Responses to the questionnaire

The response rate was poor from the beginning, but this had been expected. A certain number of companies had to be deleted from the original list, as they were no longer carting livestock. This reduced the number from 130 to 98 companies. There were probably many reasons for the poor response rate. However, one probable reason was that the questionnaires were distributed in the busy part of the season and the managers added them to their pile of paperwork and forgot about it. A similar mail survey conducted in 1975 with farmers indicated similar poor responses (Young et al., 1979). By using the technique of multiple reminders, Young et al. (1979) achieved a raw return rate of 66 percent, which correspond to a net valid response rate of 59 percent. The excellent result rate shown in figure 9.1 can, in part, be attributed to the use of modern communication technology such as fax and email. The graph (figure 9.1) indicates the level of response rate over the time period from February 1997 to August 1998.

As mentioned in the previous section, the researcher visited initially a few rural transport companies in Canterbury to obtain a picture of the industry (February - April 1997). After the Ashburton Stock Truck Effluent Workshop, the researcher visited further companies in Marlborough, Nelson and the West Coast (May/June 1997) as he suspected that the problem of effluent spillage was perceived differently in each region. The previous work experience of the researcher had shown that it was important to listen and talk to stakeholders or

visit other sites at an early stage of a project in order to achieve a better end result. This proved true for this research, as transport companies were able to indicate details related to the problem (i.e. badly operating valve-system of the effluent storage tanks or the problem of fitting holding tanks to a truck and trailer unit on a multiple purpose truck).

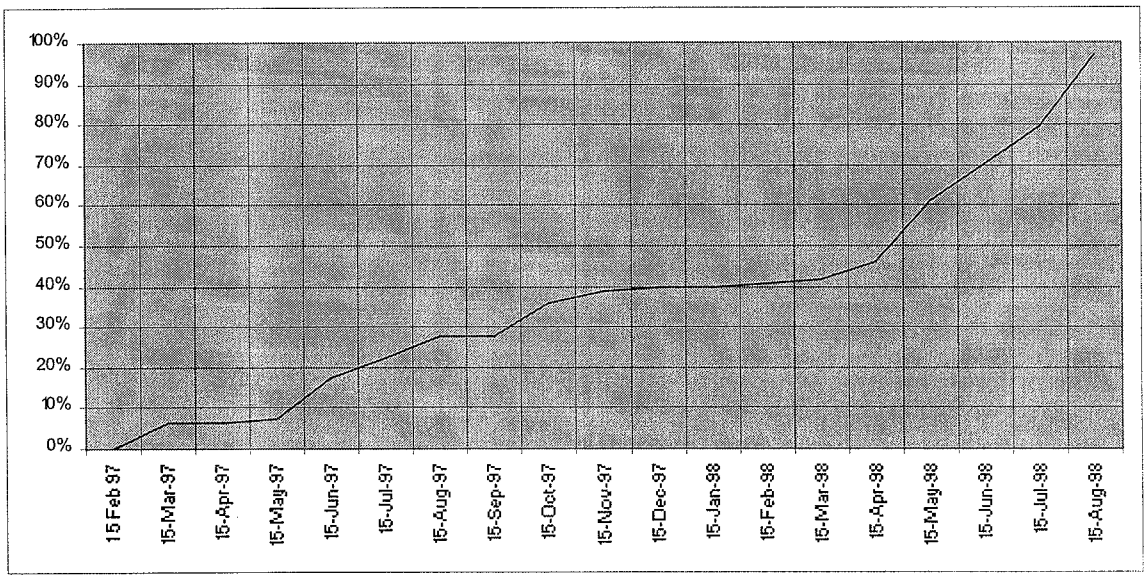


Figure 8.1 Rate of returned complete questionnaire of time [Feb 97 – Aug 98]

At the end of June 1997, the finalised questionnaire was sent to approximately 130 transport companies. Only about 10 companies returned the questionnaire over the following six weeks. A reminder including the questionnaire was sent in early October 1997. The response was still poor, although around 40 were completed by the end of 1997. Many questionnaires were not completed in the expected way and needed clarifying. This happened mostly over the phone. The researcher around March 1998 applied a different approach by sending information to the livestock carriers who had not returned the questionnaires. The information was about the activities of the National Stock Effluent Workgroup, including the educational programme and the video that was nearing completion. Some companies acknowledged that they had been reluctant to return the questionnaire, but appreciated the approach the

Workgroup had taken. They promised to return the questionnaire soon and asked for another copy because they could not 'find' the copies sent earlier. However, by June 1998, only 70 percent of the questionnaires were completed. Over the period from June to August 1998, the livestock movements were assigned on spreadsheets before exporting them into the computer simulation model. As the missing information was mainly from Southland, it was important to receive further information. The Road Transport Forum NZ invited the researcher as a guest speaker to several meetings to present the work completed so far and asked him to focus on the educational programme. This opportunity was used for further liaison with the company managers in order to attract more responses. Finally, the last questionnaires (approx. fifteen) were 'collected' by phone. This 'direct' method was efficient and all company managers interviewed reacted in a friendly and cooperative way. A combined method, of sending a questionnaire and following it up a week later through a phone interview might indeed be a efficient and quick way of getting results, especially if useful information is conveyed to the respondents as part of the process.

The quality of the questionnaires returned was variable such that the researcher needed to invest considerable time to reconcile the answers with known meat plant or saleyard throughput. In the case of obvious errors, the researcher had to liaise with the transport company to sort out the problem.

The survey (Feb 1997 – Aug 1998) revealed that approximately 33 percent of all truck and trailer units were fitted with specific effluent storage tanks in the South Island. There was a distinct difference between the area north of Timaru with 47 percent and south of Timaru with only 22 percent. The survey counted 516 truck and trailer units owned by 98 transport companies. The effluent storage tank capacity indicated by the industry was usually overly optimistic. The personal measurement of storage tanks of a few truck and trailer units clearly showed that the truck companies in the North Island fit bigger tanks on their units compared with the South Island owned vehicles. The volume in the

South Island ranged between 50 litres and 250 litres, with an average around 100 litres. This volume did not include the trough, as those overflow quickly while negotiating steep hill regions.

9.4 Field work

9.4.1 Survey on current livestock 'standing' behaviour

In order to improve the situation of 'standing' livestock prior to transport, it was important to evaluate the current practice first. The results, already identified and explained in the previous chapter, indicated that more than 80% of the cattle farmers and more than 50% of the sheep farmers were not 'standing' their livestock for approximately three to four hours prior to transport. This survey data on stock 'standing' were used to calibrate the computer model. The model input allows three simulations regarding the stock 'standing' behaviour of farmers:

- 80% of the livestock not 'stood' in order to simulate the current situation.
- 50% of the livestock not 'stood' to show better behaviour in the near future.
- 25% of the livestock not 'stood' to demonstrate the effects of achievable best practice in the longer term (5 - 7 years).

Simulating a situation of 100% application of best practice did not make sense, as this is never likely to occur, because of various livestock selling customs (i.e. sales on animal liveweight at saleyards and farm to farm movement in farmers' own vehicles).

9.4.2 Measurement of livestock effluent en route

The method applied to measure effluent produced in-transit in the trucks is described in section 5.5.4 of chapter 5. The 'defaecation accretion' curves produced by cattle and sheep for 'stood' or 'not stood' conditions are overlaid in figure 9.2. This allows better comparison. It clearly acknowledges the problem

for 'full' or 'not stood' cattle. The difference in effluent produced by 'stood' and 'not stood' sheep is only small and similar to 'stood' cattle. The number of measurements taken were limited to two or three trips each and were difficult to compare, for the following reasons:

- Different seasons and outside temperatures.
- Changing weather conditions en route; unless driving all along the West Coast of the South Island, where it may rain for one or two days non stop, the other parts of the South Island are more known for scattered or periodic rainfall.
- Most of the trips had several livestock pick-ups at different farms. This meant that some livestock was 'stood', some 'not' or for far less time. It also complicated the measurement of effluent produced in the truck.
- The farmers were reluctant to confirm the amount of time the animals had been off feed. The look of the animals and their behaviour, while moving in the truck, helped to ascertain if they had just come from the paddock or not.
- The type of feed they had been on. Some farmers sold their stock earlier than planned due to a drought in the area.
- Some loads were only half full and the animals travelled on the lower deck. This contributed to less stress and fear, as cattle are reluctant to climb the steep internal metallic ramp inside the truck or trailer to access the upper level.
- Many valves of the effluent storage tanks did not operate well, as they had not been maintained or used for a while.
- The departure time may be important for cattle coming straight from the paddock ('not stood'). As cattle do not graze in the dark, they may produce less faeces and urine if picked-up at dawn compared with another group of cattle being loaded in the afternoon.
- Different breeds produce distinct amounts of effluent and also may react in particular ways to stress and fear situations.

The literature reviewed regarding 'animal weight loss' and described in chapter 5 outlined clearly that each researcher obtained different results due to changing input situations. This is due to the nature of life and thus only trends of 'defaecation ' behaviour were possible. In this study (see section 5.5.4), due to two consecutive dry seasons in the South Island of New Zealand, the curves of figure 9.2 describe maximum values for each animal type and trial (stood/not stood). For this reason, the model will not underestimate the volume of effluent collected in-transit. They may vary due to the length of the trip.

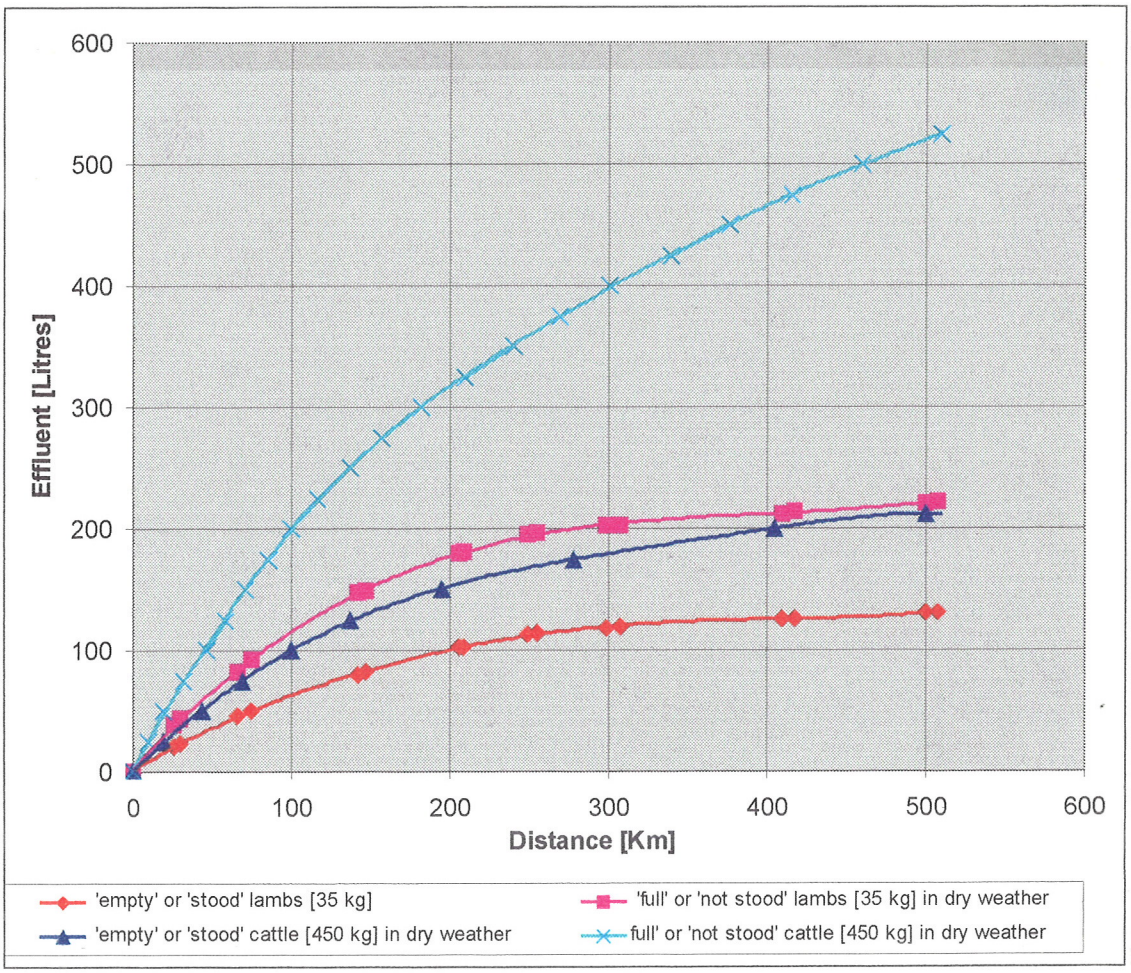


Figure 9.2 Effluent [Litres] produced in a truck & trailer unit transporting cattle or sheep, in 'stood' (emptied out) or 'not stood' (full guts) conditions

The researcher discovered that cattle, especially the ones being loaded directly from the paddock, defecated and urinated copiously after being unloaded at destination, and this even after a journey of eight hours. One can speculate how much more effluent would have been produced in the truck if the journey had been ten or twelve hours. From the point of view of an animal cientist, it is certainly an interesting question regarding animal behaviour and avoidance of defecating, however for the modelling exercise, it was not relevant, as at this stage, the 'defaecation ' rate per driven kilometre was already low.

9.5 Assignment of the data destined to be exported into the model

9.5.1 Introduction

The survey data of the 98 companies are all assigned on individual spreadsheets (i.e. Excel), as this is an appropriate way to deal with location allocation data. They are designed in a way to allow simple calibration of the model for different situations in case the model is later used for the North Island. Spreadsheet programs have macro-programming facilities that enable combination of various data sets or spreadsheets. The model is set up to consider livestock movements that occur over the period of a whole week in a busy part of the season.

In the South Island of New Zealand livestock are shifted South in the early part of the season until December/January. In the second part of the season the tendency is to transport the livestock to the next meat plant further North. This occurs mostly along the East Coast, where most meat processing plants are located. In the early part of the season, due to temperature differences between the North and the South of the South Island, the fattening process is far slower in the South. As described earlier on, two main meat processing companies, Alliance and PPCS (Primary Producers Cooperative Society), have their plants dispersed along the East Coast. In order to keep these plants running efficiently, the livestock has often to be transported over longer distances (i.e. from Marlborough to Canterbury in the early season). To allow

the simulation of these seasonal variations, two different models were created, based on two series of different spreadsheet assignments of livestock movements. The early season or 'spring' model simulates the situation from October to January, while the late season or 'autumn' model covers the time from January to July. The 'spring' model does not represent the busiest part of the season, as this happens around February-March.

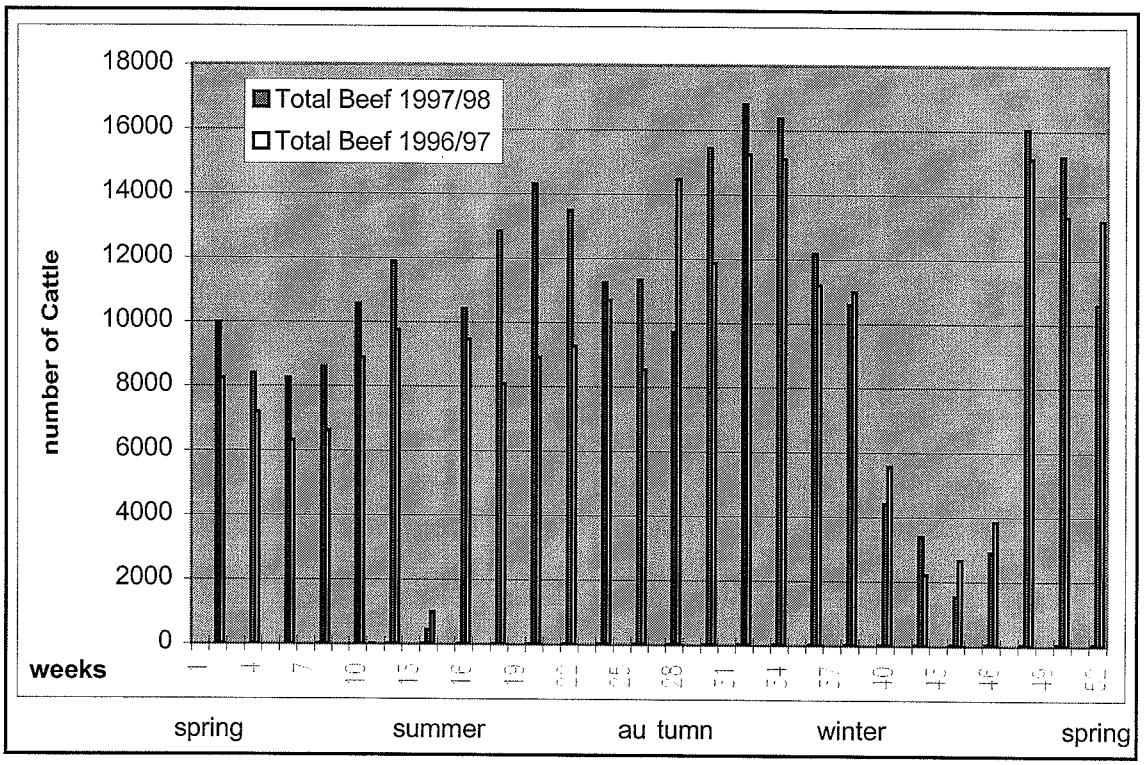


Figure 9.3 Distribution of export slaughtered cattle in the South Island over two seasons (from Meat Industry Association New Zealand, 1998)

The figures 9.3 and 9.4 give an overview on the distribution of sheep and cattle in the South Island over the period of two years. The x-axis represents in each graph the slaughter week for export livestock. The 'livestock calendar year' starts in September and ends in August of the following normal calendar year. These two graphs give a good indication of the busy time of the year. The 'autumn' model has been assigned for a peak week to assess the maximum possible effluent production in-transit.

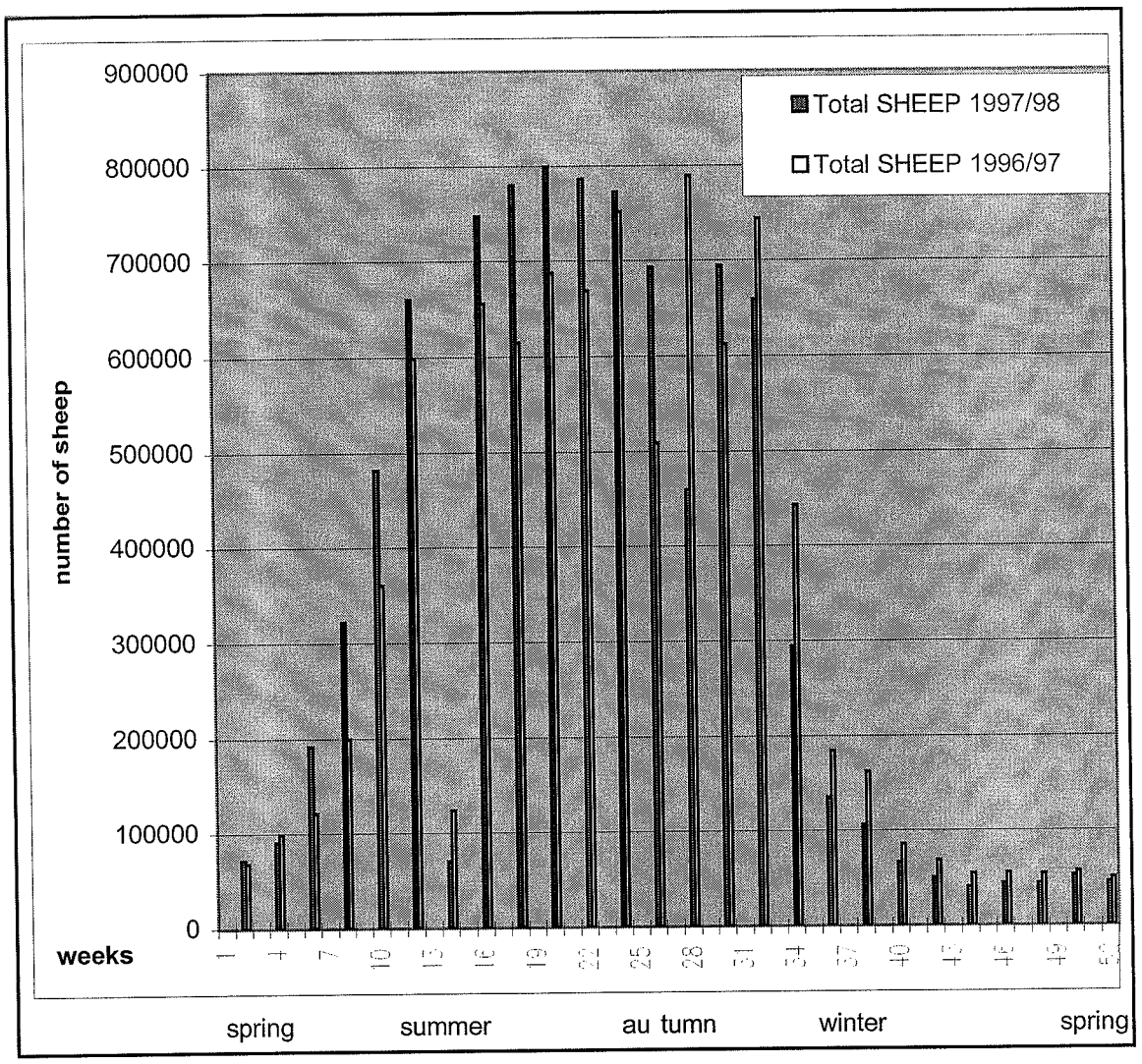


Figure 9.4 Distribution of slaughtered export sheep in the South Island over two seasons (from Meat Industry Association New Zealand, 1998)

9.5.2 Assignment of the livestock flows

The model is based on the data of 98 livestock transport companies in the South Island. From the original 130 companies targeted, only 98 confirmed they carted livestock. The information received through the survey questionnaires (Appendix 4) on livestock flows and pattern was used to allocate the trips. Each company has its journeys assigned to one specific spreadsheet. The upper rows represent the destination, starting with the various meat processing plants, continuing with the saleyards, the ports and some individual locations (i.e. farm to farm). The left column indicates the departure point of the

individual trips. Usually, they are identical for each company and are matching with the company address, as most companies pick-up the livestock in an area of around 30 kilometre distance from their depot. However, as some companies indicated they had several depots for picking up the stock from different geographical areas, these additional departure points are randomly assigned amongst all trips of this particular transport company. If a company indicated to they undertook two identical trips, these needed to be assigned twice as the binary system (0 or 1) required this. Table 9.1 shows an example, while two further detailed trip assignments are shown in Appendix 4.

Next to the departure-destination 'box', further information is stored for each trip assignment. The first column represents the type of livestock transported, such as cattle or sheep. This identification is relevant, as these trips will be associated with the respective cattle or sheep 'defaecation ' curves.

The column to the right presents the information regarding the level of farmers' behaviour. Three different levels of behaviour adoption have been modelled: (1) the current behaviour supposing 80% of the stock not being 'stood' prior to transport, (2) the improved future behaviour, by assuming 50% not 'stood' or 'stood', and finally (3) the best practice with 25% 'not stood' or 75% 'stood'. The simulation model is using the 'not stood' status (i.e. 80%, 50% and 25%) to define the particular simulation. The different trips have been randomly assigned regarding the criteria of 'full/ not stood' or 'empty/ stood' with the exception that has been paid to, is that the destination of saleyards has been attributed a far higher percentage of 'full' or 'not stood' stock, as animals are sold on liveweight basis and less likely to be 'stood'. The different standing simulations (i.e. 80%, 50% & 25%) have been randomly assigned. This method has one disadvantage: it is more difficult to compare single journeys of two different models as one may be assigned as a 'not stood' load in the 25% model but as a 'stood' load in the 50%. However, for the general picture of robustness of the model is was important to randomly assign the status of 'stood' or 'not stood'.

1	ASHBURTO N	BLENHEI M	CHRISTCHU RCH	KOKIRI	BRIGHTW ATER	CHRISTCHU RCH				
WESTCOAST 1	CMP Seafield	CMP	PPCS Belfast	Phoenix Meat Co Ltd	Saleyards	Saleyards		CATTLE (1) SHEEP (0)	Full (1) EMPTY (0)	Wet (1) Dry (0)
AHAURA	1							1	1	0
GREYMOUTH		1						1	0	1
INANGAHUA JUNCTION			1					1	1	0
INANGAHUA JUNCTION				1				1	1	0
INANGAHUA JUNCTION				1				1	0	1
HOKITIKA				1				1	1	0
HOKITIKA				1				1	1	0
ROSS				1				1	0	0
WESTPORT				1				1	1	1
KUMARA				1				1	1	0
SPRINGS JUNCTION				1				1	1	0
AHAURA					1			1	1	1
AHAURA						1		1	1	0
SUM	1	1	1	8	1	1	**13**			
CATTLE	1	1	1	8	1	1	**100%**	**13**	**10**	**4**
SHEEP	0	0	0	0	0	0	**0%**	**0**	**77%**	**31%**

Table 9.1 Example of a model assignment of one small transport company.

The extreme right column describes the weather conditions. The details on how the rain influences the faster filling up of the tanks are described in one of the next sections. This column only indicates the model to choose 'dry' or 'wet' weather. The data regarding the weather conditions have been assigned randomly within specific regions. Each region is individually allocated with a certain percentage of rainfall events to allow a more realistic simulation process approximating weather pattern in the South Island.

The extraction of information from the questionnaires and the different assignment and calibration stages, as described in the next section, took approximately nine months intensive work. If the project is to be reproduced for the North Island, the time can probably be reduced to six months, due to the experience gained with the South Island model.

9.5.3 Calibration of data

The transport companies did not provide sufficiently accurate data in the first instance. It was probably rather difficult for them to give the exact number of individual sheep or cattle truck units delivering at the specific destinations. This fact was only discovered after the completion of all assignments, which gave a clear overview. There was unfortunately no way to find out this 'error' at an earlier stage. Only when particular stakeholder groups were confronted with the apparent anomalies, they were more willing to divulge information that would allow adjustments to the data inputs to bring the assignments closer to reality. By that time, they had an interest in the results and were as concerned as the researcher for the model to produce defensible solutions.

After completion of a first assignment draft, the researcher created four new control spreadsheet files that summarised the results of the 98 individual spreadsheets by separating them into cattle and sheep and 'spring' and 'autumn' models. The first step was to indicate for each individual company the number and percentage of cattle or sheep destined to specific destinations. This check up system is represented by the two bottom lines of table 9.1. The spreadsheet became fully automated. To give an example: in case one trip within the spreadsheet is modified from 'cattle' to 'sheep', the bottom line of this sheet indicating the number of 'cattle' or 'sheep' delivering to a specific destination, will automatically change. By accumulating the results of these bottom lines to these four new control spreadsheets, it became possible to monitor easily the number of trucks and trailer units delivering 'cattle' or 'sheep' to the various destinations. Table 9.2 gives an overview of one section of these control sheets. The control sheets are not included in the Appendices as they are commercially sensitive. They can however, be viewed by external examiners on request. The specific transport company names were replaced due to commercial sensitivity.

			ASH BUR TON	BLEN HEIM	XX	CHRIST CHURCH	CHRIST CHURCH	PICTON	CHEV IOT	
	CATTLE	Summer-Autumn	CMP Seafield	CMP	XX	PPCS Belfast	Sale yard	Port		SUM
1	AHAURA	West Coast 1	1	1	x	1	1			4
X	xxxxx	xxxxxx	x	x	x	x	x	x	x	x
21	WAIPARA	North Canterbury 5	2	3	x	3	3	4		15
22	ROTHERHAM	North Canterbury 6	1	1	x	2	1	1	1	7
23	RANGIORA AMBERLEY	North Canterbury 7	1	2	x	2	3	1		9
24	OXFORD, RANGIORA, AMBERLEY	North Canterbury 8	1	5	x	6	6	2		
		Sum of truck/trailer units	71	82	x	122	52	8	1	1,501
		Number of stock per truck/trailer unit	30	21	x	21	32	35	35	
		Plant capacity by the assumption taken above on the number of cattle for meat proc. plants, saleyards/ports and abattoirs per truck/trailer unit	2130	1722	x	2562	1664	280	35	34,879
		Max plant slaughter capacity on a 5.5 day week (data given by the Industry)	2200	1800	x	2600	2800			
		Number of trucks calculated (max plant capacity/number of stock per unit)	73	86	x	124	88			
		Calculated plant capacity (by number of trucks)	97%	96%	x	99%	59%			

Table 9.2 Section of a monitor overview spreadsheet regarding the feasibility of livestock allocation to specific destinations

Table 9.2 only represents a sample to indicate the methodology of double-checking. It was relevant to gain a good understanding of the whole industry. This happened for example through personal information from stock truck drivers and liaison with the industry. Some livestock cartage units delivering to meat plants are not allocated with a full load as this does not always occur or they tend to deliver to more than one destination. Unfortunately, it was difficult to obtain a 'correct' result for this. Many iteration steps within the original assignment sheets led to the current model assignment.

In November 1998, the complete model assignments were presented as a draft to the National Stock Effluent Workgroup (NSEW). The group saw for the first time the way the data had been used and how the results would be presented to the general public after completion. They admitted that no commercially sensitive aspects were exposed and were satisfied with the data integration approach, Lincoln University had taken. Shortly after this meeting, the Meat

Industry Association New Zealand and the New Zealand Stock and Station Association made available some relevant information on livestock export slaughter data and on the number of animals sold at the various saleyards in the South Island. These data proved crucial for the calibration of the model. Unfortunately, the reluctance of the industry to divulge information earlier meant more than 500 hours of additional research was required to achieve an acceptable calibration of the data. After many iterative steps in the calibration process, still further information was required from the various meat plants within the South Island to confirm, adjust or reject the data. The requested information consisted for example the min/max number of livestock units (cattle or sheep) delivered by a specific livestock carrier at a certain plant in early or late season. Some companies such as Alliance and Canterbury Meat Packers and most local abattoirs collaborated in an excellent way to assist the Lincoln University project. Fax, email and phone were used as the communication method. Although some of the PPCS (Primary Producers Cooperative Society) processing plant managers were reluctant or simply refused to cooperate, their livestock managers assisted with general information. Finally, a certain number of livestock carriers were consulted once more to confirm the adjustment of trips concerning their company.

The careful and professional approach by Lincoln University, including the positive outcome of the educational video helped enormously towards the collection of adequate data. Table 9.3 outlines for sheep a comparison between the data assigned and the information received from various sources. A similar table for cattle is included in Appendix 4. Although a few trips may be assigned twice, as the trucks may deliver at two plants close to one another, that will have little impact on the location of in-transit sites, as only the quantity of effluent captured at those sites may vary.

	Sheep autumn model	Export Meat Plants S.I.	Local Abattoirs	Sale Yards	North Island	Store Stock	SUM INDUSTRY DATA	SUM MODEL DATA
1	**Export Processing Plants:** Number of processed sheep within a week (data given by Meat Board NZ & Meat Industry Association NZ) for 96-98	799,332					799,332	
	MODEL DATA assigned for **Export Processing Plants** (questionnaires)	**721,920**						**721,920**
2	**Local Abattoirs:** Number of max processed sheep in a week (data given by abattoirs through personal phone calls)		35,750				35,750	
	MODEL DATA assigned for **Local Abattoirs** (questionaires)		**34,000**					**34,000**
3	**Saleyards:** Number of sheep sold on a max week in S.I. saleyards (data given by NZ Stock & Station Agents Association)			151,000			151,000	
	MODEL DATA assigned for **saleyards** (questionnaires)			**125,400**				**125,400**
4	Shipment to **North Island**				35,000		35,000	
	MODEL DATA assigned for shipment to the North Island (questionnaires)				**35,000**			**35,000**
5	**Store Stock :** number of store stock moved (questionnaires)					11,000	11,000	
	MODEL DATA assigned for **store stock** (questionnaires)					**11,000**		**11,000**
	SUM						**1,032,082**	**927,320**
	Number of sheep per unit (depends on processing plant, 1 truck & trailer may drop off stock at 2 different plants >multiple delivery that involves different numbers of stock for individual destinations	291	134	455	500	500		
	Number of trips assigned	2,483	254	276	70	22	**SUM**	**3,105**

Table 9.3 Comparison of sheep movement for the 'autumn' model by assessment of industry data and model assignments.

The next chapter regarding the model describes the potential uncertainties associated with the input data.

9.5.4 Assignment of the meteorological conditions

The aim of this section is not to analyse the statistical validity or probability of precipitation throughout the South Island of New Zealand but to integrate a certain proportion of rainfall events in the model.

The weather conditions are randomly assigned through 'wet' or 'dry' for each of the 98 trip assignment spreadsheets (Table 9.1) that indicate the livestock movements of each individual transport company. It is rather uncommon for a long-haul vehicle to drive through the rain over a whole journey in New Zealand as the weather conditions change rapidly from region to region. Therefore the rainfall events are attributed as a random accumulation of wet and dry periods in the model (Figure 9.5). The rainfall events are associated with the respective cattle or sheep 'defaecation' curves by being added as a supplementary contribution to the various 'defaecation ' rates of the animals.

The meteorological situation and the analysis of statistics on meteorological data for the South Island (New Zealand Meteorological Service, 1979a, 1979b, 1980) led to the conclusion that a 'rain' factor needed to be considered in the model. It was relevant to determine (1) the percentage of rainfall days, and (2) the intensity of rainfall within certain regions.

1 **Determining the percentage of 'wet' trips assigned to the individual transport companies within a certain region.**

The South Island was divided into four climatic regions: the West Coast, the Nelson area, the East Coast/ Otago and Southland. Table 9.4 indicates the mean values for each region regarding the number of rain days and its annual percentage of rain days. The percentages indicated in table 9.4 were cut by half to assign the model. Two reasons led to this decision:

(a) Some of those trips assigned as 'wet' journeys and starting in a specific 'wet' region such as the West Coast, may only spend a small part of

their trip in this 'wet' region, the rest of the trip may happen under 'dry' conditions.

(b) A further factor for allocating a smaller amount of 'wet' trips was the fact that more livestock cartage units originating from 'wet' areas like the West Coast, are covered with a tarpaulin that avoids most of the rain penetrating into the stock crate.

Westcoast	Rain days
Reefton	156
Greymouth	169
Franz Josef	177
Harihari	169
Ross/Hokitika	171
Westport	168
Haast	178
Average number of rain days a year	**170**
Percentage of rain days a year	**46%**
Nelson	**Rain days**
Motueka	102
Moutere Hills	97
Nelson	96
Average number of rain days a year	**98**
Percentage of rain days a year	**27%**
Southland	**Rain days**
Invercargill	158
Manapouri	189
Te Anau	118
Winton	127
Otautau	140
Woodlands	159
Balclutha	118
Milton	123
Gore	142
Average number of rain days a year	**142**
Percentage of rain days a year	**39%**

East Coast	Rain days
Blenheim	81
Lake Grassmere	73
Kaikoura	90
Hanmer Springs	114
Darfield	96
Christchurch	84
Ashburton	90
Timaru	81
Fairlie	90
Temuka	81
Lake Tekapo	72
Cromwell	68
Alexandra	65
Waimate	90
Oamaru	76
Omarama	74
Wanaka	76
Palmerston	92
Dunedin airport	104
Dunedin	126
Average number of rain days a year	**86**
Percentage of rain days a year	**24%**

Table 9.4 Overview on the number and percentage of rain days within the different regions in the South Island

2 The intensity of rainfall

The intensity of rainfall depends on the duration of a rainfall event. While a municipal stormwater system design is based on the intensity of a 15-minute

rainfall event to allow rainwater to evacuate quickly within a city, the researcher chose a 240 minutes event.

Personal discussions with a Lincoln University based meteorology scientist acknowledged that anything between 120 and 360 minutes could be used, although 240 minutes were probably more appropriate for an average value (Larsen, 1998). The impact of using a 120 minutes rainfall event compared to the 240 minutes chosen would have increased the rainfall intensity. The West Coast and Southland regions are the wettest in the South Island. As many livestock movements assigned in these areas are relatively short journeys, this assumption would only affect slightly the volume of effluent collected but hardly the location of sites. The average rainfall intensity value for the simulation model was established by multiplying the specific daily rainfall intensity of each region (i.e. 18 mm) with the number of transport companies based in these regions (i.e. 6 companies on the West Coast) and dividing the sum (i.e. 863.7 mm) by 98 transport companies. This method for establishing the average daily rainfall in the South Island allows considering the percentage of transport companies operating in the different regions (Table 9.5).

The finding of a rainfall rate over time or distance that will contribute to the filling of the effluent storage tanks on 'wet' journeys included further factors such as the truck and trailer surface, the pelt absorption of water and the evaporation (Table 9.5). The open surfaces of both a truck and a trailer are approximately 37 m^2, by considering that their roof is not completely open. The open truck and trailer surface area that is able to receive rainwater was reduced for calculation purposes, due the aerodynamic factor of the truck movement. The reduction factor was assumed to be 30% or 0.7. The absorption of moisture through the pelt and evaporation is a further factor that needed consideration as the animals are transported in a very tight environment. A full load of sheep can be seen as a kind of a huge woollen carpet able to absorb a certain percentage of moisture. Together with the

evaporation factor, a potential pelt absorption and evaporation factor may reach 30% for sheep, however only 5% for cattle (Elvidge, 1998).

Rainfall intensity assumption based on 4 hrs rainfall events	Average rainfall in a rain day		Number of transport companies based in the specific region	Mean value
	[mm]			[mm]
West Coast	18	*	6	108
Nelson	11.5	*	6	69
East Coast/ Otago	7.7	*	51	392.7
Southland	8.4	*	35	294
Total			98	863.7
	863.7 / 98			
average rainfall in a day for all regions				8.81
Volume of rainwater collected in a truck & trailer unit over time				
rainfall event length			240	min
rainfall intensity per 240 minutes			8.81	[l/(4h*m**2)] or [mm]
rainfall intensity per 1 minute			0.0367	[l/(min*m**2)] or [mm/min]
surface of truck & trailer			37	m**2
reduced surface area due to aerodynamic movement [factor 0.7]	0.70 * 37		25.90	m**2
rainfall intensity per 1 minute	25.9 * 0.0367		0.95	[l/min]
Wool absorption factor and evaporation factor for sheep approx. 30%	0.70 * 0.95		**0.66**	**[l/min]**
Pelt absorption factor and evaporation factor for cattle approx. 5%	0.95 * 0.95		**0.90**	**[l/min]**

Table 9.5 Overview of factors contributing to the assignment of rainwater collected in a truck & trailer unit in-transit over time

For this reason, the rainfall events were assigned separately for sheep with 0.66 litres/min and for cattle with 0.90 litres/min (or litres/km as time becomes equal to distance on long trips (Table 9.5). The curves indicating the random assignment of rainfall 'showers' are shown in the following figures of the next section (Figures 9.5 and Appendix 4 for 'full' sheep).

Figure 9.2 outlined the 'defaecation ' behaviour of cattle and sheep that were 'stood' and 'not stood' in dry conditions. Figure 9.5 shows the influence of rainfall in the case of a truck and trailer load of full cattle. A similar graph for 'not stood' or 'full' sheep is attached in Appendix 4.

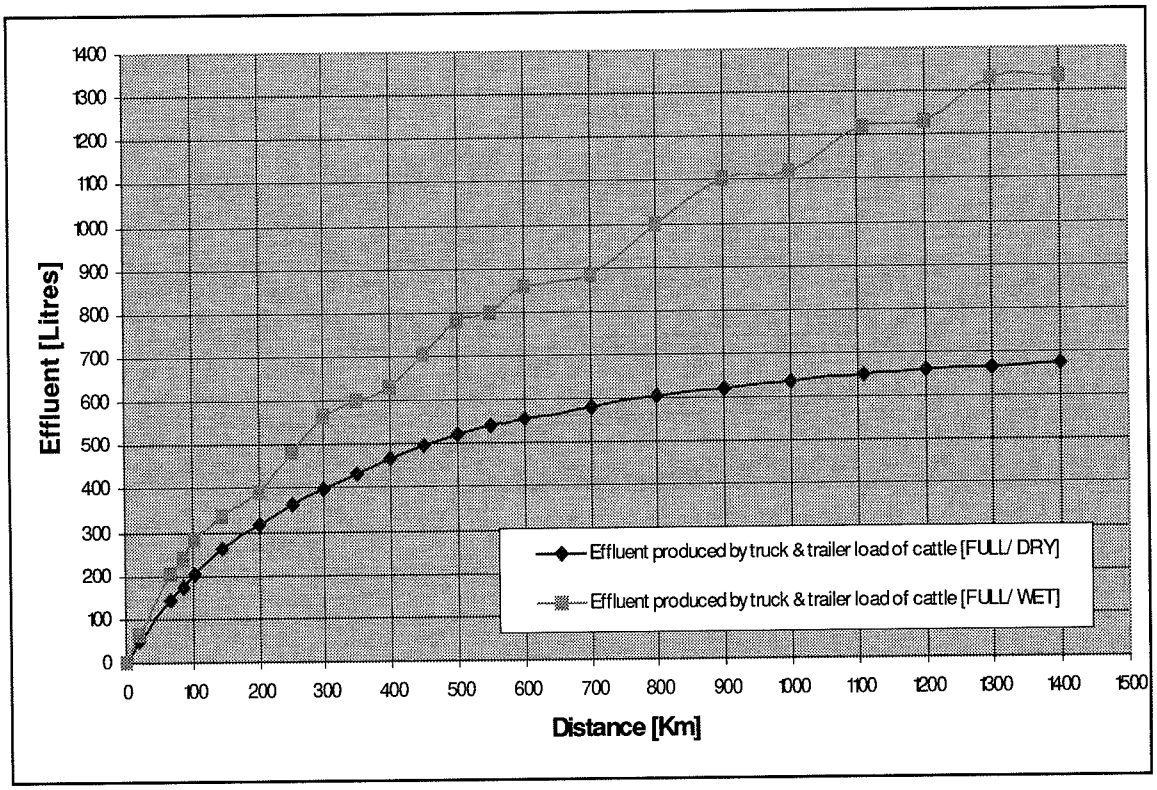


Figure 9.5 Comparison of the 'defaecation ' behaviour of 'not stood' or 'full' cattle for 'dry' and 'wet' weather conditions.

The curve for 'full' cattle in 'dry' weather differs from figure 9.2 as it was extrapolated to a transport distance of approximately 1,400 kilometres. This fact was relevant for the computer model, as some simulated journeys are further than 500 kilometres. These extrapolations have been discussed with some scientists specialised in animal science at Lincoln University and can be seen as reasonably accurate without recourse to a series of measurements (Elvidge, 1998).

These graphs all describe the accumulation of effluent produced in-transit over distance. Figure 9.6 displays the specific effluent production rate at a specific travelled distance as a function over distance [litres per kilometre] by using the data of full cattle in 'dry' weather conditions. The curve for 'wet' periods is obtained by adding 0.66 l/km for sheep (Appendix 4) and 0.90 l/km for cattle to the 'dry' curve shown in figure 9.6.

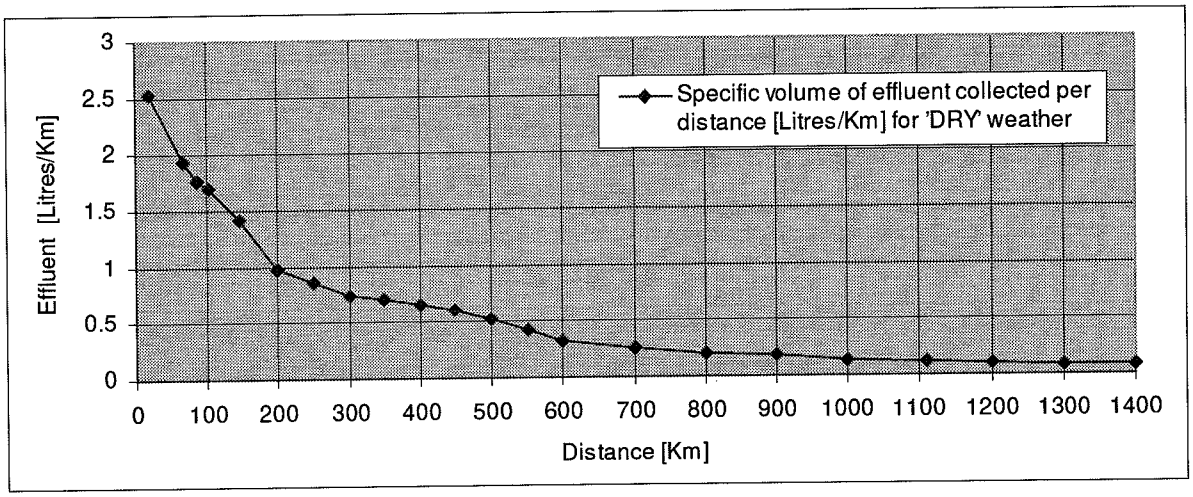


Figure 9.6 Specific effluent rate produced at distinct travel distance for cattle that were 'not stood' for 'dry' weather conditions.

9.5.5 Assignment of 'defaecation ' curves

The exportation of these curves into the model required a transformation of the information. The model that will be explained in the next chapter, needed for all eight cases (i.e. cattle / sheep, dry / wet, stood / not stood) information on the distance that could be travelled without overflowing the effluent tanks. In a first instance, an information spreadsheet was created that used steps of 100 litres. Unfortunately, after the run of several test models, the researcher discovered an error in the results due to interpolation of too big steps (100 litres). The whole information sheet on 'defaecation' behaviour was then modified to small steps of 25 litres that worked well. Table 9.6 shows a section of this table as an example to enable a better understanding of the

transformation from the curves to the data spreadsheet. The complete spreadsheet assignment on 'defaecation ' behaviour is attached in Appendix 4.

CATTLE 'Full' or 'Not Stood' & 'Dry' weather

Litres	Km	SUM KM	L/KM		Litres	Km	SUM KM	L/KM
25	10	10	2.50		100	47	47	2.13
25	10	20	2.50		100	53	100	1.89
25	12	32	2.08		100	82	182	1.22
25	15	47	1.67		100	119	301	0.84
25	12	59	2.08		100	159	460	0.63
25	13	72	1.92		100	320	780	0.31
25	14	86	1.79		100	920	1,700	0.11
25	14	100	1.79		100	1,740	3,440	0.06
25	17	117	1.47		100	3,300	6,740	0.03
25	20	137	1.25		100			
25	20	157	1.25					
25	25	182	1.00		200	100	100	2.00
25	28	210	0.89		200	201	301	1.00
25	30	240	0.83		200	479	780	0.42
25	30	270	0.83		200	2,660	3,440	0.08
25	31	301	0.81					
25	38	339	0.66		300	182	182	1.65
25	37	376	0.68		300	598	780	0.50
25	40	416	0.63		300	5,960	6,740	0.05
25	44	460	0.57		300			
25	50	510	0.50					
25	62	572	0.40		400	301	301	1.33
25	93	665	0.27		400	3,139	3,440	0.13
25	115	780	0.22		400			
25	140	920	0.18					
25	205	1,125	0.12					
25	275	1,400	0.09					
25	300	1,700	0.08					
25	340	2,040	0.07					
25	390	2,430	0.06					
25	460	2,890	0.05					
25	550	3,440	0.05					
25	650	4,090	0.04					
25	760	4,850	0.03					
25	890	5,740	0.03					
25	1,000	6,740	0.03					

Table 9.6 Display of the 'defaecation ' behaviour data for cattle in 'dry' weather that were 'not stood' prior to transport.

9.6 Conclusion

This chapter described the data collection process from the outset and its associated problems. It outlined the importance of involving each stakeholder group from the beginning and to demonstrate to them how the data would be used and applied in the future. As some data were commercially sensitive, it was relevant to gain the confidence of all parties in order to receive the helpful collaboration of each stakeholder group. This achievement of trust was a fundamental but time consuming necessity.

It took approximately 18 months to complete the data collection. This is not unusual as the use of the reminder regime has long been seen as a necessary part of mailback surveys in transport planning, to minimise potential bias in survey results. Figure 9.1 shows that the return of questionnaires always occurred in the two weeks period after sending reminders. As the educational programme was seen as the most important objective to achieve in 1997, the late completion of data collection did not affect the success of this project. Also, the educational video helped reluctant informants to cooperate.

The assignment of all basic data was achieved through application of Excel spreadsheet techniques to allow a relatively easy way to modify and calibrate the data. The model needed also to be constructed in a manner that would enable further researchers to use this model for assigning North Island livestock movements. The calibration of the model nevertheless required considerable time, as some control check data were only made available after the presentation of a draft model outcome. It is difficult to comment or speculate if the time could have been shortened through an increased number of stakeholder meetings. The political side of the exercise cannot be overlooked.

The outcome of this project is an example of multi-stakeholder research that will enable future cooperation in similar projects with those stakeholder groups to be implemented more quickly given the heightened levels of confidence achieved in this study.

10 COMPUTER SIMULATION MODEL

10.1 Introduction

The next step of the project was to find or create, develop and use a model able to provide information on an ideal network of effluent discharge facilities covering the whole of the South Island of New Zealand. This information was required to assess the benefits of preparing livestock prior to transport by 'standing' off pasture for four hours or more and of fitting all livestock truck and trailer units with large effluent containment facilities.

The aim of this chapter is to explain the objectives of the model, the different steps towards the final model, the programming methodology, the limitation of the model and the general experience.

10.2 Objectives and marginal requirements

The objectives and the marginal requirements expected from this model were quite clear. Next to a cost-effective solution outlining a certain number of relevant dump sites in the South Island, the computer software needed:

(1) To seek for cost-effective solutions by recommending a minimum network of stock effluent dump sites in-transit along State Highways for the South Island of New Zealand.
(2) To handle large volumes of data assigned on spreadsheet type files.
(3) To use spatial information such as the South Island road network and a distance based calculation system.
(4) For demonstration purposes effective visualisation and allow the display of the results in a map form.
(5) To allow a human-machine interaction to implement potential political decisions (i.e. specific dump site in specific area) or geographical feasibility (i.e. closure or opening of Arthur's Pass road, no acceptance of effluent at Picton and Nelson ports).

(6) To automate the model and make the application as user friendly as possible, to allow further application for the North Island, if successfully completed for the South Island.

10.3 Various steps towards the final model

10.3.1 Geographical Information Systems (GIS)

The objectives outlined above suggested that Geographical Information Systems (GIS) based software would be suitable. GIS technology provides a platform to import spatial information (i.e. road network), and information stored in the form of databases and spreadsheets. It has become an accepted management tool for spatial environmental analysis, monitoring or planning purposes. GIS offers effective visualisation in association with a querying function for importing information from various datasheets and using the overlay function that is part of GIS software. Harrison (1998) defines GIS as software "*combining graphic capabilities with non-graphic attribute linkages allowing complex query, map overlay, polygon processing, and spatial modelling operations.*" The value of using G.I.S. tools lay in the mapping and display of information, the calculation of shortest paths and to link this with various attribute information such as tank capacities, weather conditions and the percentage of full or empty livestock prior to transport. The way in which the model works is described with two single trip assignments in Appendix 8.

10.3.2 Modelling approach through Arc View

The first task was to find the appropriate GIS software. The Lincoln University based GIS section recommended to try 'ArcView' in 1997. Arc View is developed by ESRI (Environmental Systems Research Institute) and enables the researcher to present, map, display, query and analyse geographic information (ESRI, 1996a). An additional Arc View package called 'Network Analyst' allows one to solve network problems such as identifying the shortest distance between two locations or looking at accessibility issues (ESRI, 1996b). The importation of data from 'outside' into ArcView occurs through dBase files. However, the use of spreadsheets (i.e. Excel) is also an

appropriate way of storing required information as a transformation from spreadsheet technique into dBase is more or less instant.

Accordingly, most of the relevant data information needed to be stored in spreadsheet forms (i.e. here Excel). The following information was required:

(1) The road network of the South Island.
(2) The specification of departure, destination and other location points.
(3) The livestock movements for different seasons including the specifications of animal type ('cattle' or 'sheep'), farmers' behaviour ('stood' or 'not stood') and weather conditions ('dry' or 'wet').
(4) The distance a livestock cartage unit could travel without overflowing ('defaecation ' rate).

A suitable South Island road network coverage existed in digitised form but was only available officially for more than $10,000 through the Department of Survey and Land Information (DOSLI). Unfortunately, at that stage of the project (mid 1997), the funding and ownership issues were not resolved. Each Regional Council has access to DOSLI databases. Although the Canterbury Regional Council (CRC) acknowledged that this Lincoln University research was being undertaken in association with the CRC, DOSLI asked for an agreement amongst all South Island Regional Councils to commission this task from Lincoln University. This agreement was only obtained by mid 1998 after the presentation of the educational video. This example demonstrates again the many difficulties that can be involved in multi-stakeholder projects (i.e. here authorities). The video and the work completed at that stage convinced the other councils to agree to the use of the DOSLI road network.

The researcher received an unofficial or Public Domain copy of the South Island road network for 'test' purposes from one of the councils by late 1997. Unfortunately, this copy was not complete and most of the arc information needed editing. A research assistant spent many hours to close the gaps, such as adding missing bridges or further roads. All roads needed to be named. Nodes were then added to spatially register location data on the model. The

next step was to create a 'departure' file that contained the exact location of the depots of all transport companies and some other relevant trip departure locations. A 'destination' file accommodated the location of each point of destination (i.e. saleyards, meat processing plants and farms). The 'Network Analyst' is able to evaluate an 'accessibility' area by defining a starting location and a travel time or distance. This can be illustrated with the following example. Assuming a load of cattle that had not been 'stood' prior to transport is shifted (200 litre effluent tanks) from Geraldine to Picton in 'dry' weather conditions. By using the data base assigned with the maximal distance a truck and trailer unit can travel without overflowing the 200 litre effluent tanks in 'dry' weather conditions (Table 9.6), the 'accessibility' area will be marked by three circles. The first circle has a radius of 100 Km starting from Geraldine, the second circle with a radius of (100 Km + 201 Km) = 301 Km and the third area has a radius of (100 Km + 201 Km + 479 Km) = 780 Km. By overlaying the 'accessibility' area file with the South Island road network coverage file, the intersection points of the State Highway 1 (in this case) and the 'accessibility' boundaries will become the ideal locations for effluent discharge facilities.

This modelling approach proved unsuitable for the following reasons:

(1) The model was not human-machine interactive as it indicated the exact location for a dump site.

(2) Each modelling step was a manual process and automation process did not seem promising. GIS experienced macro-programmers contacted suggested the researcher use Arc/Info instead of ArcView. As 'Avenue', the macro-programming language of ArcView was not used much locally, it was not advisable to take the risk of spending more time with ArcView. It would also be difficult to receive competent assistance for the necessary macro programming.

Further reading on GIS applications and discussions with various governmental institutions using GIS led the researcher to look at the use of Arc/Info. Arc/Info is also a product of ESRI.

10.3.3 Modelling approach through Arc/Info

In collaboration with the GIS macro-programming experts at the International Centre for Antarctic Information and Research (ICAIR), the researcher developed a purpose designed model to assess the effluent spillage situation in the South Island. This Arc/Info model uses standard 'Visual Basic' as the internal programming language and is able to import all previously completed dBase files. A macro or 'accessibility – overflowing' algorithm that calculates and maps what occurs to every stock truck shipment of livestock in the South Island was developed to allow the simulation of different scenarios explained below. Only two possibilities could occur:

(1) A stock truck and trailer unit can reach its destination without any overflowing, and the effluent is deemed to be discharged at this destination.

(2) In case the installed tank capacity on the truck and trailer unit is reached before the final destination and before an intermediate in-transit dump site, spillage starts and is automatically mapped as a triangle. The triangle shows the location where the spillage starts. If in the course of transport, the stock truck unit passes an in-transit dump site and it is calculated that it cannot reach the final destination or another in-transit dump site further along the route, then dumping takes place and the journey resumes from that point with tanks empty but starting to refill. The new refilling rate is determined by the travelled distance to the point of discharge and the current filling rate starting at this point. This filling rate, is fully automated and saved as a dBase file but can be physically checked in the 'defaecation curves' or in the 'defaecation table' (Table 9.6). The model calculates the volumes of effluent that will need to be accommodated at in-transit dump sites, the number of incidences of spillage on the road, and the effluent volumes at destinations.

Through a soft-systems approach of human-machine interaction, it is possible to converge upon a minimum set of in-transit dump sites that will either eliminate all spillage or reduce its incidence to acceptable amounts in less sensitive areas. Details are explained below:

The aim of the model is to compute the pattern of effluent collection and spillage in the South Island of New Zealand by varying the following parameters:

(1) Livestock movements in two different seasons (i.e. 'spring-summer' season and 'summer-autumn' season), including or excluding access through Arthur's Pass and including random incidence of rainfall events.
(2) Current practice of 80% of the livestock 'not stood' prior to transport compared to 50% and 25% in the case of best practice in the future.
(3) The effects of livestock truck and trailer units with effluent containment capacities from 200 to 400 litres.

The finding of an acceptable network of sites was achieved in a two step approach: (1) the assessment of 'spillage' without dump sites, and (2) the reduction of spillage through testing various potential dump site locations. The Arc/Info network location allocation module always uses the shortest distance within the network.

(1) Defining the number and location of spills.

The number and the location of spills needed to be assessed to gain an overview through the 'spillage' maps. This information was obtained through the simulation of 'spillage' models. The data input required for such a 'spillage' simulation was simple as only the model type (i.e. 'a' for the late season model or autumn model), the size of the effluent containment (i.e. '200' litres) and the percentage of livestock that had 'not' been 'stood' (i.e. 80%) were relevant. The example given was known as 'a80_200' (Appendix 5). By considering only the 'summer-autumn' trip assignments or 'autumn model', a total of nine 'spillage' models needed to be run (i.e. a80_200; a50_200; a25_200; a80_300 ...). The same number occurred also for the 'spring' model.

Each Arc/Info simulation was output as a postscript file that was saved as 'Acrobat PDF' files for visual and demonstration purposes. This conversion occurred with the assistance of 'Acrobat Distiller', a software product of

'Adobe Acrobat'. The output was in a map form documenting the South Island road network and covered by triangles. The number of red triangles varied due to the size of the effluent containment and the percentage of stock 'not stood': the bigger the tank size and the smaller the percentage of livestock 'not stood', the fewer red triangles occurred (Appendix 6). The location of each triangle represented the position of one livestock truck that started spilling its overflowing tanks.

(2) Setting up a potential network of dump sites.

The second step was to test various scenarios in order to find a set of acceptable dump sites for various conditions. The spillage maps at the start gave a clear indication of the concentration areas of spillage. The next step was to assess with the involved stakeholder groups and especially with the regional and local authorities the necessity of providing specific 'clean' areas. It quickly became obvious that most problem areas or locations of public complaints were close to the urban areas along State Highway 1 on the East Coast such as south and north of Dunedin. To protect New Zealand's clean green image, roads highly frequented by tourists needed similarly to be protected. These included areas like Lindis Pass in Otago, Lewis Pass between Canterbury and the West Coast, the Greymouth and Buller area, parts of Southland, and port areas. The ports of Nelson and Picton were especially deemed not to have end-point receiving facilities for livestock moving inter-island. The model operates in the way that all trucks heading to a port (i.e. Picton, Nelson) discharge automatically their actual volume of effluent at the dump site located before the port. These two sites were Blenheim and Richmond. The inclusion of Blenheim saleyards in the recommended solution also takes into consideration the possible introduction of a new port at Clifford Bay, south of Blenheim and north of Kaikoura.

The convergence procedure to find an ultimate recommended network of sites in the South Island was simplified by assigning flows for sub regions independently. The simulation processing time could be reduced to

approximately a third of the time compared to a whole model. The analysis of the sensitivity test phase will be discussed in chapter 11.

The set up or preparation status of running a simulation model was fully automated for 'spillage' maps, but required quite a few Arc/Info commands to fix the desired location of test dump sites. However, the researcher found a more elegant way to switch on and off the dump sites by using 'ArcView' and importing the database that included all potential dump site nodes. The two different possibilities are listed in the quick guide for users attached to Appendix 5.

The researcher also took into account the expected opening of the Arthur's Pass-Otira route when the current construction of the Otira viaduct and associated roadwork is completed. These maps are labelled with AP at the end. For practical convenience, the junctions of highways and saleyards adjacent to State Highways were favoured as potential effluent discharge sites. A further aspect was to look at or choose sites that were adjacent or close to an urban sewage system in order to minimise the extent of pump-out and tankerage from the discharge sites to the points of disposal. The most relevant site selection criteria are listed below:

- Be on or adjacent to State Highways (no detours) & close to the intersections identified in the model.
- Be located approximately 500m from residential areas & convenient (i.e. not on a hill climb) for the users.
- Have good visibility in both directions for oncoming traffic consistent with the speed zone, have sufficient space for safe manoeuvring & be safe for users (livestock carriers).
- The identified site should be fully agreed through a consultative process by the stakeholder groups of the specific region.
- Minimise the capital & running costs and consider political issues regarding the acceptance of stock effluent at the end point of destination.

10.4 Potential fault or error sources in the model

10.4.1 Introduction

The outcome of any computer simulation model will be only as accurate as the input data. This section deals with potential error sources that may influence the outcome in some way.

10.4.2 Debugging and calibrating process

The development of the final Arc/Info macros (aml) also involved a debugging process that is certainly part of most development procedures. Some bugs could only be discovered after a certain use of the model and critical assessment of the results. This was the case here as a specific error could not be discovered by running the spillage maps. It became obvious only through the second step by running a model with an identical set of dump sites but comparing the effect of 300 litre with 400 litre tanks. In theory, the total volume of effluent (spillage, in-transit and destination) was supposed to be more or less identical but it was not. This problem was due to interpolation errors that occurred because the 'defaecation ' curves or 'filling up curves of effluent tanks' were interpreted in 100 litre steps. As the curves flattened after a certain travelled distance, the interpolation of two values was not accurate. Using 25 litre steps instead of 100 litres largely eliminated this problem.

10.4.3 Geographical inconsistencies

The model was aimed to simulate the geographical situation as accurately as possible. Unfortunately, like every model, it had some restrictions. To allow a better interpretation of the simulation maps, the most relevant 'inconsistencies' are listed below:

(1) The locations of the potential dump sites are often displayed on purpose at intersections of main highways to capture the total traffic passing this node from any direction. In reality, the sites may need to be located away from

this intersection but not too far distant in order not to lose the cooperation of truck drivers making detours.

(2) The area around Cromwell in Otago was difficult to simulate, as State Highway 6 and 8 run parallel towards Cromwell and are linked by a road section on the northern boundary of the town. The simulation of a dump site at Cromwell however, needed to catch the total traffic passing Cromwell. For this reason, the researcher linked the roads together to a theoretical node.

(3) Truck drivers often take short cuts through small roads for many reasons. The model however, operates only on the base of Main State and Provincial Highways. This phenomenon occurs in the Canterbury Plains and probably in part of Southland. Therefore, a small number of livestock movements are assigned on 'untypical' routes.

(4) The location of one meat processing plant (Canterbury Meat Packers) was shifted from its original location in Seafield to the next city (Ashburton). Unfortunately, the assigned road network had no road linked to Seafield, which is approximately 10 kilometres east of Ashburton.

10.4.4 Errors through restricted data collection or data input

One difficulty in multi-disciplinary research is to manage the adequate balance of intellectual input into each sub research area. The data collection and especially the measurement of effluent produced in-transit in a truck and trailer unit was a 'challenging' job.

The livestock transport companies were reluctant to take the researcher on trips, especially on long-haul journeys, as they did not really wish to lose much time through the measurement process. This factor led, unfortunately, to a rather restricted number of measurements. However, they were sufficiently indicative to represent the reality that has to be modelled. The next uncertainty was related to measured livestock journeys that never exceeded 550 kilometres (i.e. from Ashburton area to Picton). Some of the assigned livestock shipments distances are however longer than 550 kilometres. For this reason the curves

needed to be extrapolated. Although this extrapolation was made in collaboration with animal scientists from Lincoln University, their faces were covered with both a smile and a question mark ... (Elvidge, 1998).

By looking at the actual measurements themselves, the following list of factors might influence the 'defaecation ' curves: i.e. animal type and age, pasture type, 'standing' time off feed, access to water in the holding yards on the farm, outside temperature, cleanliness of the stock crate prior to transport, location of effluent measurement (i.e. on the flat or just after a hilly road section), working order of effluent tank valves, accuracy of measurement (i.e. overflow problem of 10-20 litre buckets due to poorly operating valves). Unfortunately, hardly any valve system operated properly and it happened in many cases that the bucket overflowed as the valve could not be shut quickly enough. The valve location on the truck or trailer sometimes only allowed the use of a 10 litre sized bucket that made the task of the researcher still more 'unpleasant'!

These factors accord with the literature review on animal weight loss issues where all authors mentioned different types of livestock, various ages, different countries and habits etc.

Another factor of concern was the small number of farm to farm trip assignments. The number of farm to farm livestock shipments was relatively small compared to the number of journeys assigned to other destinations. Most farm to farm movements differ from year to year and were not detailed by the transport companies. For this reason in particular, the model contains a feature to allow single trip assignments to evaluate a specific trip. This may be of some interest in the future if a transport company is wondering how to advise their personnel on the most efficient stops to discharge effluent at in-transit sites.

The potential parameters listed above might combine to affect the model but on the other hand, the researcher applied conservative data, choosing for each case a 'defaecation ' curve that was closer to worst case and running the model

in the busiest week in the season. This last factor has been acknowledged in the evaluation of the running costs regarding the volume of effluent discharged at in-transit sites.

10.5 Accuracy of the model

The credibility of the model was an issue the researcher had to defend before many stakeholder groups. The researcher used one way that was partly manual, partly automated. It was easy to extract from the assigned model (i.e. 'autumn' model) a list indicating a distance range (i.e. 100km) and the number or percentage of trips associated (Table 10.1).

Livestock shipment distance [Km]			Number of trips	Percentage
0	-	100	2,187	47.48%
100	-	200	1,220	26.49%
200	-	300	587	12.74%
300	-	400	371	8.05%
400	-	500	164	3.56%
500	-	600	44	0.96%
600	-	700	7	0.15%
700	-	800	10	0.22%
800	-	900	14	0.30%
900	-	1,000	2	0.04%
		SUM	4,606	99.99%

Table 10.1 Overview on the distance of the livestock shipment

Table 10.1 gives an overview on the distance of livestock shipments in the South Island. Just under 50% of the journeys are under 100km and approximately 75% under 200km.

The number or percentage of trips is extracted from the model as 100km sections. The mean value may be different for each section. Nevertheless, the

researcher wanted to demonstrate that by using test values just above the average value (i.e. 60,160, 260, 360, 460 and 560 km) the alternative calculation was feasible and close to the 'exact' results obtained through the model (cf. last line in Table 10.2).

	Cattle full		Cattle stood		Sheep full		Sheep stood	
	100% full	80% full	100% stood	20% stood	100% full	80% full	100% stood	20% stood
Km	Litres	Litres	Litres	Litres	Litres	Litres	Litres	Litres
60	125	**100**	65	**13**	75	**60**	40	**8**
160	275	**220**	132	**26**	158	**126**	85	**17**
260	368	**294**	170	**34**	194	**155**	118	**24**
360	435	**348**	185	**37**	207	**166**	124	**24.8**
460	500	**400**	205	**41**	219	**175**	127	**25.4**
560	540	**432**	220	**44**	225	**180**	132	**26.4**
	Mix of 80% full and 20% stood livestock							
		Cattle	32.6% Cattle		Sheep	67.4% Sheep		
Km		Litres		Litres	Litres		Litres	
60		113	0.326	**37**	68	0.674	**46**	
160		246	0.326	**80**	143	0.674	**96**	
260		328	0.326	**107**	179	0.674	**121**	
360		385	0.326	**126**	190.8	0.674	**129**	
460		441	0.326	**144**	200.4	0.674	**135**	
560		476	0.326	**155**	206.4	0.674	**139**	
Km	Km	Percentage of trips			Litres	Litres		
60	0-100		47.48%	*	83	**39.4**		
160	100-200		26.49%	*	176	**46.6**		
260	200-300		12.74%	*	228	**29**		
360	300-400		8.05%	*	255	**20.5**		
460	400-500		3.56%	*	279	**9.9**		
560	500-600		0.96%	*	294	**2.8**		
	600-1000		0.72%					
	average amount of effluent collected on one trip					**148.2**		
						*		
	number of trips					**4606**		
	amount of effluent collected for 4606 trips through this alternative approach					**682,609**		
	amount of effluent calculated through the spillage maps 80%					**699,788**		

Table 10.2 Alternative search for obtaining an approximate value of stock effluent involved in the South Island

This alternative method considers, as an example, the case of 80% livestock 'not stood' and takes the volume of effluent of the specific 'defaecation ' curves

('dry' weather) that are produced after a certain travelled distance. For example, 'full' cattle produce after 60km 125 litres of effluent. By using only 80% 'full' (100 litres) and 20% 'stood' (13 litres), the total volume for cattle at 60km is 113 litres. As further, cattle represent 32.6% of the South Island livestock, this 113 litres are multiplied by 32.6%. This calculation can be reproduced for sheep. Finally, for a specific distance, the value for cattle and sheep are added together and multiplied by the percentage of trips within that section (i.e. here 0-100km). Now the volume obtained at the specific distance sections is added together and multiplied by the number of assigned trips. This does not represent a real proof, but it indicates its feasibility.

10.6 Further use of the model

The model contains a data input assignment sheet (Table 10.3) that allows the researcher to simulate a range of scenarios. If a regional authority wishes in the future to evaluate the potential change in Otago from sheep farming to dairy farming with regard to the efficiency of the current set of dump sites, this can be easily undertaken. All livestock companies based in Otago would have their assignments switched to cattle. The same is possible for simulating all West Coast based stock carriers with 400 litre tanks and all other regions with 300 litres.

LOCATION REGION Transport Company		Tank Size 200 l	Tank Size 300 l	Tank Size 400 l	Status Quo Assignments (spreadsheets 1-98) Yes (1) No (0)	Status Quo Cattle / Sheep Assignements YES(1) NO(0)	All Cattle (1) No Cattle (0)	All Sheep (1) No Sheep (0)	Status Quo Full / Empty Assignements YES(1) NO(0)	All Full (1) All Empty (0)	Status Quo Wet / Dry Assignements YES(1) NO(0)	All Wet (1) All Dry (0)
West Coast 1	AHAURA	0	1	0	1	1	0	0	0	1	0	0
West Coast 2	GREYMOUTH	0	1	0	1	1	0	0	0	1	0	0
West Coast 3	KARAMEA	0	1	0	1	1	0	0	0	1	0	0
West Coast 4	MURCHISON	0	1	0	1	1	0	0	0	1	0	0
West Coast 5	WESTPORT	0	1	0	1	1	0	0	0	1	0	0
West Coast 6	HARI HARI	0	1	0	1	1	0	0	0	1	0	0
Nelson 1	COLLINGWOOD	0	1	0	1	1	0	0	0	1	0	0
Nelson 2	NELSON	0	1	0	1	1	0	0	0	1	0	0
Nelson 3	NELSON	0	1	0	1	1	0	0	0	1	0	0
xxxx	xxxxx											
Southland 17	WYNDHAM	0	1	0	1	1	0	0	0	1	0	0
Southland 18	WYNDHAM	0	1	0	1	1	0	0	0	1	0	0

Table 10.3 Overview of potential simulation combinations (sheet extract)

10.7 Conclusion

The development of this interactive human-machine Arc/Info model has met the requirements of all parties involved. The model needed to be able to reflect the current behaviour and technical level of the industry and also allow assessment of various scenarios in the future. The output needed to be clear and understandable to the general public. The best feature of this specific model is its interactive human-machine process. The success in implementation or adoption of new practices in general relies on the coordination and collaboration between all parties. Therefore, it is relevant to find efficient ways to link technical solutions with social or political agendas and willingness to process the recommended solutions.

11 RESULTS AND RECOMMENDATIONS

11.1 Introduction

This chapter examines the various outcomes of the model. It starts with the study of the spillage maps and leads to the choice of specific sets of discharge facilities. It assesses individual simulation results and demonstrates the benefits of larger effluent storage tanks in relation to best practice. A specific section covers the capital and the operational costs and indicates some examples.

11.2 Analysis of spillage maps

The first step was to obtain an overview on the number and areas of spillage in the South Island so as to be in a position to advocate a set of appropriately located in-transit discharge sites. The approach taken was to simulate the totality of livestock shipments with a specific effluent storage capacity on the vehicles and a specific stock 'standing' rate. The input parameters were the 'standing' rate of livestock prior to transport (80%, 50%, and 25%) and the effluent storage tank size (200 Litres, 300 Litres, and 400 Litres). Tank sizes larger than 400 litres were not considered as the space on a truck and trailer unit is physically limited. Each red triangle on the maps shows the location of a vehicle that starts spilling due to overflowing effluent tanks (200 to 400 litres) within a specific journey. The spillage maps were indispensable to find appropriate locations for dump sites. The case simulations were started with the 'summer-autumn' model as this model indicates some 4606 consignments of livestock movements in a peak week in the South Island. The early season model or 'spring-summer' model has only 4058 trips assigned. The analysis in this chapter will relate mostly to the 'summer-autumn' model, as it is the relevant model. A relevant set of spillage maps of the 'summer-autumn' model is attached to Appendix 6 (i.e. a80_400; a50_300; a25_200; a25_300; a25_400). Some spillage maps associated to the 'spring-summer' model are also attached to Appendix 6 (i.e. s80_200; s80_400; s25_300; s25_400).

Figure 11.1 outlines a 'summer-autumn' spillage map with 200 litre effluent storage capacity fitted to the vehicle and 80% livestock 'not stood' prior to transport (a80_200).

Figure 11.2 shows also a 'summer-autumn' spillage map (a25_400), however simulating a 400 litre holding tank and assuming best practice (25% livestock 'not stood').

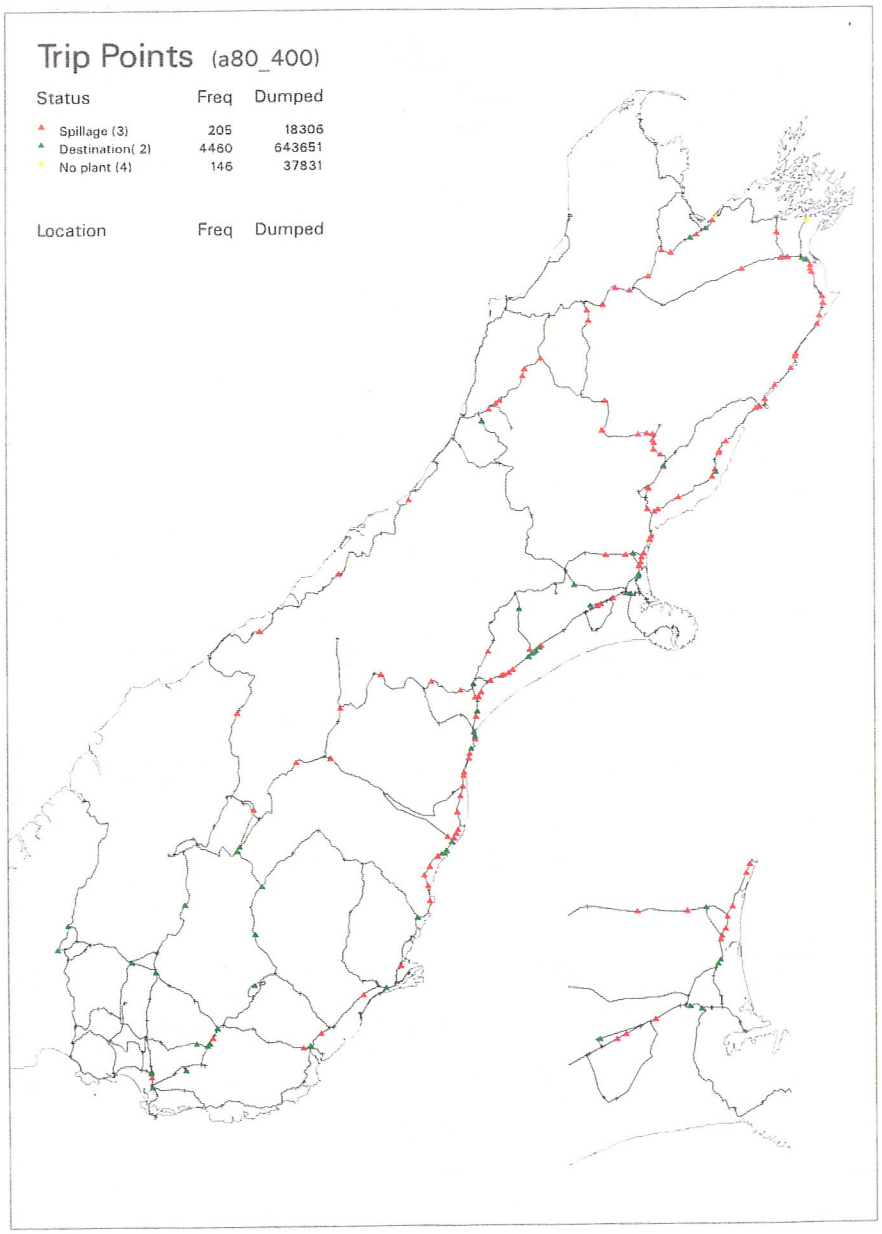


Figure 11.2 Spillage map: autumn 80_400

Table 11.1 analyses the benefits of increasing the effluent storage tanks from 200 Litres to 400 Litres in association with the 'standing' rates of 80%, 50%, and 25% (best practice). This table indicates a spillage reduction of

percent of the South Island owned livestock cartage units are fitted with holding tanks, and the current size varies from 50 Litres to 250 Litres. As 100 Litre tanks are unlikely to be a recommended size in the future, no simulations were run with 100 Litres.

summer/autumn model	200 Litres		300 Litres		400 Litres		Increase of effluent storage containment from 200 Litres to 400 Litres		
80%	FREQ	LITRES	FREQ	LITRES	FREQ	LITRES	200 >> 300	300 >> 400	200 >> 400
							Reduction		
Spillage	1,209	115,111	425	49,281	205	18,306	57%	63%	84%
							Increase		
Destination	4,460	558,449	4,460	617,405	4,460	643,651	10%	4%	13%
							Increase		
Picton & Nelson Ports	146	26,228	146	33,102	146	37,831	21%	13%	31%
TOTAL	5,815	699,788	5,031	699,788	4,811	699,788			
50%	FREQ	LITRES	FREQ	LITRES	FREQ	LITRES	200 >> 300	300 >> 400	200 >> 400
							Reduction		
Spillage	876	83,274	305	35,278	146	13,149	58%	63%	84%
							Increase		
Destination	4,460	490,936	4,460	533,134	4,460	551,316	8%	3%	11%
							Increase		
Picton & Nelson Ports	146	24,900	146	30,698	146	34,645	19%	11%	28%
TOTAL	5,482	599,110	4,911	599,110	4,752	599,110			
25%	FREQ	LITRES	FREQ	LITRES	FREQ	LITRES	200 >> 300	300 >> 400	200 >> 400
							Reduction		
Spillage	625	62,883	218	25,979	114	9,699	59%	63%	85%
							Increase		
Destination	4,460	438,041	4,460	470,743	4,460	484,097	7%	3%	10%
							Increase		
Picton & Nelson Ports	146	21,759	146	25,961	146	28,887	16%	10%	25%
TOTAL	5,231	522,683	4,824	522,683	4,720	522,683			

Table 11.1 Analysis of spillage maps: increase of effluent storage capacity (200 –400 Litres)

The increase of effluent delivered at destination (i.e. meat processor or saleyard) is approximately 10-13 percent. This fact is normal, as the volume of effluent collected in larger tank sizes is potentially higher than for trucks travelling with smaller effluent storage tanks. The results for Picton and Nelson ports are not relevant but the reason for the increase of effluent discharge is the same as for normal destinations. The percentage is higher for these two destinations as the value for all other destinations have been averaged. Table 11.2 looks at the benefits of adoption of best practice.

summer/autumn model	80%		50%		25%		Adoption of better practice throughout all stakeholder groups		
200 Litres	FREQ	LITRES	FREQ	LITRES	FREQ	LITRES	80% >> 50%	50% >> 25%	80% >> 25%
							Reduction		
Spillage	1,209	115,111	876	83,274	625	62,883	28%	24%	45%
Destination	4,460	558,449	4,460	490,936	4,460	438,041	12%	11%	22%
Picton & Nelson Ports	146	26,228	146	24,900	146	21,759	5%	13%	17%
TOTAL	5,815	699,788	5,482	599,110	5,231	522,683	14%	13%	25%
300 Litres	FREQ	LITRES	FREQ	LITRES	FREQ	LITRES	80% >> 50%	50% >> 25%	80% >> 25%
							Reduction		
Spillage	425	49,281	305	35,278	218	25,979	28%	26%	47%
Destination	4,460	617,405	4,460	533,134	4,460	470,743	14%	12%	24%
Picton & Nelson Ports	146	33,102	146	30,698	146	25,961	7%	15%	22%
TOTAL	5,031	699,788	4,911	599,110	4,824	522,683	14%	13%	25%
400 Litres	FREQ	LITRES	FREQ	LITRES	FREQ	LITRES	80% >> 50%	50% >> 25%	80% >> 25%
							Reduction		
Spillage	205	18,306	146	13,149	114	9,699	28%	26%	47%
Destination	4,460	643,651	4,460	551,316	4,460	484,097	14%	12%	25%
Picton & Nelson Ports	146	37,831	146	34,645	146	28,887	8%	17%	24%
TOTAL	4,811	699,788	4,752	599,110	4,720	522,683	14%	13%	25%

Table 11.2 Analysis of spillage maps: from current to best practice

The effluent spillage reduction by modifying the livestock 'standing' rate from 80% to 25% (best practice) is approximately 45-47%. This percentage is less by comparison with the reduction obtained through increasing the size of a vehicle effluent storage capacity from 200 to 400 Litres. The move towards adoption of best practice throughout the supply chain reduces the total production of effluent. This can only be achieved through the timely exchange of information and coordination along the supply chain. Good stock preparation and adoption of best practice contribute to the ultimate high quality of end products.

This is the reason for the reduction of effluent over all (spillage, destination and ports). Even if the reduction of effluent achieved between the 80% and 25% 'not stood' models is not as high as some stakeholders expected, it needs to be stressed that reducing the volume of effluent produced in-transit, will reduce the costs as it reduces collection and treatment costs. The recommended solution is a mixture of both, the fitting of larger tanks and the adoption of best practice throughout the whole chain.

summer/autumn model	80%		25%		80% to 25%
	200 Litres		400 Litres		200 Litres to 400 Litres
	FREQ	LITRES	FREQ	LITRES	
					Reduction
Spillage	1209	115,111	114	9,699	92%
					Reduction
Destination	4460	558,449	4460	484,097	13%
					Increase
Picton & Nelson Ports	146	26,228	146	28,887	10%
					Reduction
TOTAL	5815	699,788	4720	522,683	25%

Table 11.3 Analysis of spillage maps: combination of the increase of effluent storage capacity and the adoption of best practice

Table 11.3 outlines the benefits of adoption of best practice ('standing' rate from 80% to 25% and increase of tank size from 200 to 400 Litres). The results shown in table 11.3 indicate a total reduction of effluent of 25 percent. If the percentage of cattle was to increase in the South Island, this percentage would rise, as cattle are the main source of effluent production. The effluent to be dealt with at destination is also reduced, although not at the inter-island ports.

This last table outlines clearly that there is a real advantage in obtaining an agreement with the Road Transport Industry to fit larger tanks on all new truck and trailer units produced and to run an extensive and efficient educational programme to support the adoption of best practice throughout the livestock supply chain.

The outcome of the 'spring-summer' model is similar to the 'summer-autumn' model. The total volume of effluent is approximately 19 percent lower (Appendix 6).

11.3 Network of effluent discharge sites

11.3.1 Introduction

Many destinations are not able, in practical terms, to receive effluent with the livestock delivery or decline to accept it for a variety of reasons. There are no public facilities for dumping. Consequently effluent is spilled on roads or at inappropriate locations causing nuisance and risk to other road users and damage to New Zealand's clean green tourism image. The spillage maps, discussed in the previous section, identify the problem areas. The next section outlines a specific network of dump sites for each scenario (i.e. 'standing' rate of livestock and effluent tank size) aimed to minimise the spillage in the South Island. Besides identifying a minimum set of sites, the recommended network is aimed at a cost-effective solution.

11.3.2 Sub-models

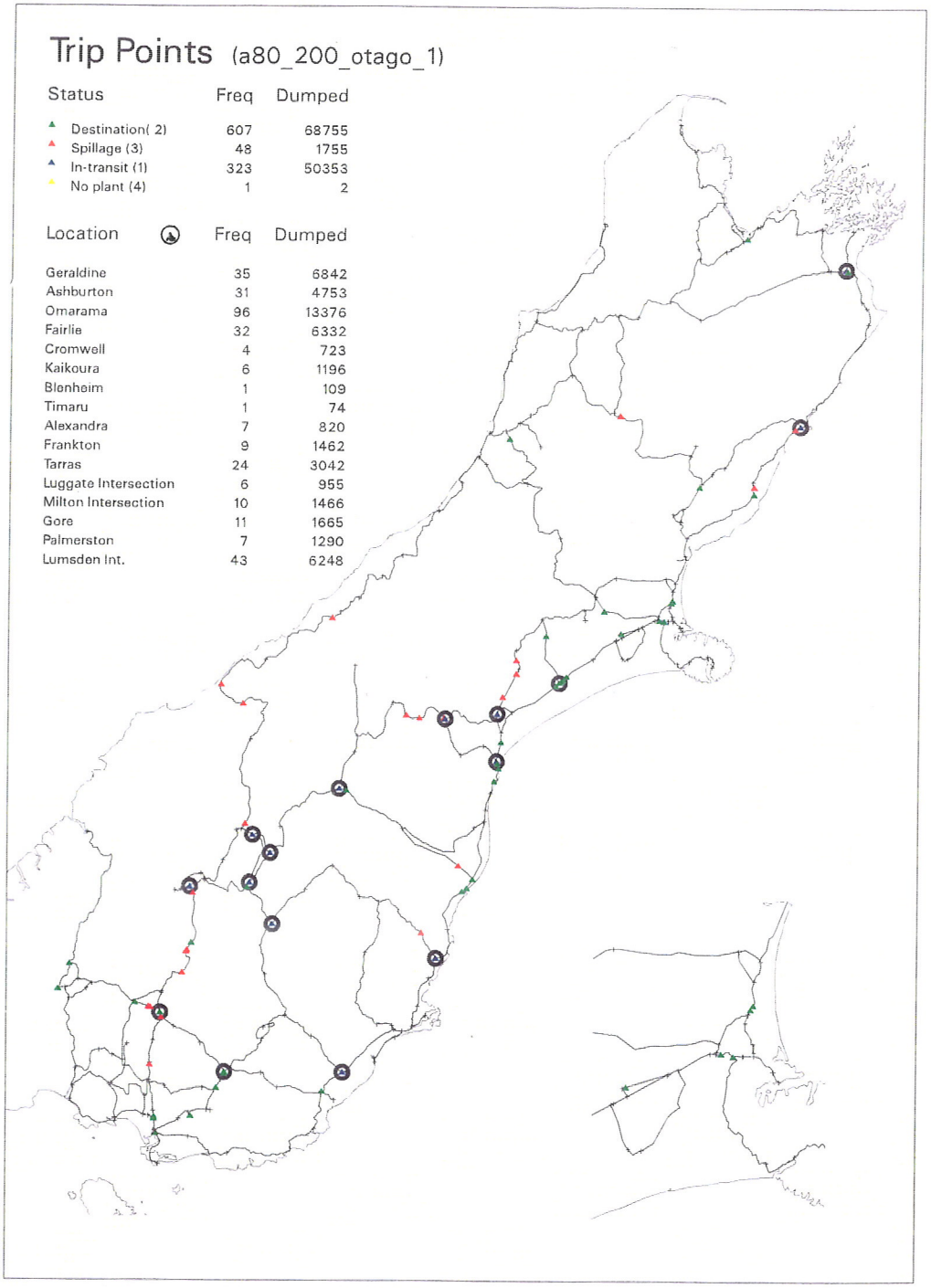
As part of the convergence procedure to distil an ultimate recommended network of discharge site in the South Island, it proved appropriate in terms of processing times to assign flows in sub regions independently, then join those solutions and apply sensitivity testing. The areas were split into (1) the 'Buller' region, including the northern part of the South Island and going as far as Christchurch, (2) the 'Otago' region, (3) the 'Southland' region, and (4) the 'East Coast' area. Table 11.4 indicates the number of sub model simulations.

regions		number of simulations
Buller		25
Otago		39
Southland		29
East Coast		12
total		**105**

Table 11.4 Overview on sub model simulations

The procedural steps in the specific sub modelling exercise started with using a specific spillage map (i.e. autumn80_300) to suggest potential suitable locations for discharge sites. Specific nodes can be switched to become dump sites. This switching 'on' or 'off' can be done in 'Arc/Info' or in 'ArcView' (cf. 'quick user guide for the model', Appendix 5). The main difference is that in the case of using Arc/Info the sites need to be switched on/off within the road network coverage map displayed in 'Arc/Info' (i.e. Arcedit). This can be tricky, as the map needs to be manipulated (i.e. using the magnifying functions) with many Arc/Info commands. The other option is a mixture of 'Arc/Info' and 'ArcView'. The setting of dump sites is relatively easy by loading the files containing the potential nodes into a spreadsheet. The spreadsheet form allows a better general picture of the situation compared to the 'Arc/Info' road network input that is difficult to overview due to the small size of the screen.

The choice of dump sites needs to be assigned before the run of a new simulation. The final output can be transformed from an encapsulated postscript file into a PDF file format to allow easy viewing on the screen and printout on any colour printer. Figure 11.3 gives an example of a sub model simulation.



As the journeys are usually assigned through more than one sub-region, a few more potential dump sites needed to be switched on. This was important, as otherwise some trucks driving into the region might already have reached the overflowing status prior to entering the specific sub-region.

The analysis of each map outcome contributed to a new combination of dump sites to be tested in the next simulation run. The red triangles displayed in the map, outlined the location of specific stock trucks that started spilling effluent due to overflowing tanks. The green triangles represent the destinations and the two yellow triangles the ports (no plant). It was important to gain a good feeling for the location allocation of those trips for adjusting the dump sites in the next simulation run. Therefore, it is suitable that the person in charge of the livestock trip assignments is also running the sensitivity testing operations. The model is able to detail individual trips and determine the point of departure, route and destination. However, this procedure using 'Arc/Info' is only suitable for troubleshooting problem assignments (i.e. checking a specific spillage triangle), as it involves the assignment of all input parameters.

From the practical point of view, an efficient heuristic way for finding a suitable set of dump sites, is to start with a small number of sites, juggling with this small number to optimise locations, then building from there towards an ideal coverage. The researcher also approached the problem by starting with far more dump sites than necessary to try avoiding spillage, then reducing from that number to the minimum set that met requirements. The first method was faster and thus more efficient.

11.3.3 400 Litre effluent storage containment

11.3.3.1 Introduction

After the run of the sub-models, it was time to converge this information and run the full models. It was at this stage far easier to decide which node to use as a potential dump site. The sub-models only gave an indication where to locate

discharge sites but could not give a complete accounting of the volume of effluent discharged at specific sites, as some journeys passed through several sub regions.

Around 50 simulations were required to find a defensible set of dump sites when considering an effluent storage capacity of 400 Litres on vehicles. Thirty models were assigned with the 'summer-autumn' journeys, with around 20 simulations to double-check those results by using the 'spring-summer' model. The first 30 'summer-autumn' simulations in the first series excluded the use of the transalpine Arthur's Pass road, while the second one included it. Maps with AP in their code (i.e. a80_400_13AP) had Arthur's Pass open. The following two examples demonstrate the code system.

a80_400_13AP	**a**	summer-**a**utumn model
	80	80% livestock 'not stood'
	400	tank size: 400 Litres
	13	simulation number
	AP	including access to Arthur's Pass
S25_300_34	**s**	**s**pring-summer model
	25	25% livestock 'not stood' (best practice)
	300	tank size: 300 Litres
	34	simulation number
		no AP means no access to Arthur's Pass

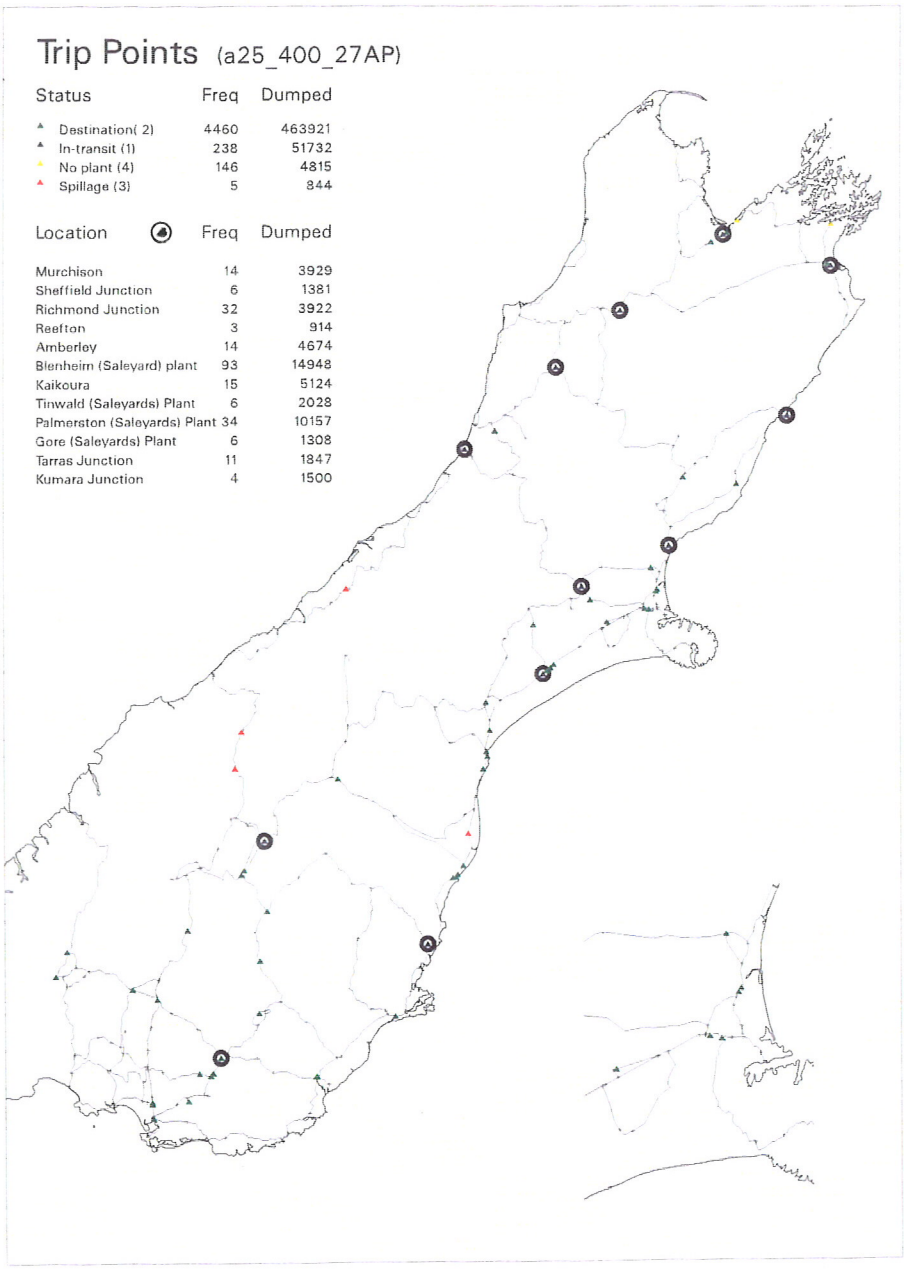
The aim was to develop two networks of sites: one to represent a minimum volume of effluent spillage and the other to identify a recommendable cost efficient solution. This involved also a distinction between the different livestock 'standing' rates. For the final results only the 80% and 25% rate are here outlined in detail.

Running these full model simulations was time consuming. The hardware consisted of a PC type Pentium II 450MHz fitted with 128MB SDRAM. Ideally,

another 128 MB Ram memory chip would have accelerated the calculation process. The whole procedure took approximately 4 hours plus 30 minutes to set up the input data and extract the output data.

11.3.3.2 Network of dump sites for minimum spillage

The simulation test 27 (Figure 11.4) was identified for the 'summer-autumn' model as the model representing the lowest number or volume of spillages.



This model was assigned with 11 or 12 dump sites depending whether Arthur's Pass road was available for transit. For the 'summer-autumn' model only 5 cases of spillage are registered. This spillage could only be avoided by adding further discharge sites along the West Coast of the South Island. As the assignments regarding the rate of livestock 'not stood' prior to transport were done randomly, the specific volume of effluent being spilled for 80% livestock 'not stood' is higher than for 25% (best practice). This higher volume is only due to one or two trips but the general volume of effluent collected in-transit and at destination is far lower for 25% compared to 80%.

Number of dump sites	11		12		11		12	
25%	autumn model				spring model			
Map number	Test 27		Test 27 AP		Test 27		Test 27 AP	
			Arthur's Pass open				Arthur's Pass open	
	Freq	Dumped [Litres]	Freq	Dumped [Litres]	Freq	Dumped [Litres]	Freq	Dumped [Litres]
Spillages	5	874	5	844	8	357	7	322
In - transit	242	53,695	238	51,732	156	35,171	153	33,500
Richmond Junction	32	3,922	32	3,922	18	1,902	18	1,902
Blenheim (sale yard)	93	14,948	93	14,948	66	10,177	66	10,177
Murchison	14	3,929	14	3,929	5	1,694	5	1,694
Kaikoura	15	5,124	15	5,124	6	2,062	6	2,062
Reefton	7	2,288	3	914	7	2,162	3	1,050
Kumara Junction	3	1,200	4	1,500	5	1,822	6	2,140
Amberley	20	6,659	14	4,674	15	5,124	11	3,736
Sheffield Junction			6	1,381			4	532
Ashburton / Tinwald	6	2,028	6	2,028	6	1,957	6	1,957
Timaru / Washdyke								
Tarras Junction	12	2,132	11	1,847	9	2,218	9	2,218
Palmerston (sale y.)	34	10,157	34	10,157	16	4,855	16	4,834
Gore	6	1,308	6	1,308	3	1,198	3	1,198
Destinations	4,460	463,165	4,460	463,921	3,965	388,467	3,965	389,226
Ports	146	4,815	146	4,815	93	2,043	93	2,043
TOTAL	4,848	521,675	4,844	520,468	4,222	426,038	4,218	425,091

Table 11.5 Effluent data associated with 11/12 sites indicating minimum spillage, 400 Litre tanks and best practice (25% 'not stood')

Table 11.5 outlines the results of the 'summer-autumn' and the 'spring-summer' model by assuming a status quo situation or 25% of the livestock 'not stood'.

A few more maps including a list of volumes of effluent discharged at destination and an overview of costs are displayed for 25% and 80% livestock 'not stood' in Appendix 6 (i.e. a25_400_27AP; s25_400_27AP; a25_400_27; a80_400_27AP). Due to best practice, more journeys can reach destination and less effluent needs to be discharged in-transit. Best practice or 75% of the livestock being 'stood' contributes to a total reduction of effluent of around 25%.

11.3.3.3 Recommended network of dump sites for 400 Litre tanks

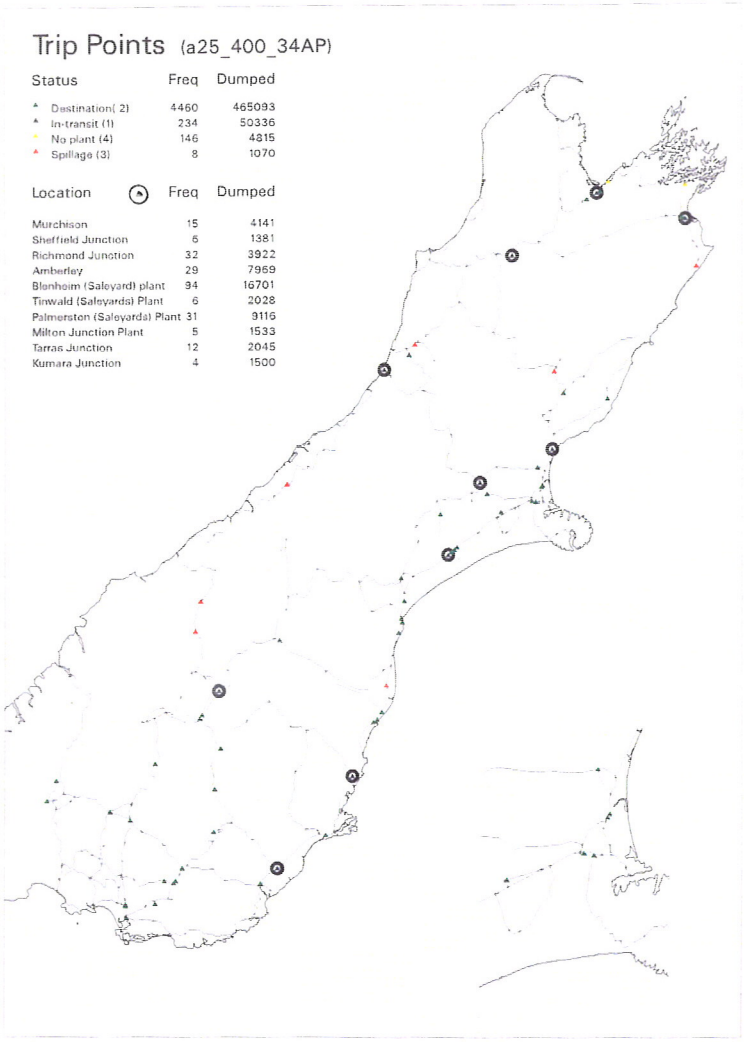


Figure 11.5 Network of 10 dump sites indicating the recommended network

The recommended network of 10 dump sites (Arthur's Pass open) is similar to the structure of 12 sites aiming for minimising the spillage. The dump sites located in Reefton and in Kaikoura could be dropped for the case of 75% livestock 'stood' prior to transport. In order to ensure that for political reasons no effluent is spilled south of Dunedin, it became necessary to shift a site from Gore to Milton Junction.

Number of dump sites	9		10		9		10	
25%	autumn model				spring model			
Map number	a25_400_34		a25_400_34 AP		s25_400_34		s25_400_34 AP	
			Arthur's Pass open				Arthur's Pass open	
	Freq	Dumped [Litres]	Freq	Dumped [Litres]	Freq	Dumped [Litres]	Freq	Dumped [Litres]
Spillages	9	1,104	8	1,070	9	522	6	438
In - transit	237	51,497	234	50,336	155	34,204	152	32,565
Richmond Junction	32	3,922	32	3,922	18	1,902	18	1,902
Blenheim (sale yard)	94	16,701	94	16,701	66	10,817	66	10,817
Murchison	15	4,141	15	4,141	8	2,396	8	2,396
Kaikoura								
Reefton								
Kumara Junction	4	1,393	4	1,500	5	1,822	6	2,140
Amberley	37	10,333	29	7,969	25	7,465	17	4,997
Sheffield Junction			6	1,381			4	532
Ashburton / Tinwald	6	2,028	6	2,028	6	1,957	6	1,957
Timaru / Washdyke								
Tarras Junction	13	2,330	12	2,045	8	2,009	8	2,009
Palmerston (sale y.)	31	9,116	31	9,116	16	4,855	16	4,834
Milton Junction	5	1,533	5	1,533	3	981	3	981
Destinations	4,460	465,171	4,460	465,093	3,965	389,321	3,965	390,043
Ports	146	4,815	146	4,815	93	2,043	93	2,043
TOTAL	4,843	521,483	4,840	520,244	4,222	426,090	4,216	425,089

Table 11.6 Effluent data associated with recommended network of 9/10 sites, 400 Litre tanks and best practice (25% 'not stood')

Table 11.6 indicates that only 4 livestock cartage units discharge at Kumara Junction and 5 at Milton Junction over the period of one week. These sites were nevertheless chosen, as in the case of Kumara Junction, the Arthur's Pass road and the Greymouth area needed to be protected, as they are main tourist areas. The site at Milton Junction is relevant to protect Dunedin's southern entrance.

Further simulations (i.e. a25_400_34AP; s25_400_34AP; a25_400_34; a80_400_35AP) are attached to Appendix 6. They also include like the volume of effluent discharged at various destinations and the costs involved for the network of in-transit sites.

The fitting of 400 Litre effluent containment to each truck and trailer livestock cartage unit is unlikely to be adopted instantaneously. Therefore, it was desirable to analyse the same scenarios for 300 litre effluent containment.

11.3.4 300 Litre effluent storage containment

11.3.4.1 Network of dump sites for minimum spillage

The first step for the 300 Litre simulations was to provide a network of sites that would minimise the spillage. This network consisted of 19 sites by allowing trucks to access the Arthur's Pass road (test model 29). The spillage was reduced to 96.2% or minimised to 3.8% by using the same comparison base (i.e. here simulation model a25_300_29AP). A total of 63 simulations (45 'summer-autumn' and 18 'spring-summer' models) were run for a potential interim solution of 300 litre containment size. Figure 11.6 shows the version indicating best practice a25_300_29AP.

Appendix 6 includes further maps, such as the same network simulated with the 'spring-summer' model (s25_300_29AP), or with the assumption of Arthur's Pass closed (a25_300_29), or with 80% stock 'not stood' (a80_300_29AP).

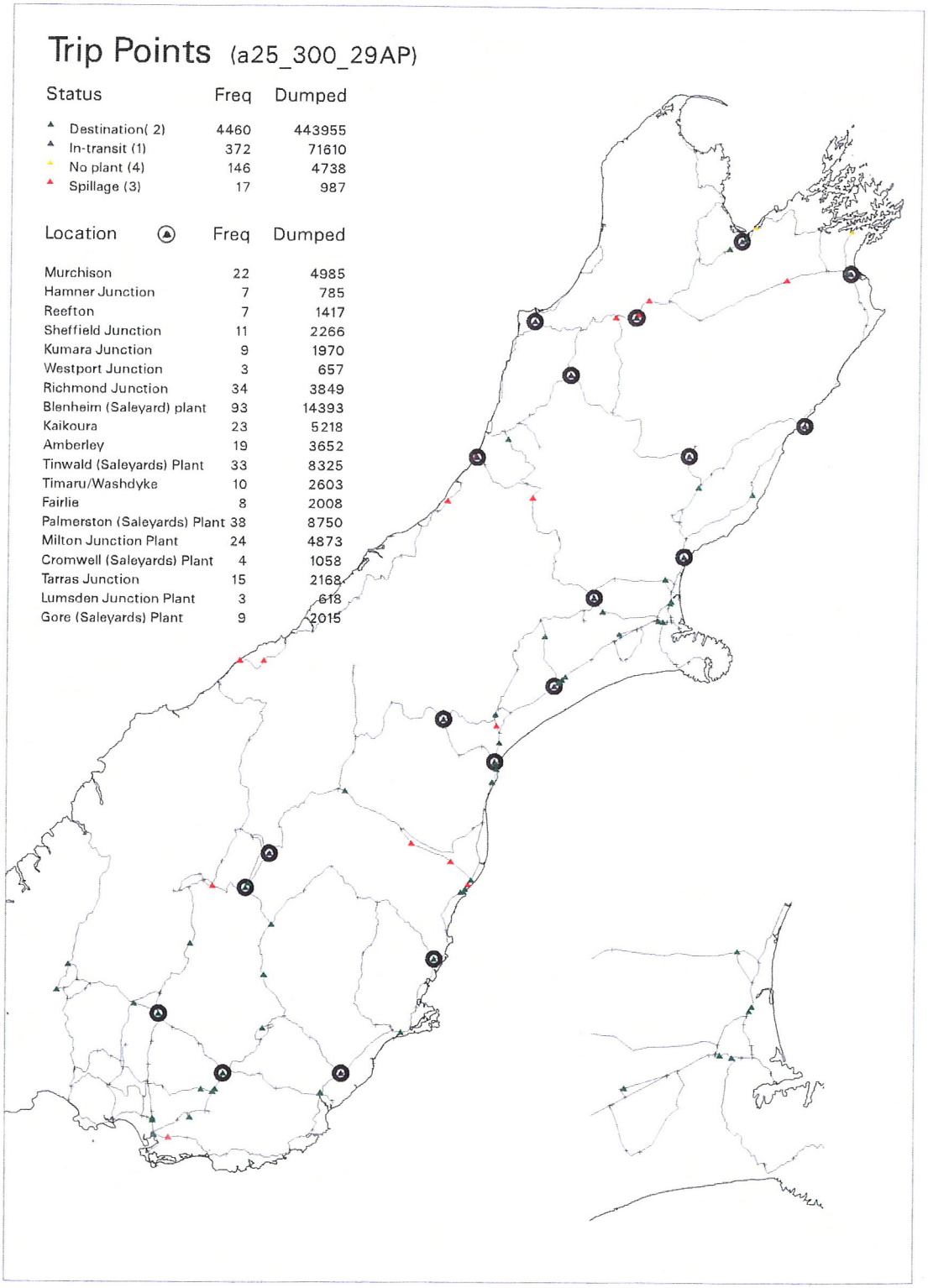


Figure 11.6 Network of 19 dump sites indicating minimum spillage, 300 Litre tanks, best practice (25% 'not stood'), Arthur's Pass open

Table 11.7 indicates the volume of effluent collected at the different dump sites

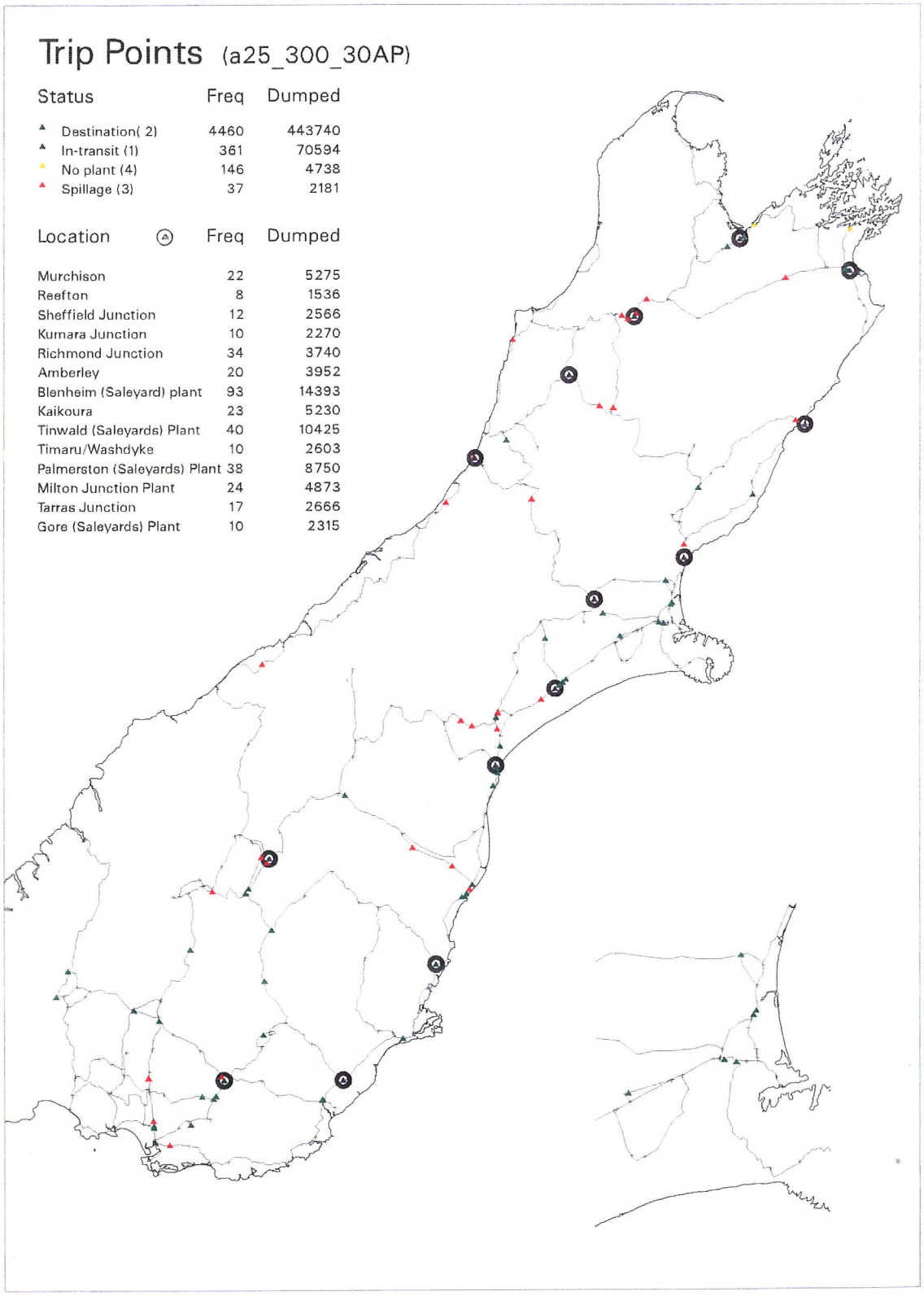
Number of dump sites	18		19		18		19	
25%	autumn model				spring model			
Map number	a25_300_29		a25_300_29 AP		s25_300_29		s25_300_29 AP	
			Arthur's Pass open				Arthur's Pass open	
	Freq	Dumped [Litres]	Freq	Dumped [Litres]	Freq	Dumped [Litres]	Freq	Dumped [Litres]
Spillages	19	1,080	17	987	25	861	26	816
In - transit	374	72,786	372	71,610	262	53,323	258	51,428
Richmond Junction	34	3,849	34	3,849	20	1,964	20	1,964
Blenheim (sale yard)	93	14,213	93	14,393	67	9,959	67	9,959
Westport Junction	3	657	3	657	3	657	4	852
Murchison	22	4,985	22	4,985	14	2,815	14	2,815
Kaikoura	24	5,398	23	5,218	14	3,382	14	3,382
Reefton	12	2,540	7	1,417	11	2,565	5	1,141
Hamner Junction	13	2,113	7	785	7	1,877	4	1,104
Kumara Junction	5	1,387	9	1,970	6	1,800	8	1,890
Amberley	22	4,629	19	3,652	12	2,836	10	2,236
Sheffield Junction			11	2,266			5	916
Ashburton / Tinwald	34	8,637	33	8,325	18	4,365	17	4,066
Timaru / Washdyke	10	2,603	10	2,603	15	3,504	15	3,504
Fairlie	8	2,008	8	2,008	4	970	4	970
Tarras Junction	16	2,453	15	2,168	8	1,537	8	1,537
Cromwell	4	1,058	4	1,058	12	2,354	12	2,354
Palmerston (sale y.)	38	8,750	38	8,750	24	6,047	24	6,047
Milton Junction	24	4,873	24	4,873	13	3,253	13	3,253
Lumsden Junction	3	618	3	618	4	900	4	900
Gore	9	2,015	9	2,015	10	2,538	10	2,538
Destinations	4,460	443,926	4,460	443,955	3,965	369,840	3,965	370,861
Ports	146	4,738	146	4,738	93	2,043	93	2,043
TOTAL	4,999	522,530	4,995	521,290	4,345	426,067	4,342	425,148

Table 11.7 Effluent data associated with 18/19 sites indicating minimum spillage, 300 Litre tanks and best practice (25% 'not stood')

11.3.4.2 Recommended network of dump sites for 300 Litre tanks

Considering that 19 sites represented a big cost factor, further investigations were required to move towards a more cost efficient network of sites. Finally, five previous planned sites were abandoned for the model representing best practice or 25%: (1) Westport Junction, (2) Hamner Junction, (3) Fairlie, (4) Cromwell, and (5) Lumsden Junction. The remaining recommended network is

shown in figure 11.7. It includes all 10 sites of the recommended network for 400 litres.



This selected model including 14 sites (Arthur's Pass open) achieves a reduction of spillage of 91.6%. Compared to the previous site selection (a25_300_29AP), 5 minor dump sites were removed to lower the overall costs. The elimination of these sites mainly affects the areas around Fairlie, Lewis Pass and the northern West Coast. Key saleyards in Blenheim, Ashburton, Palmerston and Gore are candidates for both destination and in-transit effluent reception points. Table 11.8 gives an overview of the effluent situation and in particular the volume discharged at the various in-transit sites.

This model is designed for each destination (except the ports) to receive the effluent collected in the truck and trailer units with the delivered livestock. In case anyone of the destinations refuse to accept the effluent, as they might already be at the limits of their resource consent regarding the discharge of waste, the strategic location of these 14 in-transit dump sites means that trucks could empty their storage tanks at the last in-transit discharge site before delivery at final destination and have only small volumes of effluent to discharge at their own depots or en route to their next livestock pick-up point.

Comparing the 300 litre and 400 litre effluent storage capacities in association with the amount of effluent collected, more effluent is dumped with the 300 litre tanks at the in-transit sites while more effluent is discharged with 400 litre tanks at destinations.

Appendix 6 includes a full size map of a25_300_30AP and two further scenario maps for the recommended network (s25_300_30AP; a25_300_30). In order to show the impact of additional sites or a reduced network of sites three further maps are attached to Appendix 6 (a80_300_11; a80_300_27AP; a25_30_31AP).

Number of dump sites	13		14		13		14	
25%	autumn model				spring model			
Map number	a25_300_30		a25_300_30 AP		s25_300_30		s25_300_30 AP	
			Arthur's Pass open				Arthur's Pass open	
	Freq	Dumped [Litres]	Freq	Dumped [Litres]	Freq	Dumped [Litres]	Freq	Dumped [Litres]
Spillages	**41**	**2,298**	**37**	**2,181**	**40**	**1,567**	**42**	**1,540**
In - transit	**363**	**71,574**	**361**	**70,594**	**257**	**52,503**	**253**	**51,095**
Richmond Junction	34	3,740	34	3,740	20	1,855	20	1,855
Blenheim (sale yard)	93	14,213	93	14,393	67	9,959	67	9,959
Westport Junction								
Murchison	22	5,275	22	5,275	15	3,492	15	3,492
Kaikoura	24	5,410	23	5,230	14	3,382	14	3,382
Reefton	16	3,404	8	1,536	16	3,126	9	1,591
Hamner Junction								
Kumara Junction	6	1,687	10	2,270	6	1,800	9	2,190
Amberley	27	5,616	20	3,952	16	3,654	12	2,774
Sheffield Junction			12	2,566			5	916
Ashburton / Tinwald	41	10,737	40	10,425	22	5,565	21	5,266
Timaru / Washdyke	10	2,603	10	2,603	15	3,504	15	3,504
Fairlie								
Tarras Junction	18	2,951	17	2,666	15	3,128	15	3,128
Cromwell								
Palmerston (sale y.)	38	8,750	38	8,750	24	6,047	24	6,047
Milton Junction	24	4,873	24	4,873	14	3,553	14	3,553
Lumsden Junction								
Gore	10	2,315	10	2,315	13	3,438	13	3,438
Destinations	**4,460**	**443,875**	**4,460**	**443,740**	**3,965**	**369,849**	**3,965**	**370,366**
Ports	**146**	**4,738**	**146**	**4,738**	**93**	**2,043**	**93**	**2,043**
TOTAL	**5,010**	**522,485**	**5,004**	**521,253**	**4,355**	**425,962**	**4,353**	**425,044**

Table 11.8 Effluent data associated with recommended network of 13/14 sites, 300 Litre tanks and best practice (25% 'not stood')

11.3.5 200 Litre effluent storage containment

The livestock cartage units currently fitted with effluent tanks in the South Island generally reach a maximum of 250 litres, while the average holding tank size is approximately 100- 150 litres. Therefore, it was relevant to find out the number of dump sites required in case the industry was not prepared to retrofit larger tanks. Only a few scenarios were simulated as more than 30 dump sites were required to cover the main areas. Model number 16 (a80_200_16), attached in the Appendix 6, shows a frequency of 201 cases of overflowing tanks or 6,502 litres spilled on the road. This emphasises that a 200 litre effluent containment capacity for a truck and trailer unit should not be considered in any implementation programme. In order to demonstrate the impact of 200 litres on two networks discussed in the previous sections, two further maps (a25_200_29AP & a25_200_30AP) are attached to Appendix 6.

11.4 Cost analysis

11.4.1 Introduction

No matter the type of technical project under consideration, the economic factor is always important to the decision-makers. The more expensive a project appears, the more likely it is to be shelved. Therefore, it was relevant to present a detailed cost analysis as a final recommendation had to be cost-effective.

Besides the costs of the dump sites analysed in the following sections, the capital costs of fitting or retro-fitting larger effluent containment to all truck and trailer units in the South Island could reach more than $ 1 million (NZ). The average fitting costs per truck and trailer unit are estimated around $2,000 (NZ) (Currie, 1999). The costs do not alter much between 300 and 400 litre tanks.

11.4.2 Capital costs

The capital costs are split into the categories 'A' and 'B' to allow a more realistic approach. Category 'A' represents the installation of an effluent

discharge facility while category 'B' also includes the costs of an additional storage tank at the closest wastewater treatment plant. It was not part of this research to find treatment solutions for the collected effluent. The storage tank is added to the capital costs, as the researcher perceived that most sewage treatment plants are operating near their maximum capacities. This specific storage tank would allow, as an interim solution, buffering of the effluent to enable a slow dilution into the sewage treatment system. It is seen as an advantage to monitor first the volume of effluent over one season before deciding on the best treatment systems. Thus solution 'B', including this optional tank, is applied in the cost evaluation process regarding the different networks of dump sites.

The table 11.9 outlines an overview of potential capital costs by giving three options regarding the roading infrastructure. These costs can vary enormously depending on the future location of the dump sites. In case a site is planned to be located at a saleyard, a weigh bridge or any other sealed area within a speed reduced zone, the costs for example of a lay-by or a deceleration & acceleration space can be eliminated (case B3). If an existing site is available on an open road, the costs of a lay-by do not need to be considered, however, all other features such as road widening to provide a right turn bay, acceleration & deceleration space, road marking and signage are included (B2). B1 represents the case of non-existing roading infrastructure. The individual costs were derived with the help of North Island authorities who were responsible for the installation of the two sites in the Waikato area.

The construction costs involve a receptor (Chapter 12), a cattle stop, excavation or earthwork, a collection tank and associated pipelines. The equipment costs are based on the supply and installation costs of a telemetry outstation. This station includes an ultrasonic probe, a solar power panel and a battery. The telemetry system will be connected to the council's main telemetry station to monitor the filling rate of the effluent collection tank of a specific dump site.

		Installation of effluent discharge facility			Installation of effluent discharge facility + pre-treatment on-site or off-site		
		A 1	A 2	A 3	B1	B 2	B 3
		no existing roading infrastructure	existing roading infrastructure (ie. one roadside) on open road	existing roading infrastructure (ie. weighbridge) or location within a speed reduced zone (truck stop, saleyard), signage required	no existing roading infrastructure	existing roading infrastructure (ie. one roadside) on open road	existing roading infrastructure (ie. weighbridge) or location within a speed reduced zone (truck stop, saleyard), signage required
1	**construction**						
1.1	construct reinforced concrete receptor for stock effluent including excavation, boxing, associated pipework, cattle stop grill, hotmix surround	$13,000	$13,000	$13,000	$13,000	$13,000	$13,000
1.2	supply and install in-ground holding concrete tank of approx. 23 m^3, including all parts	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
1.3	construction & supply of a dual septic tank with filter seepage trench on-site and irrigation storage or off-site storage tank including agitator and pump enabling controlled and dosed input to a town sewage treatment plant	-	-	-	$25,000	$25,000	$25,000
	total construction:	**$18,000**	**$18,000**	**$18,000**	**$43,000**	**$43,000**	**$43,000**
2	**roading infrastructure**						
2.1	road widening to provide for a right turn bay, acceleration & deceleration space, deceleration taper, roadmarking, signage	$28,000	$28,000	$3,000	$28,000	$28,000	$3,000
2.2	construct lay-by one side of the road on reasonable flat terrain including earthworks, drainage, pavement construction (except for saleyards sites)	$30,000	-	-	$30,000	-	-
	total roading infrastructure:	**$58,000**	**$28,000**	**$3,000**	**$58,000**	**$28,000**	**$3,000**
3	**equipment**						
3.1	supply & install telemetry outstation complete with ultrasonic probe, solar power panel & battery (telemetry costs for main station excluded)	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000
	total equipment:	**$10,000**	**$10,000**	**$10,000**	**$10,000**	**$10,000**	**$10,000**
	Grand total:	**$86,000**	**$56,000**	**$31,000**	**$111,000**	**$81,000**	**$56,000**

Table 11.9 Capital costs excluding land purchase, administrative and planning fees, and goods & services tax (GST)

The costs mentioned in table 11.9 exclude land purchase, administrative and planning fees, and the goods & services tax (GST).

11.4.3 Operational costs

This section outlines the operational costs or running costs that may occur over the period of one year. It is important to separate these costs as the capital costs may be paid by a combination of parties, while the running costs are more likely to be covered by regional or local authorities. It is probably less difficult to find an agreement on a funding formula towards the capital costs as a whole unit than to deal with the running costs of each individual site. The difficulty is increased by the fact that some areas, such as the territory covered by the Canterbury Regional Council may have 5 sites, while the Southland Regional Council may only need 1 site (based on the recommended version of 14 sites).

There are two philosophies for representing the running costs: (1) by including the capital costs and using annuity factors to simulate the fact of borrowing the capital, or (2) by excluding the capital costs and only considering the repair and maintenance costs and the operating costs.

Generally speaking, running costs can be divided into fixed and variable costs. The repair and maintenance costs (R&M) regarding the construction, the roading infrastructure and the equipment belong to the fixed costs. The fixed costs can also include the depreciation factor (i.e. 25 years for constructions and roading infrastructure) by using annuity factors on the capital costs if the funds need to be borrowed. Table 11.10 outlines the analysis of running costs on the basis of borrowing the capital. The analysis of the operational costs excluding the capital costs is attached for completion in Appendix 6.

The variable costs are operational expenses that include features such as checking and cleaning the site, monitoring and sampling the quality of the effluent, and tankering costs. Table 11.10 does not include tankering costs as they differ from site to site, depending on the volume of effluent collected. Despite the fact that collected effluent at each dump site may be dealt with in a different way, it has been assumed, for simulation purposes, to be transport to the nearest wastewater treatment plant.

			Installation of effluent discharge facility			Installation of effluent discharge facility + pre-treatment on-site or off-site		
			A 1	A 2	A 3	B1	B 2	B 3
			no existing roading infrastructure	existing roading infrastructure (ie. one roadside) on open road	existing roading infrastructure (ie. weighbridge) or location within a speed reduced zone (truck stop, saleyard), signage required	no existing roading infrastructure	existing roading infrastructure (ie. one roadside) on open road	existing roading infrastructure (ie. weighbridge) or location within a speed reduced zone (truck stop, saleyard), signage required
1	**Capital costs**							
1.1	**construction:**		$18,000	$18,000	$18,000	$43,000	$43,000	$43,000
1.2	**roading infrastructure:**		$58,000	$28,000	$3,000	$58,000	$28,000	$3,000
1.3	**equipment:**		$10,000	$10,000	$10,000	$10,000	$10,000	$10,000
	Grand total:		**$86,000**	**$56,000**	**$31,000**	**$111,000**	**$81,000**	**$56,000**
2	**Running costs**							
2.1	**Fixed costs**							
2.1.1	**Capital costs**							
	construction: 25 years, 6% loan							
	a	0.0782	$1,408	$1,408	$1,408	$3,363	$3,363	$3,363
	roading infrastructure: 25 years, 6% loan							
	a	0.0782	$4,536	$2,190	$235	$4,536	$2,190	$235
	equipment: 8 years, 6% loan							
	a	0.161	$1,610	$1,610	$1,610	$1,610	$1,610	$1,610
	Total capital costs:		**$7,553**	**$5,207**	**$3,252**	**$9,508**	**$7,162**	**$5,207**
2.1.2	**Repair & maintenance cos**							
	construction:		$180	$180	$180	$430	$430	$430
	1%	of investment costs						
	roading infrastructure:		$580	$280	$30	$580	$280	$30
	1%	of investment costs						
	equipment:		$300	$300	$300	$300	$300	$300
	3%	of investment costs						
	Total R&M costs:		**$1,060**	**$760**	**$510**	**$1,310**	**$1,010**	**$760**
	Total fix costs		**$8,613**	**$5,967**	**$3,762**	**$10,818**	**$8,172**	**$5,967**
2.2	**Variable Costs**							
2.2.1	**Operating costs**							
	checking & cleaning site (monthly rate)							
	$100	per month	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200
	sampling							
	$150	per month	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800
	tankering costs							
	$0.70	/ m^3*Km						
	Total variable costs		**$3,000**	**$3,000**	**$3,000**	**$3,000**	**$3,000**	**$3,000**
	Total running costs per year (except tankering costs)		**$11,613**	**$8,967**	**$6,762**	**$13,818**	**$11,172**	**$8,967**

Table 11.10 Running costs excluding land purchase, administrative and planning fees, and goods & services tax (GST)

The tankering costs are evaluated individually by looking at the distance to the nearest sewage treatment plant. These costs also depend on the model type used (i.e. 300 or 400 Litres, 80% or 25% livestock 'not stood') as the volume of effluent collected varies. Table 11.11 outlines the economic details for the recommended network of 14 sites (a25_300_30AP) and 300 litre tanks. Further examples are attached to Appendix 6.

300 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	total running costs per year
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	3.74	40	150	0.7	10	$1,047		$11,172		$12,219
Blenheim In-transit	1	14.39	40	576	0.7	1.5	$605			$8,967	$9,572
Blenheim Riverlands		3.69	40	148	0.7	1.5	$155				$155
Kaikoura	1	5.23	40	209	0.7	10	$1,464		$11,172		$12,637
Westport Junction											
Murchison	1	5.28	40	211	0.7	3	$443			$8,967	$9,410
Reefton	1	1.54	40	61	0.7	4	$172		$11,172		$11,344
Hanmer Junction											
Kumara Junction	1	2.27	40	91	0.7	18	$1,144	$13,818			$14,962
Amberley	1	3.95	40	158	0.7	5	$553		$11,172		$11,725
Sheffield Junction	1	2.57	40	103	0.7	14	$1,006		$11,172		$12,178
Tinwald in-transit	1	10.43	40	417	0.7	6	$1,751		$11,172		$12,924
Tinwald saleyard		5.28	40	211	0.7	6	$886				$886
Fairlie											
Timaru/Washdyke	1	2.60	40	104	0.7	3	$219		$11,172		$11,391
Palmerston In-transit	1	8.75	40	350	0.7	5	$1,225	$13,818			$15,043
Palmerston saleyard		4.39	40	176	0.7	5	$615				$615
Terras Junction	1	2.67	40	107	0.7	25	$1,866	$13,818			$15,684
Cromwell In-transit											
Cromwell saleyard											
Milton Junction	1	4.87	40	195	0.7	3	$409	$13,818			$14,228
Lumsden In-transit											
Gore In-transit	1	2.32	40	93	0.7	5	$324		$11,172		$11,496
Gore saleyard		5.64	40	226	0.7	5	$789				$789
SUM	14	89.59		3,584			$14,675	$55,273	$89,378	$17,934	$177,260
								$162,585			

Table 11.11 Annual running costs for the recommended network of 14 sites (a25_300_30AP) based on borrowing the capital

The table representing the operational costs structure in Appendix 6 need to be topped up by the specific tankering costs of each specific scenario to obtain the annual running costs.

The operating costs are based on the latest information from the South Waikato District Council, operating their two sites in the Waikato (Fisher, 1999). The choice regarding the level of costs set for the dump sites (i.e. B1, B2 or B3) in table 11.11 occurred partly randomly and partly based on knowledge of the potential future site location.

11.5 Recommendation

A close liaison with the stakeholder groups involved in the livestock industry throughout the supply chain has directed this research study to practical ends. The process of increasing or heightening the awareness of all players through educational extension programmes could lead to a significant reduction in the volumes of effluent that have to be dealt with in-transit and at destination when carting livestock. An even greater contribution to alleviating spillage is obtainable through the fitting of effluent containment of 400 litres to each livestock truck and trailer unit.

Nonetheless, although in the long term, a minimum network of only 10 sites is required in the South Island, the adoption of best practice ('standing' stock and 400 litre tanks) will not be instantaneous. Therefore, the recommendation is to provide 14 dump sites on the base of 300 litre tanks.

The table 11.12 summarises the available information for the recommended network of sites for 400 and 300 litres. It includes all the information regarding both, the 'spring-summer' and the 'summer-autumn' model on spillage, potential reduction of spillage achieved through the construction of sites. The total annual running costs based on borrowing the capital are recorded.

400 Litres (25%)	Test	number of sites	number of spillage	total effluent spilled [Litres]	total spillage without dump sites [base: 25% 200 Litres]	total spillage without dump sites [base: 25% 400 Litres]	total reduction of spillage [base: 25%, 400 Litres]	annual running costs based on borrowing the capital
excluding Arthur's Pass								
recommended network of dump sites (autumn model)	a25_400_34	9	9	1,104	62,883	9,699	88.62%	$116,120
recommended network of dump sites (spring model)	s25_400_34	9	9	522	44,729	6,167	91.54%	$114,219
including Arthur's Pass and dump site Sheffield								
recommended network of dump sites (autumn model)	a25_400_34 AP	10	8	1,070	62,883	9,699	88.97%	$127,357
recommended network of dump sites (spring model)	s25_400_34 AP	10	6	438	44,729	6,167	92.90%	$125,412
300 Litres (25%)	**Test**	**number of sites**	**number of spillage**	**total effluent spilled [Litres]**	**total spillage without dump sites [base: 80% 200 Litres]**	**total spillage without dump sites [base: 25% 300 Litres]**	**total reduction of spillage [base: 25%, 300 Litres]**	**annual running costs based on borrowing the capital**
excluding Arthur's Pass								
recommended network of dump sites (autumn model)	a25_300_30	13	41	2,298	115,111	25,979	91.15%	$165,525
recommended network of dump sites (spring model)	s25_300_30	13	40	1,567	83,318	17,054	90.81%	$163,007
including Arthur's Pass and dump site Sheffield								
recommended network of dump sites (autumn model)	a25_300_30 AP	14	37	2,181	115,111	25,979	91.60%	$177,260
recommended network of dump sites (spring model)	s25_300_30 AP	14	42	1,540	83,318	17,054	90.97%	$174,390

Table 11.12 Summarising table regarding the recommended network of sites for 300 and 400 litre effluent containment and best practice (25% not 'stood')

11.6 Summary of the results

Table 11.13 summarises both, the optimal network representing a minimum of spillage and the recommended network focussing on a more cost-efficient solution.

The number of sites for the recommended network associated with the 80% rate of livestock 'not stood' is not lowered compared to the network representing the minimum volume of spillage as this only made sense for assuming best practice (25% 'not stood') as the volume of effluent collected in-transit is reduced.

Network for 400 Litre tanks

One particularity appears for the 400 Litre network: in the South East of the South Island 'Gore' is replaced by 'Milton Junction' to assure that the city of Dunedin is protected efficiently from livestock trucks approaching Dunedin from the south. The recommended network showing best practice reduces the number of sites from 12 to 10 by dropping 'Kaikoura' and 'Reefton' and accepts a few potential spills in these areas.

Network for 300 Litre tanks

The main difference between the network aiming for minimum spillage (19 sites) and the recommended 14 sites is the acceptance of allowing a few spills for the fact that in the future the rate of 75% best practice may even become higher and so reduce further the volume of effluent produced in-transit. These five sites that do not need to be constructed by assuming best practice and 300 litre tanks are 'Westport', Hamner Junction', 'Fairlie', 'Cromwell' and 'Lumsden'.

including Arthur's Pass access	optimal network minimum spillage	recommended network allowing 12% spillage		Livestock 80% not stood	Livestock 25% not stood
number of sites 300 Litres	X			19	19
		X		19	14
number of sites 400 Litres	X			12	12
		X		12	10
location of recommended stock effluent discharge sites					
basic network of sites:	**Richmond** Junction, **Blenheim** (Riverlands sale yards), **Murchison**, **Amberley**, **Kumara** Junction, **Sheffield** Junction, **Ashburton** (Tinwald sale yards), **Tarras** Junction, **Palmerston**				
additional sites	X		1	**Kaikoura**	**Kaikoura**
			2	**Reefton**	**Reefton**
			3	**Timaru** (Washdyke)	**Timaru** (Washdyke)
			4	**Gore**	**Gore**
			5	**Milton Junction**	**Milton Junction**
			6	**Westport** Junction	**Westport** Junction
			7	**Hamner** Junction	**Hamner** Junction
			8	**Fairlie**	**Fairlie**
			9	**Cromwell**	**Cromwell**
			10	**Lumsden** Junction	**Lumsden** Junction
300 Litres		X	1	**Kaikoura**	**Kaikoura**
			2	**Reefton**	**Reefton**
			3	**Timaru** (Washdyke)	**Timaru** (Washdyke)
			4	**Gore**	**Gore**
			5	**Milton Junction**	**Milton Junction**
			6	**Westport** Junction	
			7	**Hamner** Junction	
			8	**Fairlie**	
			9	**Cromwell**	
			10	**Lumsden** Junction	
additional sites	X		1	**Gore**	**Gore**
			2	**Kaikoura**	**Kaikoura**
			3	**Reefton**	**Reefton**
400 L		X	1	**Milton Junction**	**Milton Junction**
			2	**Kaikoura**	-
			3	**Reefton**	-

Table 11.13 Overview summarising the number and locations of dump sites for a network representing a minimum spillage and a cost-efficient solution.

11.7 Conclusion

This chapter aimed to simulate the livestock shipments over a period of a busy week and to outline the process of finding an appropriate network of sites for various scenarios.

Initially, the researcher described, through the 'spillage' maps, the strategy for identifying the areas associated with major spillage problems. In the next step, the creation of sub-models enabled simulation of just the livestock transport passing through a specific region. The implementation of soft systems methodology started here by setting various combinations of potential dump sites to minimise the spillage on the road. This human-machine interaction focussed especially on specific potential dump sites that were discussed in meetings with stakeholder groups, authorities and working groups. The limiting factor in the sub-models was the fact that many of the trips were passing other regions and so appeared in several sub-models. These trips could not easily be identified and so it was not practicable to assemble the sub region results. They could only be used to give a rough indication on the impact of setting specific potential sites as in-transit collection points.

The main advantage of the sub-models however, was the time factor. The sub-models required about 1.5 to 2 hours computer processing time plus the input and extraction of the results. The full model required up to 4 or 5 hours depending on which simulation model was run. These times could probably be reduced by increasing the memory of the machine from 128 MB SDRAM to at least 256MB SDRAM. The processor used was a Pentium II 450 HZ. The first trials were run on SUN workstations at the International Centre for Antarctic Research (ICAIR) and required similar processing time.

The experience with the two seasonal models showed that the in-transit locations set for the 'summer-autumn' model were appropriate for the 'spring-summer' model. Unfortunately the results, obtained through the simulation of best practice (25% of livestock 'not stood'), did not produce the results that

most stakeholder groups were expecting. The main reason is that the problem of high production of effluent in-transit is related more to cattle than sheep. The percentage of cattle is around 33% in the South Island and approximately 50% of all livestock shipments are below 100 kilometres. The impact may be different when running the model for the North Island as the percentage of cattle is higher there.

The benefits of increasing the tank size from 200 to 300 litres and from 300 to 400 litres were higher compared to the adoption of best 'standing' practice. However, only the combination of both, fitting 300 to 400 litre tanks on the whole South Island livestock fleet and the adoption of best practice present a cost-effective solution through a network of 14 sites in the South Island.

It needs to be emphasised that the problem of stock effluent spillage from livestock trucks is more than an environmental or road safety issue. The reduction of stock effluent production in-transit can be achieved by adequate preparation of livestock prior to transport and will thereby contribute to raise the ultimate quality of the end product. Therefore it is essential to focus on educational programmes to achieve the adoption of best practice throughout the supply chain.

The salient point of this treatise was to find a comprehensive solution for this complex human-environmental problem as it could not be compartmentalised into separate 'environmental', 'road safety' or 'agricultural production' problems.

12 CONSEQUENTIAL ANALYSIS

12.1 Introduction

This chapter gives an overview of consequential work that needs to be undertaken. These include the different issues related to specific site investigations on the recommended network of discharge facilities and the ultimate treatment of effluent collected at those dump sites.

12.2 Specific site investigation

12.2.1 Location of sites and consent issues

The recommended network of in-transit dump sites for the South Island requires detailed site-specific investigation. Figure 12.1 shows the Tapapa pilot dump site in the North Island. Appendix 7 gives a schematic diagram of the set-up for an in-transit dump site.

The in-transit dump sites indicated in the simulation model were positioned at the intersection of State Highways or within a small town. Decisions are required to resolve, on a district or local level, the appropriate site for the discharge facility. It is usually not possible to locate a dump site at the intersection. It needs to be clear that the distance between the specific intersection designated in the model and the dump site should be minimal to encourage its use.

Generally speaking, a dump site needs to be on or adjacent to a main transport route or saleyard. This is relevant with respect to maximising availability and accessibility, and minimising delay for stock trucks using the facility. Existing facilities such as weigh stations, truck stops, truck parks or trucking company depots should be investigated if they are appropriately sited.

The necessary step towards determining a potential site location is reference to the Council's District Plan. This will indicate the zoning of the site and whether the proposed use of the site complies with the planned activity. Following clarification and agreement on an appropriate and permitted site use, the next requirement is to determine the type of resource consent and the conditions that will determine the requirements for the installation. Whether or not a resource consent is required, it is advisable to consult the neighbouring property owners at an early stage to avoid surprises. A checklist was compiled by the National Stock Effluent Working Group (1999b), which stipulates that a dump site "*should be remote from dwellings and demonstrate environmental sensitivity to avoid problems with:*

(5) Noise
(6) Smell
(7) Visibility
(8) NIMBY (not in my back yard) syndrome
(9) Risk of water pollution
(10) *Risk of infection*
(11) Loss of value of adjoining properties

(12) Reduction in traffic safety

(13) Lack of space to construct the facility

(14) Movements to and from the site should have minimal impact on the highway traffic".

The requirements of the Regional Council will largely depend on whether the installation will include effluent treatment and disposal. It is probable that if the effluent is tankered away for off-site treatment and the dump site is well removed from habitation, the Regional Council may not be involved. Ideally, a standardised consent procedure would save time and minimise the costs involved.

12.2.2 Design of an in-transit site

Once a site location has been identified, the detailed planning can start. Roger Fisher from the South Waikato District Council designed the two pilot dump sites (Figure 12.1) in the North Island. He summarises the most relevant details in a report called "*A Practical Guide to Providing Facilities for Stock Effluent Disposal from Trucks*" (National Stock Effluent Working Group, 1999b). Some important criteria are listed below:

1. Highway Access

Receptors on both sides of the highway are desirable. In some instances, the provision of two receptors and holding tanks may be more economical than constructing a right turn bay. It may also be possible to link the two receptors by a pipeline to one tank. However, if only one receptor is planned for both directions of traffic, the provision of a right turn bay may be required. The figures 12.2 and 12.3 represent a livestock cartage unit discharging effluent at one of the Waikato dump sites.

2 Signage

The dump site area will require adequate signage on both approaches on the highway to inform stock truck drivers about the discharge facility. It is probably useful to have a few warning signs at different distances from the dump site.

Figure 12.2 Truck and trailer unit manoeuvring on the Tapapa dump site (South Waikato District Council, 1999)

3 Manoeuvring

In the case where the trucks have no separate exit and are obliged to return to the main highway by the way they entered the site, a turning circle of not less than 30 metres diameter is required. The approach to the disposal receptor should allow good visibility for the driver and painted marks at specific intervals past the receptor may assist the driver locate the truck or trailer discharge valve over the receptor.

4 Receptor

The Waikato receptor is designed to a width of 4 metres and a length of 1.5 metres. The surfaces should be designed to carry heavy vehicles and easy to clean. A provision should be made for washing down the receptor surrounds with a hose. The area needs to be kept as small as possible to minimise the

the roofing and sidewalls may eventually be recovered by using the sidewalls for advertising purposes. Plans of the Waikato discharge facilities are provided in Appendix 7 (National Stock Effluent Working Group, 1999b).

Figure 12.3 Livestock truck discharging effluent over the receptor area (South Waikato District Council, 1999)

5 Holding tank

The tank should be buried below the level of receptor to allow direct drainage of the effluent. The tank used in the Waikato had a capacity of 23 m^3 and was made of transportable reinforced concrete. The effluent collection tank should be provided with a lockable top and an access for monitoring or tank servicing purposes. It needs further to meet the requirements of current septic tank servicing firms that may transport the effluent off-site.

6 Telemetry

A telemetry outstation connected to the council's telemetry system is required to warn the responsible manager that the collection tank is close to full.

12.3 Treatment and potential reuse of the disposed effluent

12.3.1 Effluent characteristics

It is difficult to predict the exact characteristics of the effluent collected, as it depends of the volume of rainwater collected the monitoring system and the percentage of faeces collected from sheep and cattle. As the disposal, treatment and reuse of effluent was not part of this research, the data monitored from the two pilot sites in the Waikato can be taken as examples.

The raw effluent is characterised through a high BOD_5 (5 day Carbonaceous Biochemical Oxygen Demand), 1.6 to 7.8 * 10^3 g/m^3 and a high level of Suspended Solids (0.7 to 5.3 * 10^4 g/m^3). Due to these two elevated parameters, any smaller municipal treatment plant would have difficulties to cope with a whole tanker load (i.e. 16 m^3) of raw stock effluent. For this reason, the capital costs elaborated in chapter 11 involved the costs for a further storage tank at the sewage treatment plant to allow for slow loading into the plant. A volume of 16 m^3 stock effluent with an average BOD_5 load of 4700 g/m^3 contains 75kg BOD_5. This is equivalent to domestic wastewater from about 90 people for a two week period. Assuming 16 m^3 stock effluent are collected at a specific dump site every two weeks, this is equivalent to a population of 90 people, provided it is evenly loaded into a sewage plant on a daily basis, rather than shock loading every two weeks.

The nitrogen level measured as ammonia nitrogen reaches 10^3 g/m^3, whereas the total Kjeldah nitrogen as N varies from 8.5 to 16 * 10^2 g/m^3. Raw effluent also contains various pathogenic bacteria, viruses, protozoa etc. The level of Faecal Coliforms measured reached 20 * 10^6 per 100 ml (National Stock Effluent Working Group, 1999b). To allow these pathogens to die off and render the effluent safe against transmission of disease, it is important to treat the effluent. This can be achieved for example through a high temperature treatment (i.e. 70^0C) or retention time in an anaerobic/aerobic process. Further research is required in this domain.

12.3.2 Treatment of stock effluent

As explained in the section above, the raw effluent is 'strong' in BOD and suspended solids and cannot be discharged directly into small municipal sewage treatment or reused without any treatment. A larger municipal treatment plant however, should be able to cope with this, especially if the load is added as a controlled continuous load. Each existing treatment plant will have major difficulties to cope with a shock load of effluent discharge (i.e. 16 m^3 tanker load). The nitrogen level needs to be lowered in case the treated effluent is to be processed into a fertiliser.

The current treatment options available include:

(1) Discharge to a municipal sewage treatment plant via continuous loading of small volumes of effluent to avoid overloading of the system. A storage tank located at the sewage treatment plant can be used as buffer reservoir. The collected effluent should be tankered from the dump site to the sewage treatment plant, especially if the slope of the sewage pipeline is minimal and the volume of normal sewage is low.

(2) Discharge to an existing farm oxidation pond system and payment to farmers that accept effluent for treatment.

(3) Separate the collected effluent in a dual septic tank to allow the first compartment as a sludge settlement area. The overflow will have a far lower BOD and will be easier to break down in a sewage treatment plant. Compost the sludge or the whole volume of effluent and reuse the product as a fertiliser, for example for forestry purposes. The effluent can also be added to current composting plants as the degree of humidity of green compost is generally too low to get the thermophil process activated. Due to the relatively high percentage of phospates and nitrates, the effluent can also be used to clean soils contaminated with hydrocarbons (i.e. soil excavation of petrol stations). The effluent may also be used to help revegetate municipal landfills and embankments or assist with recultivation programmes aimed to combat erosion areas. This system requires excellent aerobic conditions, a compost temperature of 45^0-55^0 C and a pH of 8-9 to

enable an ultimate fertiliser with a low odour level, a high level of nitrogen and a level of pathogens that can be neglected (Rueckert et al., 1990).

(4) Add lime (40-50 kg/m^3) to the effluent in order to hygienise the final product within 1-2 days by obtaining a pH of 10. This is a quick way to kill all pathogens, but the pH is increased, ammonia evaporates and the lime has to be purchased.

(5) Discharge to a purpose-built anaerobic/aerobic 2 pond system.

(6) Discharge to a purpose-built package plant.

(7) Discharge the effluent into a dual septic tank and irrigate the effluent on-site. This may be possible for dump sites collecting only small volumes of effluent.

(8) Discharge the effluent into a tank fitted with forced-aeration for a certain period. A high degree of emissions will be expected.

(9) Dry the effluent in green houses through solar energy and obtain a dry end product that can be handled easier (i.e. 10% of the original weight; variable dry matter content) and reused as a fertiliser (Thermo-System, 1999).

(10) Discharge to a purpose-built anaerobic central treatment plant to recover methane gas. This is only cost-effective by combining collected bio-waste from a large city.

Discharges direct to land or waterways without any prior treatment are unacceptable. The quality level of the treated effluent accepted for the resource consent of the Tapapa pilot site was for example (National Stock Effluent Working Group, 1999b):

BOD	=	50 g/m^3	(0.70 kg/day)
Suspended Solids	=	50 g/m^3	(0.70 kg/day)
Total Nitrogen	=	95 g/m^3	(1.35 kg/day)

The raw effluent was treated through a combination of an anaerobic/aerobic 2-pond system and a soakage drain system. This combination predicted an efficiency removal of 95% of the BOD load and 75% of nitrogen removal.

No one single treatment system is likely to be applied in the future. The researcher believes that the treatment system will depend on the volume of raw effluent collected and on the region in which the dump site is located. It is important to monitor over a period of one to two years the volume of effluent collected to allow for the appropriate design. It is therefore desirable in the first instance to seek via further research projects (i.e. literature review and practical trials) a range of feasible, environmentally acceptable and cost-efficient solutions. Surrounding farm properties adjacent to a potential dump site should be surveyed to discuss the possibility of treating the raw effluent in their current 2-pond treatment system to find out if these farmers would see this as a 'new business' opportunity. It is probably a 'cheap' alternative to the current suggestion of diluting the effluent slowly into a municipal sewage treatment plant or building a specific treatment plant. The resolve of the National Working Group to promote research into the treatment of stock effluent is vital for the quick resolution of this problem.

12.4 Conclusion

This chapter gives an overview of some issues related to the investigation of a specific dump site location and its associated resource consent. It further outlines the final site design based on the experience of the North Island pilot sites, by mentioning details such as the site access, the signage, the manoeuvring area, the receptor area, the effluent collection tank and the telemetry system.

The second section describes some characteristics (i.e. BOD) of raw stock effluent based on samples analysed at the North Island pilot sites. It summarises possible methods for treatment of stock effluent and stresses the importance of identifying a variety of feasible treatment options, as each dump site may have a different method for treatment.

13 PROSPECT

13.1 Introduction

The role of this chapter is to review the tasks, boundaries and achievements of this research project and to foreshadow the implementation process and further research that is required in the future.

13.2 Research task

Some research studies are very specific and can be considered closed after the achievement of their goals. This research, looking at an optimal management system for reducing stock effluent spillage from trucks, was aimed at leading the development of a way to accomplish that task (Chapter 2). It was necessary to find means to promote cooperation and coordination among the stakeholder groups (chapters 6, 7 & 8). The soft systems methodology was applied throughout this multi-disciplinary and multi-stakeholder research project (chapters 6, 7 & 8). The production of the educational video was not only a relevant tool to promote better communication and cooperation in the future (Chapter 7), it was also a management strategy to help motivate the executives of each stakeholder group and to obtain a common agreement and acceptance that this 'effluent spillage' problem was 'no longer acceptable' (chapters 3, 6, 7 & 8). This research contributes to the breaking down of the barriers of industry suspicion, misinformation, and lack of awareness of what is required throughout the supply chain to achieve closure on the spillage problem. As a result, for the first time it has been possible to obtain a general agreement that the problem is an 'Industry' problem that needs to be solved by the entire industry involved in the livestock supply management chain.

This research can be seen as facilitating a management approach to building on the initial work done in the Waikato (two pilot dump sites), thereby the establishment of an appropriate network of sites in the South Island, at the same time encouraging adoption of best practice throughout the whole supply

chain. This research shows that through the adoption of best practice, not only the problem of stock effluent spillage can be reduced but, far more importantly, it could contribute to improving the ultimate meat quality. It was therefore important to look at the problems related to the adoption of best practice (Chapter 5). This quality issue is a critical factor for New Zealand as the meat export sector is a five billion dollar industry, employing twenty thousand employees in New Zealand (Lynch, 1999). The aim of this research complements the trends in the New Zealand meat industry where their preoccupations are to administer modern food regulations, produce high quality products and to promote animal identification and trace-back procedures back to the farm. The concept of a potential 'stock standing' certification card will help to build the confidence of both, the livestock producer and the meat processing company to do the right thing. The animals that have been emptied out on the farm and arrive in clean condition at destination need less intensive washing, and thus contribute through a low stress level to an end product with an ideal pH factor, that will be appreciated by the consumer. By considering the 'effluent problem' from this perspective, the capital costs associated with the recommended network of 14 sites (Chapter 11) and the costs of the educational programme can be seen as reasonable and acceptable, as it contributes to the benefit of New Zealand's oldest export industry. The Chief Executive of the New Zealand Meat Industry Association said in July 1999 that it is important to recognise that there is a 'switch' from a 'freezing-works' mentality to an industry that is about food creation and finding meal solutions. This shift is driven by the dynamics of the market place, a regulatory framework and technical innovations. The transport aspect is a significant component in each of these contexts listed above (Lynch, 1999). There is a similar view in the tourism industry that no longer accepts messy roads as that will lower the 'clean green image' of New Zealand currently perceived by overseas tourists (chapter 1).

This research contributed to risk analysis studies carried out by the Ministry of Health looking at the spread of diseases through contamination on the road

(i.e. funding was obtained from the Crown Public Health) and by the Land Transport Safety Authority (LTSA) investigating the causes of road accidents.

An important component in the research strategy was to find a network of dump sites that could help reduce the spillage on the roads (chapters 9-11). It was important to develop a model allowing the stakeholder groups involved to participate and contribute as partners towards identifying an ultimate cost-efficient, politically acceptable and practical solution (chapter 10). Although it was relevant to analyse the costs for various scenarios, it was not the task of the researcher to work out an ideal formula for the funding of the dump sites. That matter involves national politics and policy issues on principles for funding such as 'polluter pays' or 'public good' criteria.

The current New Zealand legislation related to the problem of stock effluent spillage from trucks needed to be reviewed in order to outline the applicability of the current state of legislation. This review was needed to point out current gaps and potential for amendments in case the current legislation was to undergo an amendment process in the future. It was, however, not the task of the researcher to craft a new piece of legislation or formulate specific amendments (Chapter 4).

The design of a potential dump site was illustrated in chapter 12 by using the example of one of the pilot sites in the Waikato (Chapter 3, section 3.2.20). It was not the task of the researcher to critique the technical design or suggest improvements. Along with the treatment of the disposed effluent these aspects require further research. A few pointers are included in chapter 12.

13.3 Process extension to the whole country

This research was initially focussed on the Canterbury area, but the dump sites modelling exercise covered the whole of the South Island. The model outputs demonstrate a feasible system to all stakeholder groups. It is now highly desirable to apply the model to the North Island to obtain a recommended

network of sites for the whole of New Zealand. This task will be less time consuming for the North Island as the data collection and assignment of the livestock shipments will be far more efficient following the South Island experience. On the other hand, the number of livestock companies is higher in the North Island and there will be more and new stakeholder groups to encourage into cooperation and coordination regarding the collection of the necessary survey data.

A national communication strategy needs to be developed to promote the adoption of best practice. This educational programme requires substantial funding, as it needs to run over a long period (i.e. 5-10 years time). It is important besides the stakeholder group associations to involve external consultants specialised in extension programmes (i.e. Agriculture New Zealand or MAF). A monitoring system to evaluate progress towards adoption of best practice needs to be established. A report back system on progress is important to evaluate success or failure (Chapters 6 & 8). The on-going commitment of the NSEW is likely to be an essential ingredient for the successful conduct of a national communication strategy.

13.4 Debate on the next steps and on the funding issues

Having researched and recommended a network of dump sites for the South Island, produced the educational video with its associated brochure and encouraged the adoption of a new Industry Code of Practice, it is important to be reminded that the original goal of working towards the minimisation or substantial reduction of stock effluent spillage on New Zealand roads is still a task to be completed. A dedicated national steering committee including a project manager could ensure that implementation takes place. This involves for example:

(1) A nationwide communication strategy including a monitoring system.
(2) A detailed individual site investigation and the construction of the recommended set of dump sites in the South Island.

(3) The identification of a network of suitable sites in the North Island.
(4) A detailed individual site investigation and the construction of dump sites in the North Island.
(5) Research regarding the treatment and reuse of the disposed stock effluent.
(6) Resolution of the issue of funding of dump sites.
(7) The funding to cover the costs of the project manager and the steering committee.

It will be important to resolve the funding issue and agree on a formula to finance the capital and the operational costs associated with the construction of dump sites. Without agreement in the near term, the whole implementation process will be in jeopardy.

13.5 Conclusion

This chapter emphasises the research tasks and constraints, and highlights the benefits and the position of this research in the New Zealand economy (i.e. meat export) and environment (tourism industry). It outlines the contribution to parallel risk management studies carried out by the Ministry of Health and the Land Transport Safety Authority. It stressed the importance of extending the process nationwide in order not to jeopardise the progress made so far and identifies the various funding issues.

The most important statement can only be repeated again and again that all the results obtained so far are rather useless if the perseverance of the last three years is not continued in the future.

14 PROJECT ACHIEVEMENTS

The aim of this final chapter is to summarise the achievements made by the researcher towards solving the multi-disciplinary problem of stock effluent spillage from trucks. The researcher acted as a facilitator throughout. The main achievements are listed below:

(1) Willing cooperation of the leadership of all key stakeholder groups (the Hon Minister of Agriculture introduced the new Industry Code of Practice)

(2) Successful integration of disciplinary areas and ongoing actions in the fields of

- **network modelling** and operations research
- **environmental education** and media tools (video)
- **engineering** & design
- **communication**, **consultative procedures** and quality management (Industry code of Practice)
- **animal science** and farm management
- public policy, administration, **politics** and risk management
- law
- economics

(3) Contribution towards a feasible, efficient (quality management), effective (geographically), economic (affordable) and fair (equitable) solution involving best practice to a 20^{+} year old problem.

(4) It has been highlighted that quality management leading to economic returns to the industry will drive the implementation strategies and win-win scenarios uncovered by this research.

(5) The outcome of this research may encourage other countries (i.e. Australia or South American countries) that experience stock effluent spillage in some areas to use a similar approach.

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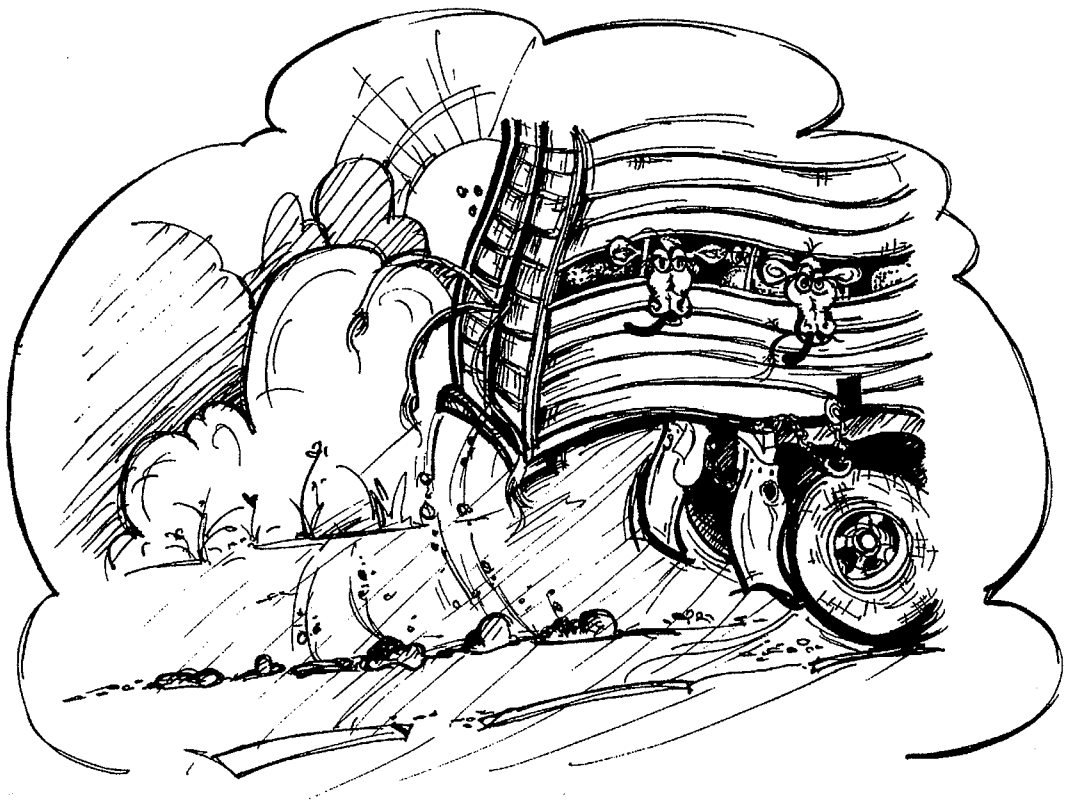
APPENDICES 1 – 8



(drawing by Sharin Ley, 1997)

APPENDIX 1

- **New Zealand Map** (publisher: Automobile Association New Zealand, 3rd Edition 1996) 270

(Not included in online version)

APPENDIX 2

- **Video brochure**

  Stock Effluent from Trucks: The Answer, June 1998 272

  (Not included in online version)

- **Industry Code of Practice**

  Industry Code of Practice for the Minimisation of Stock Effluent Spillage from Trucks on Roads, April 1999 273

APPENDIX 3

SURVEY FORMS

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  (survey conducted with the assistance of livestock carriers) 275

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    (folds out as A3 sheet)

QUESTIONNAIRE FORM
ON STOCK 'STANDING' BEHAVIOUR

Survey conducted with the assistance
of livestock carriers in Canterbury in 1997
under the supervision
of the researcher

DATE: .....

SURVEY about Stock Preparation Prior to Transport

as part of the educational programme for the National Stock Truck Effluent Workgroup: Step II

NAME OF DRIVER: .....

COLLECTION							DESTINATION				COMMENTS	
COLLEC-TION TIME	LOCATION	WEATHER CONDITIONS	SHEEP or CATTLE	PIGS or DEER	NUMBER OF COLLECTED STOCK	STOCK FULL (not stood) Yes / No	WORKS	SALE-YARD	FARM to FARM Yes/ No	FERRY TERMINAL Y/N	NOTICE TIME GIVEN TO THE FARMER FOR STOCK COLLECTION	OTHERS COMMENTS (ie. problems with effluent)

QUESTIONNAIRE FORM REGARDING STAKEHOLDER ATTITUDES

Survey conducted on stakeholders' 'behaviour' attitudes

Example of questionnaire form presented to meat company managers

BEFORE VIDEO PRESENTATION

This questionnaire is part of a pilot educational programme run by Lincoln University. We would like to know **your view** regarding **"stock effluent spillage"** from trucks and would appreciate you cooperation.

1. **W**hat type of stock are you dealing with? **SHEEP** ☐ % **CATTLE** ☐ % **DEER** ☐ %

2. **D**oes your firm **advise** farmers **explicitly** to prepare their stock prior to transport by "standing" livestock in the holding yards to empty out by **highlighting the benefits of stock preparation** [e.g. less bruising, less animal stress, better presentation of stock at destination (cleaner stock), better meat quality for the consumer and less effluent in-transit and at destination]?

   YES ☐ **NO** ☐

   If **Yes,** in what year did you commence this policy? _____

   If **No,** are you considering adopting such a policy? _____

3. **H**ow much time in advance do you advise farmers to prepare the stock? _____

   Comment: _____

   Do you explain the reason to them? _____

4. **W**hat days of the week are your drafters working on the farms? (please tick)

   SUN **MO** **TU** **WED** **THU** **FRI** **SAT**

   Comment: _____

5. **H**ow much time in advance do you draft the stock on the farms?

   Less than 6 hours ☐ 6-12 h ☐ 13-24 h ☐ 25-48 h ☐ greater than 48 hours ☐

   Comment: _____

6. **H**ow much time in advance do you give to stock carriers to pick-up the stock?

   Less than 6 hours ☐ 6-12 h ☐ 13-24 h ☐ 25-48 h ☐ greater than 48 hours ☐

   Comment: _____

7. **H**ow much time in advance do you arrange your killing schedule?

   Less the 12 hours ☐ 13-24 h ☐ 25-35 h ☐ 3- 6 days ☐ 1 week or more ☐

   Comment:

   _____

8. **I**s there a report back procedure to farmers on the condition of their stock on arrival at the meat processing plant?

   Comment: _____

9. **W**ho do you see as the key stakeholders able to remedy the problem of stock effluent spillages from trucks? _____

10. **A**re **meat processing companies** able to influence the current practice, by taking a leadership

AFTER VIDEO PRESENTATION

1. **D**id you find the video informative? **YES** ☐ **NO** ☐

   Comment: _____

2. **D**id you learn anything **NEW** from the video? **YES** ☐ **NO** ☐

   Comment: _____

3. **D**o you expect your segment of the industry to contribute towards quality controls throughout the supply chain? **YES** ☐ **NO** ☐

   Comment: _____

4. **W**hat changes are you prepared to do to help make a coordinated supply system work, as suggested on the video?

   Comment: _____

   _____

5 **W**ould a "**STOCK STANDING**" certification card, which confirms the total time off feed, be a good means of encouraging coordination by all stakeholders?

   YES ☐ **NO** ☐

   Comment: _____

   _____

6. **B**y what means can the current communications be improved between meat processing companies (managers and drafters) and

   Independent Stock and Station Agents_____

   Farmers

   _____

   Stock carriers

   _____

7. **W**hat is the percentage of stock carriers emptying their effluent storage tanks at your wash facilities? _____ %

   Does your company accept effluent discharge from trucks delivering stock at your plant?

   YES ☐ **NO** ☐

8. **D**o you think that this stock effluent issue can be solved in a self-regulating and self-policing way? Explain: _____

Age group: 20-39 ☐ 40-49 ☐ 50-59 ☐ over 60 ☐

Employment category: Management ☐ **D**rafter ☐ other **E**mployee ☐

ATTITUDES OF SURVEYED STAKEHOLDER GROUPS

BEFORE THE VIDEO PRESENTATION

SURVEY RESULTS

3.1/A Farmers

1	**Farming type**	**Cattle**	**52.3%**
	percentage of farmers preparing cattle prior to transport by "standing"	farm to **meat processing plant**	**58.1%**
		farm to **sale yard**	**55.1%**
		farm to **farm**	**48.6%**
		average percentage	**51.5%**
2	**Farming type**	**Sheep**	**47.7%**
	percentage of farmers preparing sheep prior to transport by "standing"	farm to **meat processing plant**	**93.7%**
		farm to **sale yard**	**84.2%**
		farm to **farm**	**100.0%**
		average percentage	**91.9%**
3	**General attitude of stock preparation**		
	percentage of farmers preparing their stock by "standing" prior to transport	only **yes/ no** answers were possible	**65.8%**
	"standing" periods: percentage of farmers standing their stock for	less than 1 hour	**13.7%**
		1 -3 hours	**35.0%**
		4 - 6 hours	**23.4%**
		over 6 hours	**27.9%**
4	**Subsidiary information**		
	age group	20 - 39	**40.0%**
		40 - 49	**24.4%**
		50 - 59	**23.4%**
		> 60	**12.2%**
	number of questionnaires collected		**48**
	number of meetings		**6**

3.1/B Stock agents and company drafters (1)

1	Percentage of livestock dealt with	Sheep	67.8%
		Cattle	32.3%
2	Percentage of stock agents & drafters advising farmers to "prepare" their stock prior the transport by highlighting the benefits as part of the company policy	Yes	79.7%
		No	20.3%
2.1	Starting year of this educational company policy		1994/96
3	How much notice do stock agents & drafters give farmers before stock are drafted?	< 12 hrs	20.4%
		12 - 24 hrs	9.9%
		1 - 2 days	20.1%
		2 - 3 days	13.3%
		3 - 6 days	9.5%
		>= 1 week	13.2%
		no comment	13.6%
3.1	Percentage of drafters explaining to farmers the reason for stock preparation	Yes	68.9%
		No	10.4%
		no comment	20.7%
4	Drafting days used	Mo	100.0%
		Tu	92.7%
		Wed	89.0%
		Thu	92.7%
		Fri	89.0%
		Sat	41.9%
		Sun	89.0%
5	Time gap between drafting and livestock pick-up	< 6 hrs	17.8%
		6 - 12 hrs	20.2%
		12 - 24 hrs	22.8%
		24 - 48 hrs	20.4%
		> 48 hrs	18.8%
6	Advance notice given to the stock carriers to pick-up the stock	< 12 hrs	12.5%
		12 - 24 hrs	28.7%
		25 - 48 hrs	27.0%
		> 48 hrs	31.8%
7	Lead time given by meat processing plants to arrange the killing schedule	< 1 day	2.1%
		1 - 3 days	13.8%
		3 - 6 days	58.3%
		> 1 week	25.8%

3.1/B Stock agents and company drafters (2)

8	**Percentage of stock agents & drafters aware of a report back procedure to farmers on their stock conditions at final destination**	**Yes**	**100.0%**
		No	**0.0%**
9	**Who is seen as the key stakeholders able to remedy the problem?** (multiple answers possible)	**farmer**	**53.3%**
		transport operator	**24.0%**
		drafter / stock agent	**14.4%**
		meat company	**5.9%**
		authorities	**2.4%**
		sale yard owner	**0.0%**
10	**Whose responsibility is it?** (multiple answers possible)	**farmer**	**55.0%**
		transport operator	**27.0%**
		drafter / stock agent	**9.0%**
		meat company	**9.0%**
		no comment	
11	**Percentage of independent stock agents & drafters who saw the possibility of influencing the current practice, by taking a leadership role , enhancing better communication right at the beginning of the supply chain**	**Yes**	**100.0%**
		No	**0.0%**
11.1	**Perception how stock agents and meat company drafters could contribute towards best practice, by taking a leadership role.**		
a	encouraging farmers to prepare the stock through provision of better information (education) on its benefit (clean stock required for chilled meat)		**16.0%**
b	better coordination through improved communication (more advance notice for drafting & stock pick-up)		**8.0%**
c	advising meat companies to increase feedback on the assessment procedure of stock arrival conditions by giving detailed feedback on the kill-sheets (according to QA system)		**8.0%**
d	no comment or did not know		**68.0%**
			100.0%

3.1/B Stock agents and company drafters (3)

12	**Do stock agents or meat company drafters see a possibility of meat processing companies influencing current practice?**	**Yes**	**84.4%**
		No	**0.0%**
		no comment	**15.6%**
12.1	**Perception how meat processors could contribute towards best practice, by taking a leadership role.**		
a	encouraging farmers to prepare the stock through provision of better information (education) on its benefit (clean stock required for chilled meat)		**69.0%**
b	demanding compulsory "stand down" periods and setting signals through payment formula (penalising farmers for dirty stock)		**14.5%**
c	increasing feedback on the assessment procedure of stock arrival conditions by giving detailed feedback on the kill-sheets (according to QA system)		**14.4%**
d	contracting only livestock carriers with QA accredited equipment (code of practice for livestock crates requires approx 400 litres containment for effluent collection)		**2.1%**
			100.0%
13	**Subsidiary information**		
	Age group	20 - 39	**42.5%**
		40 - 49	**31.1%**
		50 -59	**26.4%**
		> 60	-
	number of valid questionnaires		**32**

3.1/C Meat company managers (1)

1	Percentage dealt with	Sheep		92.5%
		Cattle		7.5%
2	Percentage of meat companies advising each time farmers to prepare their stock prior the transport by highlighting the benefits of stock preparation as part of the company policy	Yes		100.0%
		No		-
		no comment		-
	Starting year of this educational company policy			1994/96
3	Time gap between drafting and livestock pick-up	< 6 hrs		45.0%
		6 - 12 hrs		10.0%
		12 - 24 hrs		15.0%
		24 - 48 hrs		25.0%
		> 48 hrs		5.0%
4	Advance notice given to the stock carriers to pick-up the stock	< 12 hrs		-
		12 - 24 hrs		30.0%
		25 - 48 hrs		50.0%
		> 48 hrs		-
		no comment		20.0%
5	Advance notice of killing schedule of meat processing plants	< 1 day		-
		1 - 3 days		-
		3 - 6 days		10.0%
		> 1 week		70.0%
		no comment		20.0%
6	Percentage of processing plant managers aware of a report back procedure (ie. stock presentation report) to farmers on their stock conditions at final destination	Yes		90.0%
		No		-
		no comment		10.0%
7	Who is seen as the key stakeholders able to remedy the problem? (multiple answers possible)	farmer		31.0%
		transport operator		27.0%
		meat company		23.0%
		drafter / stock agent		11.5%
		sale yard owner		3.8%
		authorities		3.8%

3.1/C Meat company managers (2)

8	**How meat processors perceive they could contribute towards best practice, by taking a leadership role.**			
	Suggestions received were:			
a	provision of better information (education) to farmers & other stakeholders on the benefits of "emtpying out " stock prior to transport			**34.3%**
b	demanding compulsory "stand down" periods and setting signals through payment formula (penalising farmers for dirty stock)			**24.3%**
c	pre-drafting			**17.2%**
d	increasing feedback on the assessment procedure of stock arrival conditions by giving detailed feedback on the kill-sheets (according to QA system)			**17.2%**
e	contracting only livestock carriers with QA accredited equipment (code of practice for livestock crates requires approx 400 litres containment for effluent collection)			**7.2%**
9	**Subsidiary information**			
	Age group	20 - 39		**30.0%**
		40 - 49		**50.0%**
		50 -59		**20.0%**
		> 60		**-**
	Number of valid questionnaires			**10**

3.1/D Livestock carriers (1)

1	**Percentage of livestock dealt with**	**Sheep**	**60.3%**
		Cattle	**39.7%**
2	**Percentage of livestock carriers expecting farmers to prepare their stock prior the transport**		**100.0%**
2.1	**How often do farmers prepare their stock properly?**		**45.0%**
	Result range		**0% - 90%**
2.2	**Any improvement of the situation over the last 12 months ?**	**No**	**71.7%**
		Yes	**25.6%**
		no comment	**2.6%**
2.3	**Reasons for improvement (suggestions received were):**		
a	more awareness through information & education driven by media, organisations such as Federated Farmers & Meat Processors		**14.52%**
b	increase of responsibility taken by farmers		**5.21%**
c	improved communication between stock carriers & famers		**1.97%**
d	meat processors get tougher on farmers sending dirty & full stock		**1.97%**
e	increase of pre-drafting		**1.97%**
			25.6%
	Reasons for status quo (suggestions received were):		
a	educational programs still not efficient enough (issues such as weight loss need increased information)		**28.9%**
b	general attitude: lack of awareness, a continuous high supply demand does not require any change		**13.2%**
c	some stock agents & drafters of some meat companies not organised		**4.4%**
d	farmers do not have adequate 'standing' facilities		**2.2%**
e	farmers do often not receive enough time to prepare the stock properly		**2.2%**
f	no comment or did not know		**20.8%**
			71.7%
2.4	**Suggestions of livestock carriers how to improve the current situation**		
a	higher focus on education of all stakeholders (especially farmers) by raising awareness on the importance of high quality end products		**34.4%**
b	better communication & coordination between all stakeholders (ie. meat processors & farmers) to allow also a better personal organisation		**10.9%**
c	more pre-drafting (farmers to arrange pre-drafting with their agents)		**8.8%**
d	through legislation & controls on stock hygiene by MAF Quality officers		**8.7%**
e	through penalties for delivering dirty or full stock to the meat processing plants		**6.6%**
f	provision of a network of effluent discharge facilities		**3.9%**
g	no comment or did not know		**26.7%**
			100.0%
3	**Do stock carriers receive normally sufficient notice from stock agents & drafters**	**Yes**	**45.0%**
		No	**26.3%**
		sometimes	**16.8%**
		no comment	**12.0%**
3.1	**Any improvement of the situation over the last 12 months ?**	**No**	**64.0%**
		Yes	**30.9%**
		no comment	**5.1%**

3.1/D Livestock carriers (2)

3.1.1	**Reasons for improvement (suggestions received were):**		
a	improved coordination (pre-drafting), communication between drafters and farmers		7.1%
b	bigger drafts in 97/98 reduced the problem within the South Island		5.1%
c	no comment or did not know		18.7%
			30.9%
3.1.2	**Reasons for status quo (suggestions received were):**		
a	a high stock supply demand (competition to procure stock) & an increase of just in time livestock supply policy requires more efficient coordination & communication		11.9%
b	perception that the general public , authorities and all stakeholders are not concerned or still accept effluent spillage		10.9%
c	improvement needs of personal organisation and coordination of drafters & stock agents		3.6%
d	education required to raise awareness of all issues involved		2.6%
e	livestock sales on live weight basis		2.3%
f	no advantage (incentive) or disadvantage (fine) to farmers and stock agents & drafters		2.3%
g	no comment or did not know		30.3%
			63.9%
3.2	**How livestock carriers saw a way of improving the current situation**		
a	pre-drafting needs to become compulsory to allow enough time for the farmer to empty out the stock		13.7%
b	better coordination through better communication and personal responsibility amongst all stakeholders		13.7%
c	education amongst all stakeholders through media or organsiations such as Federated Farmers, RTF, MAF etc to raise awareness of the issues		9.1%
d	industry requirements at destination need to become tougher (penalties)		9.0%
e	increasing the size of effluent containment on truck & trailer		6.6%
f	provision of a network of effluent discharge facilities		6.6%
g	legislation		2.4%
h	no comment or did not know		39.0%
			100%
4	**Percentage of livestock carrier discharging stock effluent other than at destination**		82.3%
5	**Whose responsibility is it?** (multiple answers possible)	farmer	40.6%
		meat company	21.5%
		drafter / stock agent	15.6%
		transport operator	13.9%
		authorities	2.2%
		no comment	6.2%
6	**Subsidiary information**		
	Age group	20 - 39	36.7%
		40 - 49	36.8%
		50 -59	19.6%
		> 60	5.3%
	number of valid questionnaires		38

ATTITUDES OF SURVEYED STAKEHOLDER GROUPS

AFTER THE VIDEO PRESENTATION

SURVEY RESULTS

3.2/A Farmers (1)

1	Percentage of farmers finding the video interesting	Yes	97.9%
		No	2.1%
1.1	**Positive comments received were:**		
a	video seen as well structured & informative (short, sharp & precise)		47.6%
b	too long & repetitive		2.1%
c	appreciation of effort put into this issue		2.1%
d	no comment or did not know		46.2%
			97.9%
1.2	**Comments (no) received were:**		
a	no comment or did not know		2.1%
2	Percentage of farmers having learnt anything new from the video	Yes	66.7%
		No	33.3%
2.1	**Positive comments received were:**		
a	- heightened the awareness of stock effluent spillages		24.4%
	- benefits of pre-drafting		
	- importance of stock preparation prior to transport		
	- possible reduction of effluent volumes collected in transit		
b	- role & number of required in-transit dump sites		7.8%
	- concern about costs		
c	magnitude of the issue being much bigger than perceived so far		7.5%
d	reduction of the problem through education & improved communication & coordination		6.7%
e	effect of stock preparation prior to transport on meat quality (weight loss issues, eventually better returns)		5.3%
f	no comment or did not know		14.9%
			66.7%
2.2	**Comments of stakeholders well aware of the problem**		
a	well aware of the situation that communication, coordination & education need to be improved as reinforced in the video		12.5%
b	no comment or did not know		20.8%
			33.3%
3	Percentage of farmers expecting the industry to require quality controls to remain viable	Yes	85.3%
		No	14.8%
3.1	**Positive comments received were:**		
a	expectations of higher meat requirements by all processors (quality assurance programs have become imminent) which can ensure sustainability for stock farming in New Zealand		12.8%
b	expectations of higher requirements on hygiene & animal welfare		6.3%
c	stock effluent spillage on the road is environmentally not longer acceptable		6.1%
d	network of dump sites required & higher focus on those expected		5.6%
e	enforcement & control systems required		2.2%
f	education (i.e. encouraging farmers to prepare their stock prior to transport) and communication (feedback from farmers)		2.2%
g	no comment or did not know		50.1%
			85.2%

3.2/A Farmers (2)

3.2	**Comments of stakeholders not perceiving quality controls may become relevant in the future**			
a	education will fix the problem			4.2%
b	livestock carrier will never be in a position to refuse a load			2.1%
c	unless incentives for better products or fines for non compliance			2.1%
d	no higher quality controls expected, as the plants must run efficiently >demand and supply. Only customer is able to request quality			2.1%
e	no comment or did not know			4.3%
				10.6%
4	**Percentage of farmers prepared to help make a coordinated supply system work**	**Yes** **No** **no comment**		**87.3%** **6.4%** **6.3%**
4.1	**Positive suggestions received were:**			
a	through continuous education & improved communication amongst all stakeholders			15.5%
b	increased responsibility along the whole chain in order to improve the product quality , to restore the viability of farmers & keep a high profile industry image overseas			15.3%
c	confidence needs to be given to farmers that best practice is assured all along the chain			15.1%
d	exert influence on livestock carrier by requesting clean crates, in time pick-up & effluent containment			1.9%
e	no comment or did not know			39.5%
				87.3%
4.2	**Concerns received were:**			
a	too much preparation involved for dairy cows & bulls			2.1%
b	no comment or did not know			4.3%
				6.4%
5	**Percentage of farmers believing a "Stock Standing" Certification Card (CC), perhaps combined with TB card, would be a good means of encouraging compliance by all stakeholders**	**Yes** **No**		**67.3%** **32.8%**
5.1	**Positive suggestions received were:**			
a	a proof for stock preparation which could assist raising awareness and responsibility on their obligations by setting an overall standard			14.6%
b	CC would assist meat industry TQM system & reward or penalise the stakeholders and make each stakeholder think ahead			9.2%
c	CC could work, even a first resistance being expected, if filled it in honestly			5.9%
d	CC only will only help fixing the problem, but dump sites still required			1.7%
e	no comment or did not know			35.9%
				67.3%
5.2	**Concerns received were:**			
a	more paperwork & regulations and how to achieve a honest compliance			12.0%
b	hard to enforce as farmers do not even fill in their TB cards			3.1%
c	farmers concerned that stock may, despite of CC, stay too long in the yards at destination before processing			1.6%
d	no comment or did not know			16.1%
				32.8%
	number of questionnaires collected			48

3.2/B Stock agents and company drafters (1)

1	**Percentage of stock agents & drafters finding the video interesting**	**Yes**	**96.9%**
		No	**3.1%**
1.1	**Positive comments received were:**		
a	video seen as well structured & informative (short, sharp & precise)		22.1%
b	perception & satisfaction that everybody has been involved in the video (ownership) and prepared to accept responsibility		5.4%
c	no comment or did not know		69.4%
			96.9%
1.2	**Comments (no) received were:**		
a	no comment or did not know		3.1%
2	**Percentage of stock agents & drafters having learnt anything new from the video**	**Yes**	**62.5%**
		No	**37.5%**
2.1	**Positive comments received were:**		
a	- heightened the awareness of stock effluent spillages		19.3%
	- benefits of pre-drafting		
	- importance of stock preparation		
	- possible reduction of effluent volumes collected in transit		
b	- role & number of required in-transit dump sites		8.0%
	- concern about costs		
c	effect of stock preparation prior to transport on meat quality (weight loss issues, eventually better returns)		4.9%
d	reduction of the problem through education & improved communication & coordination		2.4%
e	magnitude of the issue being much bigger than perceived so far		2.4%
f	perception that a comprehensive study is undertaken and not just talk		2.4%
g	no comment or did not know		23.1%
			62.5%
2.2	**Comments of stakeholders well aware of the problem**		
a	well aware of the situation that communication, coordination & education need to be improved as reinforced in the video		6.3%
b	no comment or did not know		31.3%
			37.5%
3	**Percentage of stock agents & drafters expecting the industry to require quality controls to remain viable**	**Yes**	**100.0%**
		No	**0.0%**
3.1	**Positive comments received were:**		
a	education (i.e. encouraging farmers to prepare their stock prior to transport) and communication (feedback from farmers)		14.2%
b	it is in everybody's interest that each stakeholder group is accepting responsibility and meeting their obligations		11.3%
c	enforcement & control systems required		9.6%
d	expectations of higher meat requirements by all processors (quality assurance programs have become imminent) which can ensure sustainability for stock farming in New Zealand		9.6%
e	stock effluent spillage on the road is environmentally not longer acceptable		4.5%
f	importance of network of dump sites		2.8%
g	expectations of higher requirements on hygiene & animal welfare		2.3%
h	no comment or did not know		45.8%
			100.0%

3.2/B Stock agents and company drafters (2)

4	Percentage of stock agents & drafters prepared to help make a coordinated supply system work	Yes	87.5%
		No	3.1%
		no comment	9.4%
4.1	**Positive suggestions received were:**		
a	through continuous education & improved communication amongst all stakeholders		30.7%
b	increased responsibility along the whole chain in order to improve the product quality, to restore the viability of farmers & keep a high profile industry image overseas		29.4%
c	adoption of best practice (pre-drafting, more advanced notice, better personal organsiation) has already started		5.9%
d	no comment or did not know		21.5%
			87.5%
4.2	**Concerns received were:**		
a	it will not fix the problem, Regional Councils should provide effluent dump sites		3.1%
5	Percentage of stock agents & drafters believing a "Stock Standing" certification card (similar to TB card) , perhaps combined with TB card, would be a good means of encouraging compliance by all stakeholders	Yes	60.6%
		No	39.4%
5.1	**Positive suggestions received were:**		
a	a proof for stock preparation which could assist raising awareness and responsibility on their obligations by setting an overall standard		16.6%
b	CC would assist meat industry TQM system & reward or penalise the stakeholders and make each stakeholder think ahead		9.0%
c	CC could work, even a first resistance being expected, if filled it in honestly		5.6%
d	no comment or did not know		29.5%
			60.6%
5.2	**Concerns received were:**		
a	more paperwork & regulations and how to achieve a honest compliance		13.6%
b	hard to enforce as farmers do not even fill in their TB cards		6.5%
c	no comment or did not know		19.3%
			39.4%

3.2/B Stock agents and company drafters (3)

6	**Perception of stock agents & drafters how the problem could be reduced (ie. communication & coordination)**		
6.1	**with livestock carrier**		
a	better coordination (advanced notice regarding drafting visits, livestock pick-up arrangements & stock supply requirements (QA programs) & livestock supply contracts)		**69.6%**
b	contracting only livestock carriers with QA accredited equipment (code of practice for livestock crates requires approx 400 litres containment for effluent collection)		**9.4%**
c	education required for increased awareness & better understanding		**5.1%**
d	did not know or no comment		**16.0%**
			100.1%
6.2	**with farmer**		
a	better coordination (advanced notice regarding drafting visits, livestock pick-up arrangements & stock supply requirements (QA programs) & livestock supply contracts)		**67.7%**
b	continuous personal education required to increase the awareness & better understanding of the issues involved		**18.6%**
c	increasing feedback on the assessment procedure of stock arrival conditions by giving detailed feedback on the kill-sheets (according to QA- System)		**10.2%**
d	did not know or no comment		**3.5%**
			100.0%
6.3	**with meat processing plant**		
a	better communication & coordination between stock agents & meat company in order to improve planning & space allocation (ie. advanced notice for drafting & enable pre-drafting)		**81.8%**
b	continuous personal education required to increase the awareness & better understanding of the issues involved		**4.6%**
c	did not know or no comment		**13.6%**
			100.0%
7	**Perception of stock agents & drafters whether the issue of effluent spillage could be solved in a self regulating and self policing way**	**Yes** **No** **no comment**	**62.5%** **25.0%** **12.5%**
7.1	**Positive comments received were:**		
a	through continuous communication & education programs to share responsibility & to enhance co-operation and coordination processes in a Win Win way throughout the whole chain		**39.5%**
b	the theory sounds great (some hope), however the practice of the past looked different		**4.7%**
c	did not know or no comment		**18.4%**
			62.5%
7.2	**Concerns received were:**		
a	as the attitude of farmers & other stakeholders is not likely going to change (too much <she'll be right> attitude) unless it hits them in the pocket (legislation & penalties required!). If only one part of the chain is broken it will not work! Compulsory Certification cards combined with TB card may help to reduce the problem		**25.0%**

3.2/C Meat company managers (1)

1	**Percentage of meat company managers finding the video interesting**	**Yes**	**100.0%**
		No	**-**
1.1	**Positive comments received were:**		
a	video seen as well structured & informative (short, sharp & precise)		35.0%
b	perception & satisfaction that everybody has been involved in the video (ownership) and prepared to accept responsibility		8.3%
c	no comment or did not know		56.7%
			100.0%
2	**Percentage of meat company managers having learnt anything new from the video**	**Yes**	**50.0%**
		No	**40.0%**
		no comment	**10.0%**
2.1	**Positive comments received were:**		
a	- heightened the awareness of stock effluent spillages		22.0%
	- benefits of pre-drafting		
	- importance of stock preparation		
	- possible reduction of effluent volumes collected in transit		
b	magnitude of the issue being much bigger than perceived so far		12.0%
c	perception that a comprehensive study is undertaken and not just talk		6.0%
d	no comment or did not know		10.0%
			50.0%
2.2	**Comments of stakeholders well aware of the problem**		
a	well aware of the situation that communication, coordination & education need to be improved as reinforced in the video		10.0%
b	no comment or did not know		30.0%
			40.0%
3	**Percentage of meat company managers expecting the industry to require quality controls to remain viable**	**Yes**	**100.0%**
		No	**-**
3.1	**Positive comments received were:**		
a	expectations of higher meat requirements by all processors (quality assurance programs have become imminent) which can ensure sustainability for stock farming in New Zealand		46.8%
b	education (i.e. encouraging farmers to prepare their stock prior to transport) and communication (feedback from farmers) required		18.3%
c	effluent disposal facilities required at destinations		8.3%
d	expectations of higher requirements on hygiene & animal welfare		8.3%
e	no comment or did not know		18.3%
			100.0%

3.2/C Meat company managers (2)

4	**Percentage of meat company managers prepared to help make a coordinated supply system work**	**Yes**	**100.0%**
		No	**-**
4.1	**Suggestions received were:**		
a	reviewing the feedback procedure on livestock arrival presentations		33.3%
b	adoption of best practice (pre-drafting, more advanced notice, better personal organisation, improved coordination of stock procurement)		31.3%
c	through continuous education & improved communication amongst all stakeholders		20.8%
d	meat plants will have to accept effluent from delivering livestock truck & trailer units		8.3%
e	increased responsibility along the whole chain in order to improve the product quality, to restore the viability of farmers & keep a high profile industry image overseas		6.3%
			100.0%
5	**Percentage of meat company managers believing a "Stock Standing" certification card (similar to TB card) , perhaps combined with TB card, would be a good means of encouraging compliance by all stakeholders**	**Yes**	**80.0%**
		No	**20.0%**
5.1	**Positive suggestions received were:**		
a	CC would assist meat industry TQM system & reward or penalise the stakeholders and make each stakeholder think ahead		22.8%
b	a proof for stock preparation which could assist raising awareness and responsibility on their obligations by setting an overall standard		17.2%
c	CC could work, even a first resistance being expected, if filled it in honestly		10.0%
d	no comment or did not know		30.0%
			80.0%
5.2	**Concerns received were:**		
a	more paperwork & regulations and how to achieve a honest compliance		10.0%
b	hard to enforce as farmers do not even fill in their TB cards		5.0%
c	no compliance unless education program is set up		5.0%
			20.0%
6	**Perception of meat company managers how the problem could be reduced (ie. communication & coordination)**		
6.1	**with livestock carrier**		
a	better coordination (advanced notice regarding drafting visits, livestock pick-up arrangements & stock supply requirements (QA programs) & livestock supply contracts) and increased personal responsibility		31.4%
b	review of assessment of livestock arrival presentations		20.0%
c	contracting only livestock carriers with QA accredited equipment (code of practice for livestock crates requires approx 400 litres containment for effluent collection)		20.0%
d	through improved logistics in the killing schedule by ie. giving more advanced notice to all stakeholders		14.2%
e	education required for increased awareness & better understanding		7.2%
f	did not know or no comment		7.2%
			100.0%

3.2/C Meat company managers (3)

6.2	**with farmer**		
a	better coordination (advanced notice regarding drafting visits, livestock pick-up arrangements & stock supply requirements (QA programs) & livestock supply contracts) and increased personal responsibility		36.7%
b	better coordination (advanced notice regarding drafting visits & stock supply requirements (QA programs))		28.3%
c	improved logistics (increased advanced notice regarding stock supply requirements, drafting & livestock pick-up arrangements)		16.7%
d	increasing feedback on the assessment procedure of stock arrival conditions by giving detailed feedback on the kill-sheets (according to QA system)		10.0%
e	did not know or no comment		8.3%
			100.0%
7	**Perception of the meat company managers whether the issue of effluent spillage could be solved in a self regulating and self policing way**	**Yes**	**80.0%**
		No	**10.0%**
		no comment	**10.0%**
7.1	**Positive comments received were:**		
a	through continuous communication & education programs to share responsibility & to enhance co-operation and coordination processes in a Win Win way throughout the whole chain		64.0%
b	increasing feedback on the assessment procedure of stock arrival conditions by giving detailed feedback on the kill-sheets (according to QA system)		16.0%
			80.00%
7.2	**Concerns received were:**		
a	as the attitude of farmers & other stakeholders is not likely going to change (too much <she'll be right> attitude) unless it hits them in the pocket (legislation & penalties required!). If only one part of the chain is broken it will not work! Compulsory Certification cards combined with TB card may help to reduce the problem		10.0%
			10.0%

3.2/D Livestock carriers (1)

1	**Percentage of livestock carriers finding the video interesting**	**Yes**	**100.0%**
		No	**-**
1.1	**Positive comments received were:**		
a	video seen as well structured & informative (short, sharp & precise)		**28.8%**
b	perception & satisfaction that everybody has been involved in the video (ownership) and prepared to accept responsibility		**19.0%**
c	appreciation of effort put into this issue		**2.1%**
d	video needs to be circulated widely		**2.0%**
e	no comment or did not know		**48.1%**
			100.0%
2	**Percentage of livestock carriers having learnt anything new from the video**	**Yes**	**40.6%**
		No	**59.4%**
2.1	**Positive comments received were:**		
a	great achievement that every stakeholder has agreed to address the problem by being involved in the video		**18.4%**
b	- heightened the awareness of stock effluent spillages		**9.8%**
	- benefits of pre-drafting		
	- importance of stock preparation		
	- possible reduction of effluent volumes collected in transit		
c	- role & number of required in-transit dump sites		**5.9%**
	- concern about costs		
d	perception that a comprehensive study is undertaken and not just talk		**4.6%**
e	reduction of the problem through education & improved communication & coordination		**2.0%**
			40.7%
2.2	**Comments of stakeholders well aware of the problem**		
a	well aware of the situation that communication, coordination & education need to be improved as reinforced in the video		**27.0%**
b	no comment or did not know		**32.4%**
			59.4%
3	**Percentage of livestock carriers expecting the industry to require quality controls to remain viable**	**Yes**	**86.8%**
		No	**13.2%**
3.1	**Positive comments received were:**		
a	expectations of higher meat requirements by all processors (quality assurance programs have become imminent) which can ensure sustainability for stock farming in New Zealand		**20.5%**
b	it is in everybody's interest that each stakeholder group is accepting responsibility and meet their obligations (ie. code of practice for stock crates)		**19.4%**
c	education (i.e. encouraging farmers to prepare their stock prior to transport) and communication (feedback from farmers) required		**4.5%**
d	enforcement & control systems required		**2.1%**
e	no comment or did not know		**40.3%**
			86.8%

3.2/D Livestock carriers (2)

3.2	**Comments of stakeholders not perceiving quality controls may become relevant in the future**		
a	unless incentives for better products or fines for non compliance		7.9%
b	no higher quality controls expected, as the plants must run efficiently >demand and supply. Only customer is able to request quality		2.6%
c	no comment or did not know		2.6%
			13.1%
4	**Percentage of livestock carriers prepared to help make a coordinated supply system work**	Yes	92.1%
		No	7.9%
4.1	**Positive suggestions received were:**		
a	through continuous education & improved communication amongst all stakeholders		24.9%
b	increased responsibility along the whole chain in order to improve the product quality, to restore the viability of farmers & keep a high profile industry image overseas		22.9%
c	livestock company prepared to fit holding tanks to their truck & trailer units		7.7%
d	no comment or did not know		36.6%
			92.1%
4.2	**Concerns received were:**		
a	reluctant to fit multi purpose units with effluent holding tanks		2.6%
b	no comment or did not know		5.3%
			7.9%
5	**Percentage of livestock carriers believing a "Stock Standing" certification card (similar to TB card), perhaps combined with TB card, would be a good means of encouraging compliance by all stakeholders**	Yes	66.6%
		No	33.4%
5.1	**Positive suggestions received were:**		
a	a proof for stock preparation which could assist raising awareness and responsibility on their obligations by setting an overall standard		28.6%
b	CC could work, even a first resistance being expected, if filled it in honestly		10.7%
c	CC would assist meat industry TQM system & reward or penalise the stakeholders and make each stakeholder think ahead		8.4%
d	no comment or did not know		18.9%
			66.6%
5.2	**Concerns received were:**		
a	more paperwork & regulations and how to achieve a honest compliance		15.3%
b	hard to enforce as farmers do not even fill in their TB cards		6.7%
c	no compliance unless education program is set up		1.9%
d	no comment or did not know		9.5%
			33.4%

3.2/D Livestock carriers (3)

6	**Perception of livestock carriers how the problem could be reduced (ie. communication & coordination)**		
6.1	**with stock agent or company drafter**		
a	better coordination (advanced notice regarding drafting visits, livestock pick-up arrangements & stock supply requirements (QA programs) & livestock supply contracts) and increased personal responsibility		**47.9%**
b	continuous personal education required to increase the awareness & better understanding of the issues involved		**9.8%**
c	increased pre-drafting (2 days at least)		**8.8%**
d	did not know or no comment		**33.6%**
			100.0%
6.2	**with farmer**		
a	better coordination (advanced notice regarding drafting visits, livestock pick-up arrangements & stock supply requirements (QA programs) & livestock supply contracts) and increased personal responsibility		**55.3%**
b	continuous personal education required to increase the awareness & better understanding of the issues involved		**10.4%**
c	improved holding yards at the farm		**4.4%**
d	increasing feedback on the assessment procedure of stock arrival conditions through meat companies by giving detailed feedback on the kill-sheets (reward or penalty system)		**3.0%**
e	did not know or no comment		**27.0%**
			100.0%
6.3	**with meat processing plant**		
a	improved plant logistics (ie. increased stock delivery hours for long haul journeys & adequate unloading facilities for rush hours & more uniformed approach to space allocation)		**31.6%**
b	better communication & coordination between stock agents & meat company in order to improve planning & space allocation (ie. advanced notice for drafting & enable pre-drafting)		**23.5%**
c	continuous personal education required to increase the awareness & better understanding of the issues involved		**8.8%**
d	increasing feedback on the assessment procedure of stock arrival conditions through meat companies by giving detailed feedback on the kill-sheets (reward or penalty system)		**6.2%**
e	did not know or no comment		**29.9%**
			100.0%
7	**Livestock carrier perception whether the issue of effluent spillage could be solved in a self regulating and self policing way**	**Yes**	**46.4%**
		No	**40.8%**
		no comment	**12.8%**
7.1	**Positive comments received were:**		
a	through continuous communication & education programs to share responsibility & to enhance co-operation and coordination processes in a Win Win way throughout the whole chain		**27.9%**
b	the theory sounds great (some hope), however the practice of the past looked different		**4.9%**
c	did not know or no comment		**13.5%**
			46.4%
7.2	**Concerns received were:**		
a	as the attitude of farmers & other stakeholders is not likely going to change (too much <she'll be right> attitude) unless it hits them in the pocket (legislation & penalties required!). If only one part of the chain is broken it will not work! Compulsory Certification cards combined with TB card may help to reduce the problem		**33.1%**
b	did not know or no comment		**7.7%**
			40.8%

Summary of attitudes of all surveyed stakeholder groups

			Farmers	Stock agents & drafters	Meat company managers	Livestock carriers	Average
1	Percentage of stakeholder groups finding the video interesting	Yes	97.9%	96.9%	100.0%	100.0%	98.7%
		No	2.1%	3.1%	0.0%	0.0%	1.3%
1.1	**Positive comments received were:**						
a	video seen as well structured & informative (short, sharp & precise)		47.6%	22.1%	35.0%	28.8%	**33.4%**
b	perception & satisfaction that everybody has been involved in the video (ownership) and prepared to accept responsibility		-	5.4%	8.3%	18.9%	**8.2%**
c	appreciation of effort put into this issue		2.1%	-	-	2.1%	**1.0%**
d	video needs to be circulated widely		-	-	-	2.0%	**0.5%**
e	too long & repetitive		2.1%	-	-	-	**0.5%**
f	no comment or did not know		46.2%	69.4%	56.7%	48.1%	**55.1%**
							98.7%
1.2	**Comments (no) received were:**						
a	no comment or did not know		2.1%	3.1%	0.0%	-	1.3%
2	Percentage of stakeholder groups having learnt anything new from the video	Yes	66.7%	62.5%	50.0%	40.6%	55.0%
		No	33.3%	37.5%	40.0%	59.4%	42.5%
		no comment	0.0%	0.0%	10.0%	0.0%	2.5%
2.1	**Positive comments received were:**						
a	- heightened the awareness of stock effluent spillages - benefits of pre-drafting - importance of stock preparation - possible reduction of effluent volumes collected in transit		24.4%	19.3%	22.0%	9.8%	**18.9%**
b	magnitude of the issue being much bigger than perceived so far		7.5%	2.4%	12.0%		**5.5%**
c	- role & number of required In-transit dump sites - concern about costs		7.8%	8.0%		5.9%	**5.4%**
d	great achievement that every stakeholder has agreed to address the problem by being involved in the video					18.4%	**4.6%**
e	perception that a comprehensive study is undertaken and not just talk			2.4%	6.0%	4.6%	**3.2%**
f	reduction of the problem through education & improved communication & coordination		6.7%	2.4%		2.0%	**2.8%**
g	effect of stock preparation prior to transport on meat quality (weight loss issues, eventually better returns)		5.3%	4.9%			**2.6%**
h	no comment or did not know		14.9%	23.1%	10.0%		**12.0%**
							55.0%
2.2	**Comments of stakeholders well aware of the problem**						
a	well aware of the situation that communication, coordination & education need to be improved as reinforced in the video		12.5%	6.3%	10.0%	27.0%	**13.9%**
b	no comment or did not know		20.8%	31.3%	30.0%	32.4%	**28.6%**
							42.5%

Summary of attitudes of all surveyed stakeholder groups

			Farmers	Stock agents & drafters	Meat company managers	Livestock carriers	Average
3	**Percentage of stakeholder groups expecting the industry to require quality controls to remain viable**	**Yes**	**85.3%**	**100.0%**	**100.0%**	**86.8%**	**93.0%**
		No	**14.8%**	**0.0%**	**0.0%**	**13.2%**	**7.0%**
3.1	**Positive comments received were:**						
a	expectations of higher meat requirements by all processors (quality assurance programs have become imminent) which can ensure sustainability for stock farming in New Zealand		12.8%	9.6%	46.7%	20.5%	**22.4%**
b	education (i.e. encouraging farmers to prepare their stock prior to transport) and communication (feedback from farmers) required		2.2%	14.2%	18.3%	4.5%	**9.8%**
c	it is in everybody's interest that each stakeholder group is accepting responsibility and meet their obligations (ie. code of practice for stock crates)			11.3%		19.4%	**7.7%**
d	expectations of higher requirements on hygiene & animal welfare		6.3%	2.3%	8.3%		**4.2%**
e	enforcement & control systems required		2.2%	9.6%		2.1%	**3.5%**
f	stock effluent spillage on the road is environmentally not longer acceptable		6.1%	4.5%			**2.6%**
g	importance of network of dump sites		5.6%	2.8%			**2.1%**
h	effluent disposal facilities required at destinations				8.3%		**2.1%**
I	no comment or did not know		50.1%	45.8%	18.3%	40.4%	**38.6%**
							93.0%
3.2	**Comments of stakeholders not perceiving quality controls may become relevant in the future**						
a	unless incentives for better products or fines for non compliance		2.1%			7.9%	**2.5%**
b	no higher quality controls expected, as the plants must run efficiently >demand and supply. Only customer is able to request quality		2.1%			2.6%	**1.2%**
c	education will fix the problem		4.2%				**1.0%**
d	livestock carrier will never be in a position to refuse a load		2.1%				**0.5%**
e	no comment or did not know		4.3%			2.6%	**1.7%**
							7.0%
4	**Percentage of stakeholder groups prepared to help make a coordinated supply system work**	**Yes**	**87.3%**	**87.5%**	**100.0%**	**92.1%**	**91.7%**
		No	**6.4%**	**3.1%**	**0.0%**	**7.9%**	**4.4%**
		no comment	**6.3%**	**9.4%**	**0.0%**		**3.9%**
4.1	**Positive suggestions received were:**						
a	through continuous education & improved communication amongst all stakeholders		15.5%	30.7%	20.8%	24.9%	**23.0%**
b	increased responsibility along the whole chain in order to improve the product quality, to restore the viability of farmers & keep a high profile industry image overseas		15.3%	29.4%	6.3%	22.9%	**18.5%**
c	adoption of best practice (pre-drafting, more advanced notice, better personal organisation, improved coordination of stock procurement)			5.9%	31.3%		**9.3%**
d	reviewing the feedback procedure on livestock arrival presentations				33.3%		**8.3%**

Summary of attitudes of all surveyed stakeholder groups

			Farmers	Stock agents & drafters	Meat company managers	Livestock carriers	Average
e	confidence needs to be given to farmers that best practice is assured all along the chain		15.1%				**3.8%**
f	meat plants will have to accept effluent from delivering livestock truck & trailer units				8.4%		**2.1%**
g	livestock company prepared to fit holding tanks to their truck & trailer units					7.7%	**1.9%**
h	exert influence on livestock carrier by requesting clean crates, in time pick-up & effluent containment		1.9%				**0.5%**
I	no comment or did not know		39.5%	21.5%		36.6%	**24.4%**
							91.7%
4.2	**Concerns received were:**						
a	it will not fix the problem, Regional Councils should provide effluent dump sites			3.1%			**0.8%**
b	reluctant to fit multi purpose units with effluent holding tanks					2.6%	**0.7%**
c	too much preparation involved for dairy cows & bulls		2.1%				**0.5%**
d	no comment or did not know		4.3%			5.3%	**2.4%**
							4.4%
5	**Percentage of stakeholder groups believing a "Stock Standing" certification card (similar to TB card), perhaps combined with TB card, would be a good means of encouraging compliance by all stakeholders**	**Yes**	**67.3%**	**60.6%**	**80.0%**	**66.6%**	**68.6%**
		No	**32.8%**	**39.4%**	**20.0%**	**33.4%**	**31.4%**
5.1	**Positive suggestions received were:**						
a	a proof for stock preparation which could assist raising awareness and responsibility on their obligations by setting an overall standard		14.6%	16.6%	17.2%	28.6%	**19.2%**
b	CC would assist meat industry TQM system & reward or penalise the stakeholders and make each stakeholder think ahead		9.2%	9.0%	22.8%	8.4%	**12.4%**
c	CC could work, even a first resistance being expected, if filled it in honestly		5.9%	5.6%	10.0%	10.7%	**8.0%**
d	CC only will only help fixing the problem, but dump sites still required		1.7%				**0.4%**
e	no comment or did not know		35.9%	29.5%	30.0%	18.9%	**28.6%**
							68.6%
5.2	**Concerns received were:**						
a	more paperwork & regulations and how to achieve a honest compliance		12.0%	13.6%	10.0%	15.3%	**12.7%**
b	hard to enforce as farmers do not even fill in their TB cards		3.1%	6.5%	5.0%	6.7%	**5.3%**
c	no compliance unless education program is set up				5.0%	1.9%	**1.7%**
d	farmers concerned that stock may, despite of CC, stay too long in the yards at destination before processing		1.6%				**0.4%**
e	no comment or did not know		16.1%	19.3%		9.5%	**11.2%**
							31.4%

Summary of attitudes of all surveyed stakeholder groups

			Farmers	Stock agents & drafters	Meat company managers	Livestock carriers	Average
	Perception of stakeholder groups how the problem could be reduced (ie. communication & coordination)						
1	**with livestock carrier**						
	better coordination (advanced notice regarding drafting visits, livestock pick-up arrangements & stock supply requirements (QA programs) & livestock supply contracts) and increased personal responsibility		-	69.6%	31.4%	-	**50.5%**
	contracting only livestock carriers with QA accredited equipment (code of practice for livestock crates requires approx 400 litres containment for effluent collection)		-	9.4%	20.0%	-	**14.7%**
	review of assessment of livestock arrival presentations		-		20.0%	-	**10.0%**
	through improved logistics in the killing schedule by ie. giving more advanced notice to all stakeholders		-		14.3%	-	**7.2%**
	education required for increased awareness & better understanding		-	5.1%	7.2%	-	**6.1%**
	did not know or no comment		-	16.0%	7.2%	-	**11.6%**
							100.0%
2	**with stock agent or company drafter**						
	better coordination (advanced notice regarding drafting visits, livestock pick-up arrangements & stock supply requirements (QA programs) & livestock supply contracts) and increased personal responsibility		-	-	-	47.9%	47.9%
	continuous personal education required to increase the awareness & better understanding of the issues involved		-	-	-	9.8%	9.8%
	increased pre-drafting (2 days at least)		-	-	-	8.8%	8.8%
	did not know or no comment		-	-	-	33.6%	33.6%
							100.0%
3	**with farmer**						
	better coordination (advanced notice regarding drafting visits, livestock pick-up arrangements & stock supply requirements (QA programs) & livestock supply contracts) and increased personal responsibility		-	67.7%	28.3%	55.3%	**50.5%**
	continuous personal education required to increase the awareness & better understanding of the issues involved		-	18.6%	36.7%	10.4%	**21.9%**
	increasing feedback on the assessment procedure of stock arrival conditions through meat companies by giving detailed feedback on the kill-sheets (reward or penalty system)		-	10.2%	10.0%	3.0%	**7.7%**
	improved logistics (increased advanced notice regarding stock supply requirements, drafting & livestock pick-up arrangements)		-		16.7%		**5.6%**
	improved holding yards at the farm		-			4.4%	**1.5%**
	did not know or no comment		-	3.5%	8.3%	27.0%	**12.9%**
							100.0%

Summary of attitudes of all surveyed stakeholder groups

			Farmers	Stock agents & drafters	Meat company managers	Livestock carriers	Average
6.4	**with meat processing plant**						
a	better communication & coordination between stock agents & meat company in order to improve planning & space allocation (ie. advanced notice for drafting & enable pre-drafting)		-	81.8%	-	23.5%	**52.6%**
b	improved plant logistics (ie. increased stock delivery hours for long haul journeys & adequate unloading facilities for rush hours & more uniformed approach to space allocation)		-		-	31.6%	**15.8%**
c	continuous personal education required to increase the awareness & better understanding of the issues involved		-	4.6%	-	8.8%	**6.7%**
d	increasing feedback on the assessment procedure of stock arrival conditions through meat companies by giving detailed feedback on the kill-sheets (reward or penalty system)		-		-	6.2%	**3.1%**
e	did not know or no comment		-	13.6%	-	30.0%	**21.8%**
							100.0%
7	**Perception of stakeholder groups whether the issue of effluent spillage could be solved in a self regulating and self policing way**	**Yes**	-	**62.5%**	**80.0%**	**46.4%**	**63.0%**
		No	-	**25.0%**	**10.0%**	**40.8%**	**25.3%**
		no comment	-	**12.5%**	**10.0%**	**12.8%**	**11.8%**
7.1	**Positive comments received were:**						
a	through continuous communication & education programs to share responsibility & to enhance co-operation and coordination processes in a Win Win way throughout the whole chain		-	39.5%	64.0%	27.9%	**43.8%**
	increasing feedback on the assessment procedure of stock arrival conditions by giving detailed feedback on the kill-sheets (according to QA system)		-		16.0%		**5.3%**
b	the theory sounds great (some hope), however the practice of the past looked different		-	4.7%		4.9%	**3.2%**
c	did not know or no comment		-	18.4%		13.5%	**10.6%**
							63.0%
7.2	**Concerns received were:**						
a	as the attitude of farmers & other stakeholders is not likely going to change (too much <she'll be right> attitude) unless it hits them in the pocket (legislation & penalties required!). If only one part of the chain is broken it will not work! Compulsory Certification cards combined with TB card may help to reduce the problem		-	25.0%	10.0%	33.1%	**22.7%**
b	did not know or no comment		-			7.7%	**2.6%**
							25.3%
8	**Subsidiary information**						
	number of questionnaires collected		48	32	10	38	**128**

APPENDIX 4

- **Questionnaire form sent to livestock carriers to survey the livestock movements in the South Island** 307

- **Three examples of livestock trip assignments** 312

- **Table representing a calibration proof for 'cattle' shipment assignments table regarding 'cattle' assignments** 314

- **Graph representing the 'defaecation' behaviour of 'full' or 'not stood' sheep** 315

- **Model input data regarding the 'defaecation' behaviour of surveyed Livestock** 317

Region	Company	No.

QUESTIONNAIRE TO LIVESTOCK CARRIERS OPERATING IN THE SOUTH ISLAND

			Trucks	Trailers
1.	Number of livestock units (truck and trailer)			
2.	Number of units fitted with effluent holding tanks (with taps)?			
3.	Capacity [Litres] of these tanks (only the tank)	min		
		max		

4. Where can you currently empty the holding tanks now?

4.1 **SALEYARD** Please list the saleyards that **have** effluent discharge **facilities**:

.....

4.2 **MEAT PROCESSING PLANTS**/ Please list the Meat Plants that **have no facilities**:

.....

5. What is the percentage of cattle, sheep & deer **you carry** over a period of one year ?

Cattle ☐ % **Sheep** ☐ % **Deer** ☐ %

6. What kind of livestock characterise **your area**?

Cattle ☐ % **Sheep** ☐ % **Deer** ☐ %

How would you see cattle being represented in your area?

Dairy cows ☐ % **Beef** ☐ % **Bulls** ☐ %

7. Using the following marking criteria, please estimate in the table underneath in which months you carry especially *cattle* or *sheep* ?

   Please *mark* in each box a number between *0 - 2* to indicate the degree of business in these months

   no transport = 0 *busy = 1* *very busy = 2*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dairy cows												
Beef												
Bulls												
Sheep												

8. What do you estimate, is the number of stock truck units (of your own company) on South Island roads within the following months? This is important for the analysis of the seasonal patterns.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
units per day												
number of trips per day with one unit												
working days per week												

9. Please indicate your **BUSIEST MONTHS** of livestock cartage (**please tick):**

Sept Oct Nov Dec Jan Feb Mar Apr May June July Aug

Please indicate in the next tables the **destinations** (i.e. meat plants, saleyards and ports) you deliver the livestock, the **type of animals** (cattle or sheep), the **number of truck & trailer units** that go daily, weekly or monthly.

As some shifting of livestock may occur in the **early** or **late season**, please consider the columns for the early (Oct - Jan) and the later (Jan – July).

In case you do regular **farm to farm** or **store stock** shifting, please do use the second tables, as you can easily mention the departure location (FROM) and the end destination (TO).

MEAT PROCESSING PLANTS	LOCATION	Cattle / Sheep	TRUCK UNITS A DAY	TRIPS A WEEK	TRIPS A MONTH	TRUCK UNITS A DAY	TRIPS A WEEK	TRIPS A MONTH
			October - January			January - July		
Abattoir - Bay City Meats Ltd.	TIMARU	C						
		S						
Abattoir Malvern	MALVERN	C						
		S						
Abco Meats Ltd	OAMARU	C						
		S						
Alliance	LORNVILLE	C						
		S						
Alliance	MAKAREWA	C						
		S						
Alliance	MATAURA	C						
		S						
Alliance	PUKEURI	C						
		S						
Alliance- Sockburn	CHRISTCHURCH	S						
Alliance Smithfield	TIMARU	S						
Ashburton Meat processors	ASHBURTON	C						
		S						
Blue Sky Meats (NZ) Ltd.	INVERCARGILL	C						
		S						
CMP- Canterbury Meat Packers Ltd	SEAFIELD (Ashburton)	C						
		S						
Hartland Prime Meat NZ Ltd	RIPPONVALE / CROMWELL	S						
Hereford Prime Range New Zealand Ltd	INVERCARGILL	C						
		S						
Nelson Bays Meat Producers Ltd	NELSON	C						
		S						
Omakau Meat Processors	OMAUKAU	S						
Phoenix Meat Co Ltd.	KOKIRI	C						
PPCS	FAIRTON	S						
PPCS	PAREORA	S						
PPCS Waitane	GORE	C						
		S						
PPCS - Belfast	BELFAST	C						
PPCS - Canterbury	BELFAST	S						
PPCS - Finegand	BALCLUTHA	C						
		S						
PPCS- Marlborough	BLENHEIM	S						
CMP Riverlands	BLENHEIM	C						

SALEYARDS	LOCATION	Cattle / Sheep	TRUCK UNITS A DAY	TRIPS A WEEK	TRIPS A MONTH	TRUCK UNITS A DAY	TRIPS A WEEK	TRIPS A MONTH
			October - January			January - July		
Riverlands	BLENHEIM	C						
		S						
Canterbury Agric. Park	CHRISTCHURCH	C						
		S						
Tinwald	TINWALD	C						
		S						
Temuka	TEMUKA	C						
		S						
Gore	GORE	C						
		S						
Lorneville	LORNEVILLE	C						
		S						
Palmerston	PALMERSTON	C						
		S						
Oamaru	OAMARU	C						
		S						
Brightwater	BRIGHTWATER	C						
		S						
Omarama	OMARAMA	S						
Cromwell	CROMWELL	C						
		S						
Ferry Terminal	PICTON	C						
		S						
	NELSON	C						
		S						

10. Seasonal Patterns (i.e. **Farm to Farm**)

Please indicate relevant trips you do at different times of the year due to special events. These are important to be able to assign particular journeys to the computer simulation model.

FROM	TO	Cattle / Sheep	TRUCK UNITS A DAY	TRIPS A WEEK	TRIPS A MONTH	TRUCK UNITS A DAY	TRIPS A WEEK	TRIPS A MONTH
			October - January			January - July		
		C						
		S						
		C						
		S						
		C						
		S						
		C						
		S						
		C						
		S						
		C						
		S						
		C						
		S						
		C						
		S						
		C						
		S						
		C						
		S						
		C						
		S						

Comments:.....

.....

.....

11. What percentage of trips (**single** trips such as trip to the works) are under 100 Km ?

0% - 10 % ☐ 10% - 20 % ☐ 20% - 30% ☐ 30% - 40% ☐

If more, please estimate ☐ %

12. *Please indicate* the precise locations (e.g. truck stop or service station "BP/ Shell /Caltex / Mobil", located at the entrance of "NZ-town" on Highway 1) you think would be most suitable for a stock effluent discharge facility, especially the ones that your drivers would use such as regular stopping places.

PLEASE DON'T FORGET THE PROVINCIAL HIGHWAYS !!

- .....
- .....
- .....
- .....
- .....
- .....
- .....
- .....

COMPANY DETAILS NORTH / SOUTH

Name of your company: .....

Contact person: .....

Postal address: .....

Daytime phone number: ..... Fax number: .....

Email address: .....

THANK YOU FOR YOUR ASSISTANCE

PLEASE RETURN THIS QUESTIONNAIRE DIRECTLY TO

Jean-Paul Thull

Transport Studies Group; Division of Environmental Management
PO BOX 84, LINCOLN UNIVERSITY / CANTERBURY.

WE CAN ASSURE YOU THAT THE INFORMATION PROVIDED BY YOUR COMPANY WILL BE KEPT TOTALLY CONFIDENTIAL. THE DATA WILL ONLY BE USED IN AGGREGATED FORM IN TABLES, GRAPHS OR MAPS SUCH THAT THE BUSINESS OF INDIVIDUAL TRANSPORT OPERATORS WILL NOT BE IDENTIFIED.

THREE EXAMPLES OF LIVESTOCK TRIP ASSIGNMENTS OF SMALL TRANSPORT COMPANIES

33	ASHBURTON	ASHBURTON	CHRISTCHURCH	CHRISTCHURCH	CHRISTCHURCH	KOKIRI	MALVERN	TINWALD	CHRISTCHURCH				
MID CANTERBURY 9	Ashburton Meat Processors	CMP Seafield	Alliance Sockburn	PPCS Belfast	PPCS Canterbury	Phoenix Meat Co Ltd.	Abattoir Malvern	Saleyards	Saleyards		CATTLE (1) SHEEP (0)		Full (1) EMPTY (0)	Wet (1) Dry (0)
LEESTON	1										1		1	0
DUNSANDEL	1										0		1	0
LEESTON		1									1		0	0
DUVAUCHELLE		1									0		0	0
LEESTON			1								0		1	0
DUNSANDEL			1								0		1	0
LEESTON				1							1		1	0
LEESTON				1							1		0	1
LEESTON				1							1		1	0
DUNSANDEL					1						0		1	0
LEESTON					1						0		1	0
LEESTON					1						0		1	0
LEESTON						1					1		1	1
LEESTON							1				1		0	0
LEESTON							1				1		1	0
DUNSANDEL							1				1		1	0
LEESTON							1				0		0	0
DUNSANDEL							1				0		1	0
DUNSANDEL								1			1		1	1
LEESTON									1		1		1	0
LEESTON									1		1		1	0
LEESTON									1		0		1	0
SUM	**2**	**2**	**2**	**3**	**3**	**1**	**5**	**1**	**3**	**22**				
CATTLE	1	1	0	3	0	1	3	1	2	**55%**	**12**		**17**	**3**
SHEEP	1	1	2	0	3	0	2	0	1	**45%**	**10**		**77%**	**14%**

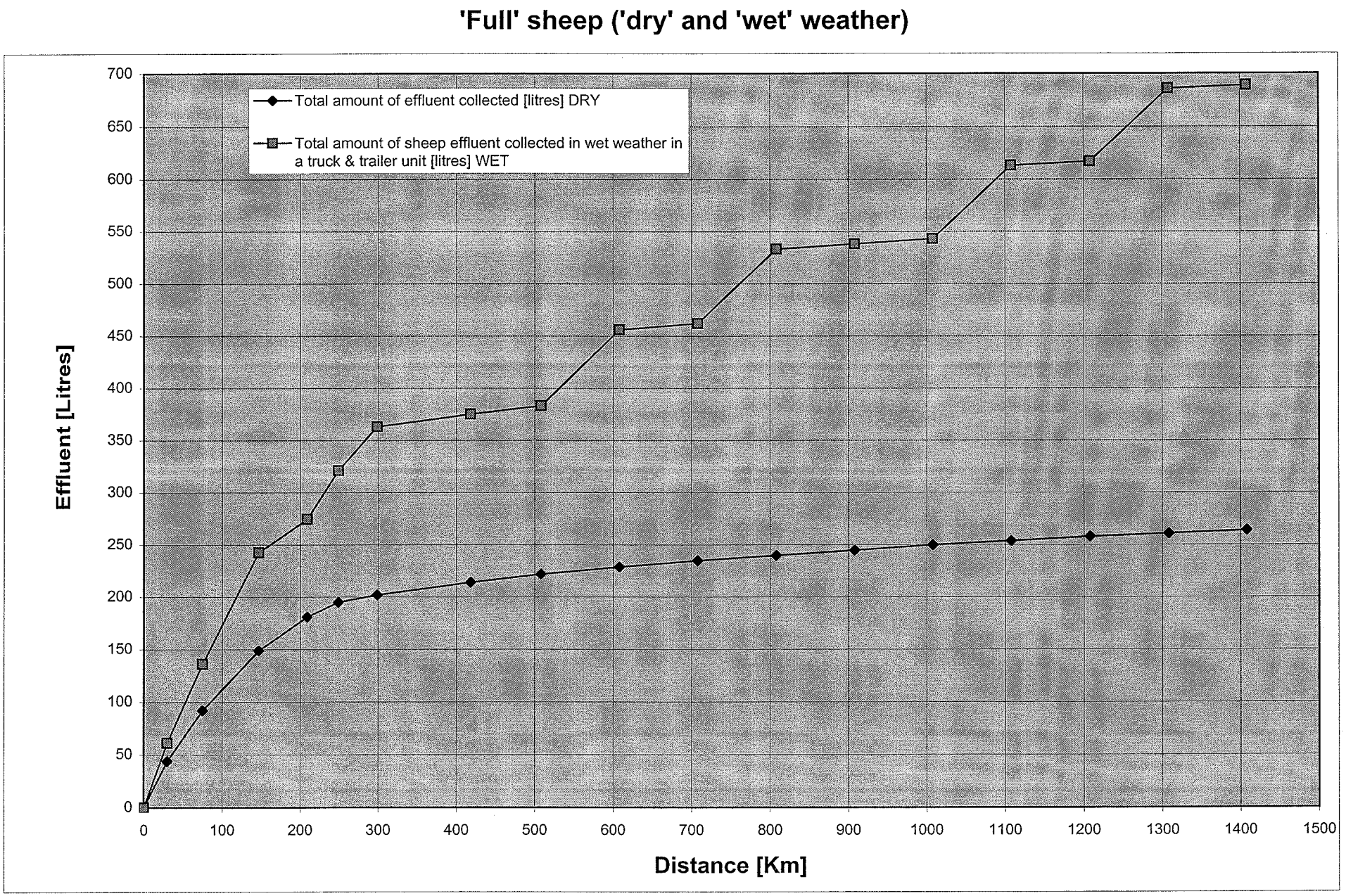
52	CHRISTCHURCH	CHRISTCHURCH	ASHBURTON	MATAURA	OAMARU	PAREORA	PUKEURI	TIMARU	TIMARU	OAMARU	PALMERSTON				
NORTH OTAGO 1	URCH Alliance Sockburn	URCH PPCS Belfast	ON PPCS Fairton	Alliance Mataura	Abco Meats Ltd	PPCS Pareora	JUNCTION Alliance Pukeuri	Bay City Meats Ltd	Alliance Smithfield	Saleyards	Saleyards		CATTLE (1) Sheep (0)		Full (1) EMPTY (0)	Wet (1) Dry (0)
HAMPDEN	1												0		1	0
HAMPDEN		1											1		0	1
OMARAMA			1										0		1	0
RANFURLY			1										0		1	0
HAMPDEN				1									0		1	0
HAMPDEN					1								1		1	0
RANFURLY						1							0		1	0
KUROW						1							0		0	0
HAMPDEN						1							0		1	0
OMARAMA						1							0		1	0
RANFURLY						1							0		0	0
HAMPDEN						1							0		1	0
HAMPDEN							1						1		1	0
RANFURLY							1						1		0	0
KUROW							1						0		1	1
HAMPDEN							1						0		1	0
OMARAMA								1					1		1	0
RANFURLY									1				0		1	0
HAMPDEN									1				0		0	0
KUROW										1			1		1	0
RANFURLY										1			0		1	0
HAMPDEN											1		1		1	0
HAMPDEN											1		0		1	0
RANFURLY											1		0		1	0
SUM	1	1	2	1	1	6	4	1	2	2	3	**24**				
CATTLE	0	1	0	0	1	0	2	1	0	1	1	**29%**	**7**		**19**	**2**
SHEEP	1	0	2	1	0	6	2	0	2	1	2	**71%**	**17**		**79%**	**8%**

98	ASHBURTON CMP	ASHBURTON PPCS	BALCLUTHA PPCS	INVERCARGILL Alliance	INVERCARGILL Prime Range	MAKARE WA Alliance	MATAURA Alliance	PAREORA PPCS Pareora	TIMARU Alliance	WAITANE PPCS	GORE	LORNEVILLE				
SOUTHLAND 18	Seafield	Fairton	Fingegand	Lomeville	Meats	Makarewa	Mataura		Smithfield	Waitane	Saleyards	Saleyards		CATTLE (1) Sheep (0)	Full (1) EMPTY (0)	Wet (1) Dry (0)
WYNDHAM	1													0	1	0
WYNDHAM		1												0	0	0
WYNDHAM			1											1	1	1
WYNDHAM			1											0	1	0
WYNDHAM			1											0	1	0
WYNDHAM				1										1	1	0
WYNDHAM				1										1	1	1
TOKANUI				1										1	0	0
WYNDHAM				1										1	1	0
WYNDHAM				1										0	1	0
TOKANUI				1										0	1	0
WYNDHAM				1										0	0	1
WYNDHAM				1										0	1	0
GORE				1										0	1	0
WYNDHAM				1										0	1	0
WYNDHAM				1										0	1	0
WYNDHAM				1										0	0	0
WYNDHAM				1										0	1	1
WYNDHAM				1										0	1	0
TOKANUI				1										0	1	0
WYNDHAM					1									1	0	0
GORE					1									0	1	0
WYNDHAM						1								0	1	0
WYNDHAM						1								0	1	1
WYNDHAM						1								0	0	0
TOKANUI						1								0	1	0
WYNDHAM						1								0	1	0
WYNDHAM						1								0	1	0
TOKANUI						1								0	0	0
WYNDHAM						1								0	1	0
OWAKA						1								0	1	0
WYNDHAM						1								0	1	0
WYNDHAM						1								0	0	0
GORE						1								0	1	0
WYNDHAM						1								0	1	0
TOKANUI						1								0	1	0
WYNDHAM							1							0	1	1
TOKANUI							1							0	1	0
WYNDHAM								1						0	0	0
WYNDHAM								1						0	1	0
WYNDHAM									1					0	1	0
WYNDHAM										1				1	1	1
WYNDHAM										1				0	1	0
WYNDHAM											1			1	1	0
TOKANUI											1			0	1	0
WYNDHAM												1		1	1	0
TOKANUI												1		0	1	0
SUM	1	1	3	15	2	14	2	2	1	2	2	2	47			
CATTLE	0	0	1	4	1	0	0	0	0	1	1	1	19%	9	38	8
SHEEP	1	1	2	11	1	14	2	2	1	1	1	1	81%	38	81%	17%

TABLE REPRESENTING A CALIBRATION PROOF FOR 'CATTLE' SHIPMENT ASSIGNMENTS

	Cattle autumn model	Export Meat Plants S.I.	Local Abattoirs	Sale Yards	North Island	Store Stock	SUM INDUSTRY DATA	SUM MODEL DATA
1	**Export Processing Plants:** Number of processed cattle within a week (data given by Meat Board NZ & Meat Industry Association NZ) for 96-98	16,800					16,800	
	MODEL DATA assigned for **Export Processing Plants** (questionnaires) plus 5% for domestic market	**17,797**						**17,797**
2	**Local Abattoirs:** Number of max processed cattle in a week (data given by abattoirs through personal phone calls)		3,520				3,520	
	MODEL DATA assigned for **Local Abattoirs** (questionaires)		**3,220**					**3,220**
3	**Saleyards:** Number of cattle sold on a max week in S.I. saleyards (data given by NZ Stock & Station Agents Association)			14,000			14,000	
	MODEL DATA assigned for **saleyards** (questionnaires)			**9,312**				**9,312**
4	Shipment to **North Island**				2,660		2,660	
	MODEL DATA assigned for shipment to the North Island (questionnaires)				**2,660**			**2,660**
5	**Store Stock :** number of store stock moved (questionnaires)					1,890	1,890	
	MODEL DATA assigned for **store stock** (questionnaires)					**1,890**		**1,890**
	SUM						**38,870**	**34,879**
	Number of sheep per unit (depends on processing plant, 1 truck & trailer may drop off stock at 2 different plants >multiple delivery that involves different numbers of stock for individual destinations	21	12	32	35	35		
	Number of trips assigned	813	267	291	76	54	**SUM**	**1,501**

GRAPH REPRESENTING THE 'DEFAECATION' BEHAVIOUR OF 'FULL' OR 'NOT STOOD' SHEEP IN 'DRY' AND 'WET' WEATHER CONDITIONS


'Full' sheep ('dry' and 'wet' weather)
Total amount of effluent collected [litres] DRY
Total amount of sheep effluent collected in wet weather in a truck & trailer unit [litres] WET
Effluent [Litres]
Distance [Km]
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500

MODEL INPUT DATA REGARDING THE 'DEFAECATION' BEHAVIOUR OF SURVEYED LIVESTOCK

	CATTLE FULL DRY			CATTLE FULL WET			CATTLE EMPTY DRY			CATTLE EMPTY WET			SHEEP FULL DRY			SHEEP FULL WET			SHEEP EMPTY DRY			SHEEP EMPTY WET		
Litres	Km	SUM KM	L/KM	Km	SUM KM	L/KM	Km	SUM KM	L/KM	Km	SUM KM	L/KM	Km	SUM KM	L/KM	Km	SUM KM	L/KM	Km	SUM KM	L/KM	Km	SUM KM	L/KM
25	10	10	2.50	8	8	3.13	20	20	1.25	12	12	2.083	17	17	1.47	12	12	2.08	33	33	0.76	18	18	1.39
25	10	20	2.50	6	14	4.17	24	44	1.04	11	23	2.273	18	35	1.39	12	24	2.08	42	75	0.60	18	36	1.39
25	12	32	2.08	8	22	3.13	26	70	0.96	14	37	1.786	25	60	1.00	14	38	1.79	55	130	0.45	20	56	1.25
25	15	47	1.67	10	32	2.50	30	100	0.83	13	50	1.923	25	85	1.00	15	53	1.67	70	200	0.36	19	75	1.32
25	12	59	2.08	8	40	3.13	36	136	0.69	13	63	1.923	32	117	0.78	15	68	1.67	200	400	0.13	23	98	1.09
25	13	72	1.92	9	49	2.78	59	195	0.42	14	77	1.786	32	149	0.78	16	84	1.56	490	890	0.05	22	120	1.14
25	14	86	1.79	9	58	2.78	83	278	0.30	25	102	1	48	197	0.52	18	102	1.39	640	1530	0.04	22	142	1.14
25	14	100	1.79	10	68	2.50	127	405	0.20	30	132	0.833	88	285	0.28	16	118	1.56	800	2330	0.03	68	210	0.37
25	17	117	1.47	12	80	2.08	195	600	0.13	18	150	1.389	265	550	0.09	18	136	1.39				28	238	0.89
25	20	137	1.25	12	92	2.08	280	880	0.09	19	169	1.316	450	1000	0.06	24	160	1.04				30	268	0.83
25	20	157	1.25	8	100	3.13	420	1300	0.06	21	190	1.19	650	1650	0.04	50	210	0.50				34	302	0.74
25	25	182	1.00	17	117	1.47	550	1850	0.05	53	243	0.472	900	2550	0.03	21	231	1.19				210	512	0.12
25	28	210	0.89	16	133	1.56	660	2510	0.04	22	265	1.136				21	252	1.19				36	548	0.69
25	30	240	0.83	22	155	1.14	780	3290	0.03	22	287	1.136				31	283	0.81				34	582	0.74
25	30	270	0.83	25	180	1.00	900	4190	0.03	22	309	1.136				135	418	0.19				129	711	0.19
25	31	301	0.81	23	203	1.09	1050	5240	0.02	21	330	1.19				112	530	0.22				34	745	0.74
25	38	339	0.66	15	218	1.67				82	412	0.305				35	565	0.71				36	781	0.69
25	37	376	0.68	14	232	1.79				26	438	0.962				34	599	0.74				221	1002	0.11
25	40	416	0.63	14	246	1.79				23	461	1.087				128	727	0.20				37	1039	0.68
25	44	460	0.57	16	262	1.56				24	485	1.042				33	760	0.76				36	1075	0.69
25	50	510	0.50	14	276	1.79				95	580	0.263				40	800	0.63				132	1207	0.19
25	62	572	0.40	16	292	1.56				42	622	0.595				220	1020	0.11				35	1242	0.71
25	93	665	0.27	25	317	1.00				25	647	1				32	1052	0.78				37	1279	0.68
25	115	780	0.22	33	350	0.76				25	672	1				38	1090	0.66				221	1500	0.11
25	140	920	0.18	40	390	0.63				26	698	0.962				130	1220	0.19						
25	205	1125	0.12	22	412	1.14				114	812	0.219				37	1257	0.68						
25	275	1400	0.09	16	428	1.56				28	840	0.893				33	1290	0.76						
25	300	1700	0.08	17	445	1.47				25	865	1												
25	340	2040	0.07	18	463	1.39				25	890	1												
25	390	2430	0.06	17	480	1.47				210	1100	0.119												
25	460	2890	0.05	18	498	1.39				29	1129	0.862												
25	550	3440	0.05	52	550	0.48				26	1155	0.962												
25	650	4090	0.04	22	572	1.14				26	1181	0.962												
25	760	4850	0.03	20	592	1.25				27	1208	0.926												
25	890	5740	0.03	68	660	0.37				25	1233	1.00												
25	1000	6740	0.03	53	713	0.47				27	1260	0.93												
25				24	737	1.04				27	1287	0.93												
25				22	759	1.14																		
25				22	781	1.14																		
25				22	803	1.14																		
25				25	828	1.00																		
25				22	850	1.14																		

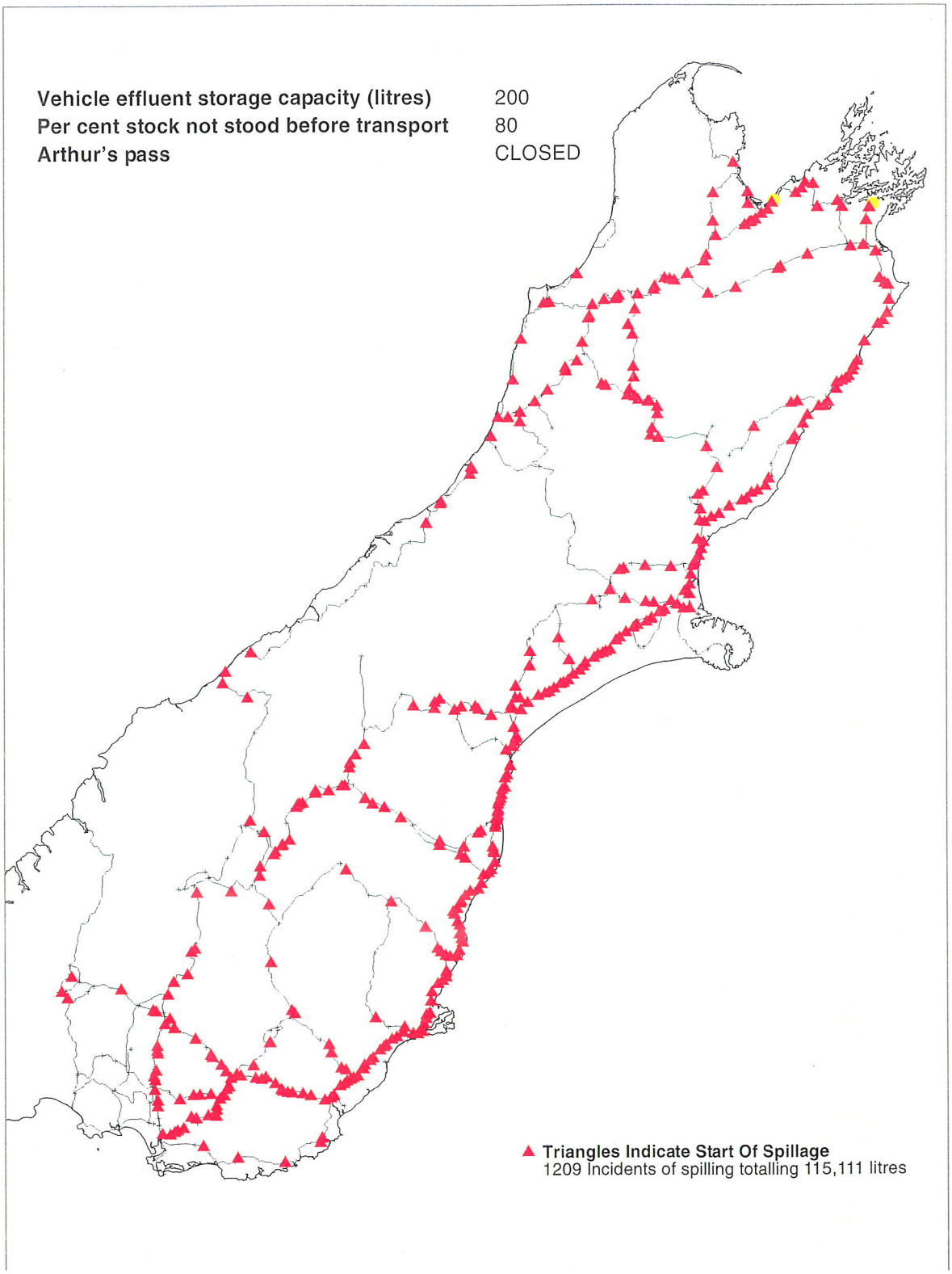
25				22	872	1.14																			
25				25	897	1.00																			
25				111	1008	0.23																			
25				26	1034	0.96																			
25				28	1062	0.89																			
25				27	1089	0.93																			
25				66	1155	0.38																			
25				65	1220	0.38																			
25				26	1246	0.96																			
25				24	1270	1.04																			
25				28	1298	0.89																			
100	47	47	2.13	32	32	3.13	100	100	1.00	50	50	2.00	85	85	1.18	53	53	1.89	200	200	0.50	75	75	1.33
100	53	100	1.89	36	68	2.78	305	405	0.33	82	132	1.22	200	285	0.50	65	118	1.54	2130	2330	0.05	135	210	0.74
100	82	182	1.22	49	117	2.04	1445	1850	0.07	111	243	0.90	2265	2550	0.04	113	231	0.88	2670	5000	0.04	302	512	0.33
100	119	301	0.84	86	203	1.16	3390	5240	0.03	87	330	1.15	5150	7700	0.02	299	530	0.33	3000	8000	0.03	233	745	0.43
100	159	460	0.63	59	262	1.69				155	485	0.65				230	760	0.43				330	1075	0.30
100	320	780	0.31	88	350	1.14				187	672	0.53				330	1090	0.30				425	1500	0.24
100	920	1700	0.11	95	445	1.05				193	865	0.52				*250*								
100	1740	3440	0.06	105	550	0.95				290	1155	0.34				*320*								
100	3300	6740	0.03	163	713	0.61				105	1260	0.95												
100				90	803	1.11																		
100				94	897	1.06																		
100				192	1089	0.52																		
100				181	1270	0.55																		
100																								
100																								
200	100	100	2.00	68	68	2.94	405	405	0.49	132	132	1.515	285	285	0.70	118	118	1.69	2330	2330	0.09	210	210	0.95
200	201	301	1.00	135	203	1.48	4835	5240	0.04	198	330	1.01	7415	7700	0.03	412	530	0.49				535	745	0.37
200	479	780	0.42	147	350	1.36				342	672	0.585				560	1090	0.36				755	1500	0.26
200	2660	3440	0.08	200	550	1.00				483	1155	0.414												
200				253	803	0.79																		
200				286	1089	0.70																		
200				307	1396	0.65																		
300	182	182	1.65	117	117	2.56	1850	1850	0.16	243	243	1.23	2550	2550	0.12	231	231	1.30	5000	5000	0.06	512	512	0.59
300	598	780	0.50	233	350	1.29				429	672	0.70				859	1090	0.35				988	1500	0.30
300	5960	6740	0.05	363	713	0.83				588	1260	0.51												
300				376	1089	0.80																		
300				400	1489	0.75																		
400	301	301	1.33	203	203	1.97	5240	5240	0.08	330	330	1.21	7700	7700	0.05	530	530	0.75	8000	8000	0.05	745	745	0.54
400	3139	3440	0.13	347	550	1.15				825	1155	0.48				1130	1660	0.35				1550	2295	0.26
400				539	1089	0.74																		
400				571	1660	0.70																		

APPENDIX 5

- **Spillage map representing the 'summer-autumn' model with 80% livestock 'not stood' and 200 litre effluent storage capacity on each truck unit** 320

- **Quick user guide for the Arc/Info simulation model** 321

Spillage Map a80_200 (80% 'not stood' 200 litre tanks)



Quick user guide
to run the "STOCK EFFLUENT" simulation model

How to start:

Start Pc with WinNT Start (Mouse click) Programs (Mouse click)
Arc Info Users (Mouse click) Arc (Mouse click)

First Step: choose **autumn model** or **spring model**

Arc:	type	**<workspace d:\effluent>**	
Arc:		**<&Terminal 9999>**	(means DOS and not Unix
	Or	**<&Station 9999>**	(important if you change routes!)

2 ways to be selected: through ARC/INFO or ARCVIEW

A) ARC/INFO

<AE> or **<Arcedit>**	
<display 9999 2>	bigger screen size for map
<ec sicov>	edit coverage
<de arc node>	draw node
<draw>	
<map E>	
<ef node>	edit feature
<sel all>	
<cal plant = 0>	calculate

next step is to indicate whether use of in-transit sites or no site (spillage map) is required!

a) no sites **<save>**
<quit>

b) several sites **<sel many>** select many sites by clicking with the mouse on the sites and after completion, clicking on **ctrl and right mouse button**

<cal plant = 1>
<save>
<quit>

B) Arcview

Open **<ARCVIEW>**
<NEW>
<VIEW> **<add theme>**
open **<d:\effluent>**
<SICOV> click only once!
<node>
<THEME> **<table>**
<TABLE> **<start editing>**
small middle arrow enables editing, big arrow enanles for selection

<table> <stop editing>
to print the new sicov: <table> <properties>
click what you wish to be printed, then select the whole table with the big left arrow and save it, wherever you find it back....
<File> <export> use the bottom possibility

Then import the file in Excel, by adjusting **comma** to **columns** and finally save as an Excel file, which will enable you to print it.

Choice of SPRING/summer or AUTUMN/summer trips

Make sure you started Arc Info with <&Station 9999> (important if you change routes!)

Arc: type <&run amls/create_routes>
open dialog box which contains list of all 'csv' files
select ie. <autumn_stops.csv> or <spring_stops.csv> by mouse click (autumn is currently in)

Question will appear like, do you want to use barriers? Yes/No, which means whether you wish to exclude Arthurs Pass and Cardrona Valley road. type <Yes>
type <quit>

In case you had already been working with an autumn file before, you don't need to change or specify it again and go to the next step

RUN THE MODEL

Second Step (or first Step, in case you were running the same season before):

- (Arc: type <workspace c:\effluent>)
- (Arc: type <&station 9999>)
- Arc: type <&menu menus/run_model_3.menu>
  - a **new box** will appear on screen, whereas
    - the first box on top will make you select (click) your chosen shitdata, called here <Fillmodel.csv>

    - the second box will make you select on the original input data sheet for example the tank size and will also enable you to do modifications for different companies. In a first instance, the inputdata has been automated to different tank sizes. So you will choose between <Input_100.csv> <Input_200.csv> <Input_300.csv> <Input_400.csv> (<Input_500.csv> does not work) and click on one of them.

  How to change this? go to <input.csv> file in the file manager under <effluent> directory and double click on it, which will convert it back to an Excell file. Change whatever you want in the input sheet and then <save as> an <csv> file the whole lot again, but under another name, not to confuse the first inputdata sheet. Remind to have access to the whole Excell sheet, called <inputdata.xls> as a hard copy, as the different columns are not explained with text.
  - the third box will make you select between <Autumn80_trips> <Autumn50_trips> <Autumn25-trips> <Spring80_trips> <Spring50_trips> <Spring25_trips>

It needs to be consistent with the first step choice (AUTUMN run needs Autumn 25/50/80)

- On the bottom you find an empty box, called **'Result Info File'**, in which you type the name of the file you will run, ie. **<a50_400>**, which means a run of the autumn model with 50% of stock being full and using 400 litres tank

In case the model crashes, type **<quit>** and call Icair....

The model configuration will run between 2-12 hours and at the end you will find a few data indicated and it will stop or on

- ARC Plot: type **<quit>** which will lead you to ARC Prompt or it will show ARC Prompt

- **Display results on screen:**

In case a white cursor box is on/off clicking on screen, just go into the start menu and start arc/info again and create a new arc window and type

- Arc: type **<workspace D:\effluent>**
- Arc: type **<&station 9999>**
- Arc: type **<&run amls/display_trips a50_400>**

- **Display results printed:**
In case a white cursor box is on/off clicking on screen, just go into the start menu and start arc/info again and create a new arc window and type

- Arc: type **<workspace D:\effluent>**
- Arc: type **<&station 9999>**
- Arc: type **<&run amls/display_trips a50_400>**
- it will request an 'eps' (encapsulated postscript file)
- on screen? **<NO>**
- sending file to Icair by generating file **<a50_400.eps>**
(go into DOS and **<pkzip a50_400.zip a50_400.eps** >which will zip the file to be emailed)

- the text file *.txt can easily be open or in word (and saved as a doc file) or better in Excel, which requires less paper, but perhaps more steps to get the right shape.

08.04.99
J.-P. Thull

APPENDIX 6

- **Spillage maps 'summer-autumn' model** 325
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- **Network of dump sites (samples) for 400 litre storage capacity ('spring-summer' & 'summer-autumn' model including Arthur's Pass (AP)) and associated costs** 339
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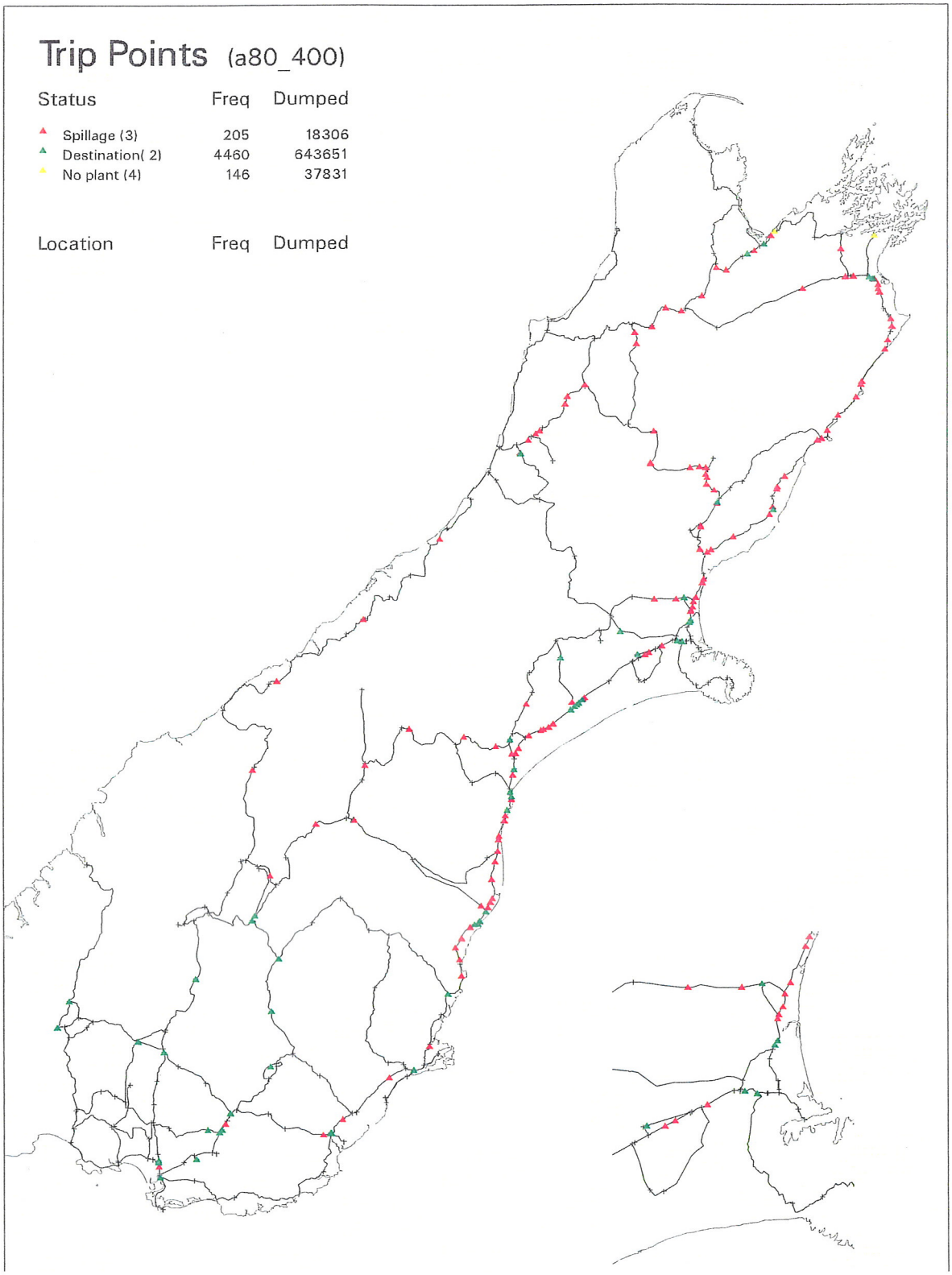
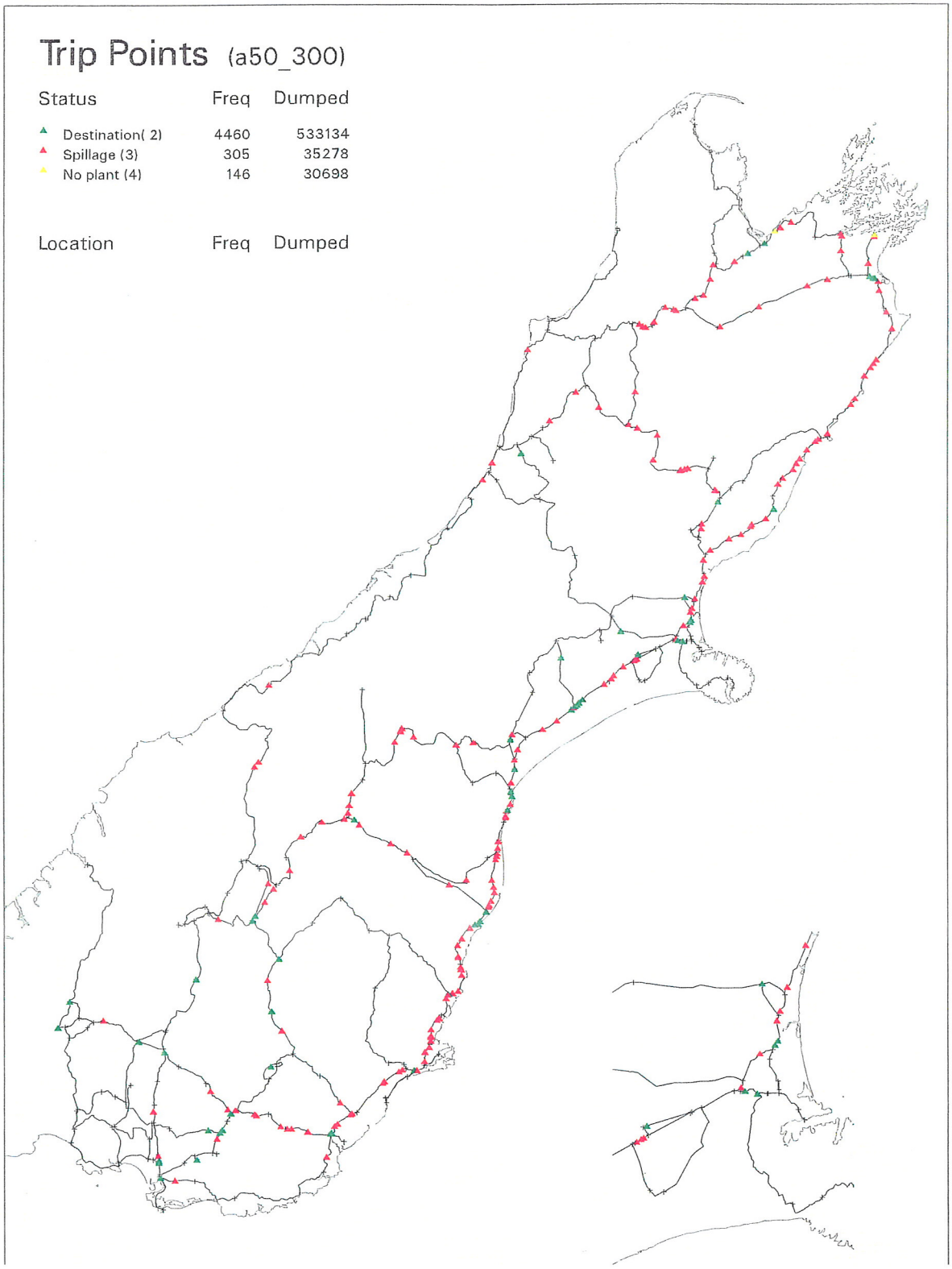
SPILLAGE MAPS
'SUMMER-AUTUMN' MODEL

80% 'not stood'	**a80_400**
50% 'not stood'	**a50_300**
25% 'not stood'	**a25_200**
	a25_300
	a25_400

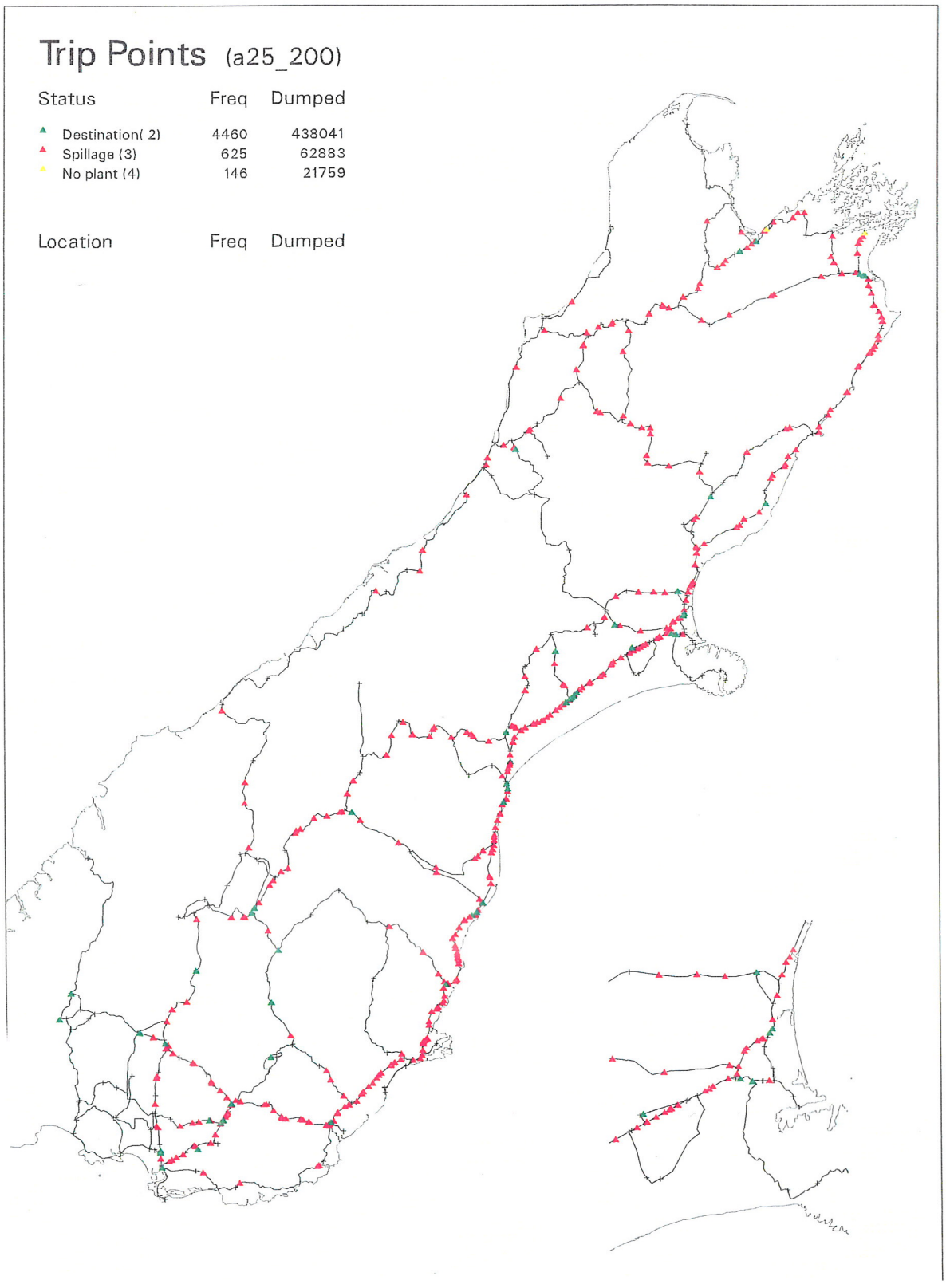
Spillage Map a80_400 (80% 'not stood' 400 litre tanks)



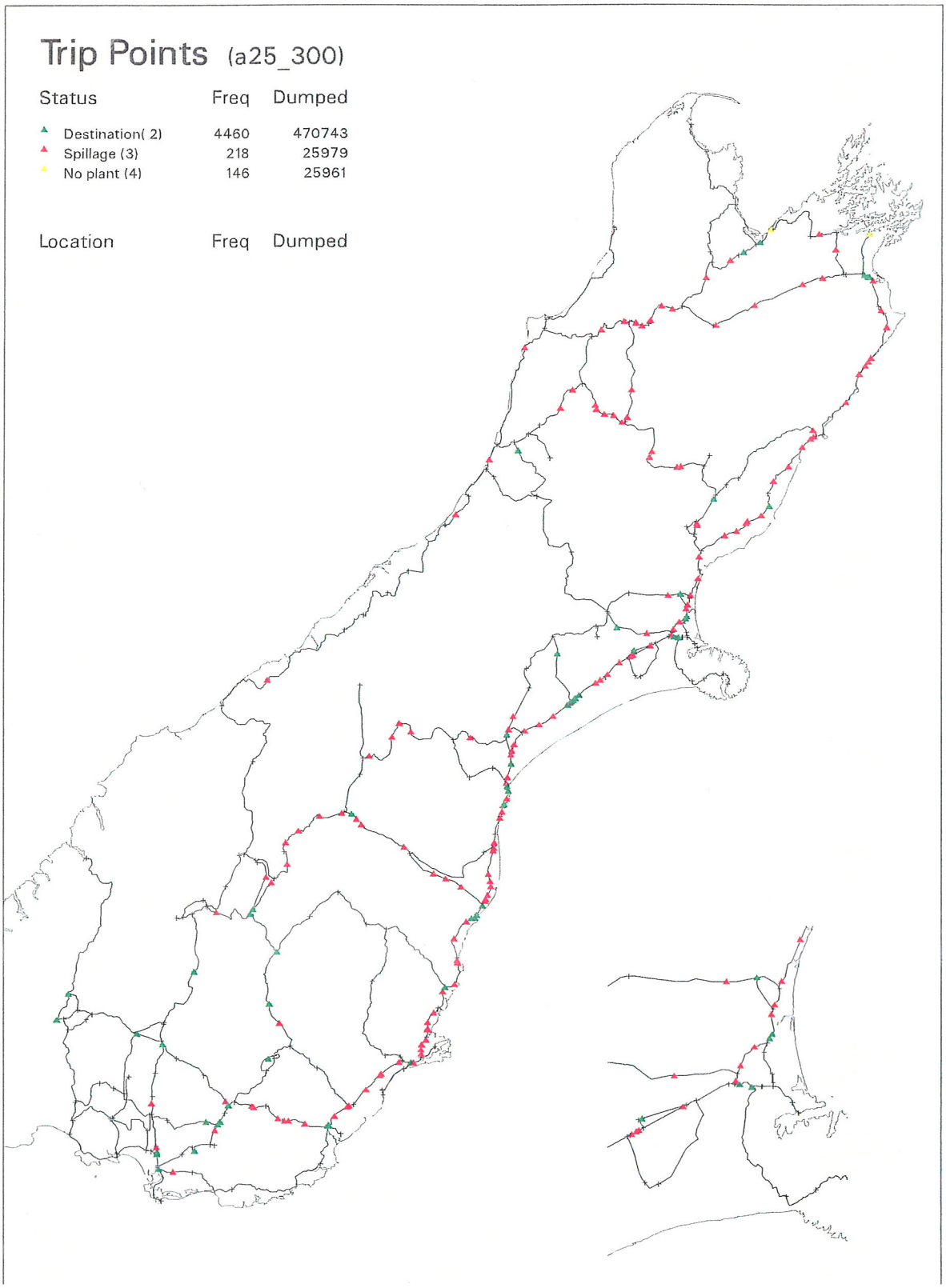
Spillage Map a50_300 (50% 'not stood' 300 litre tanks)



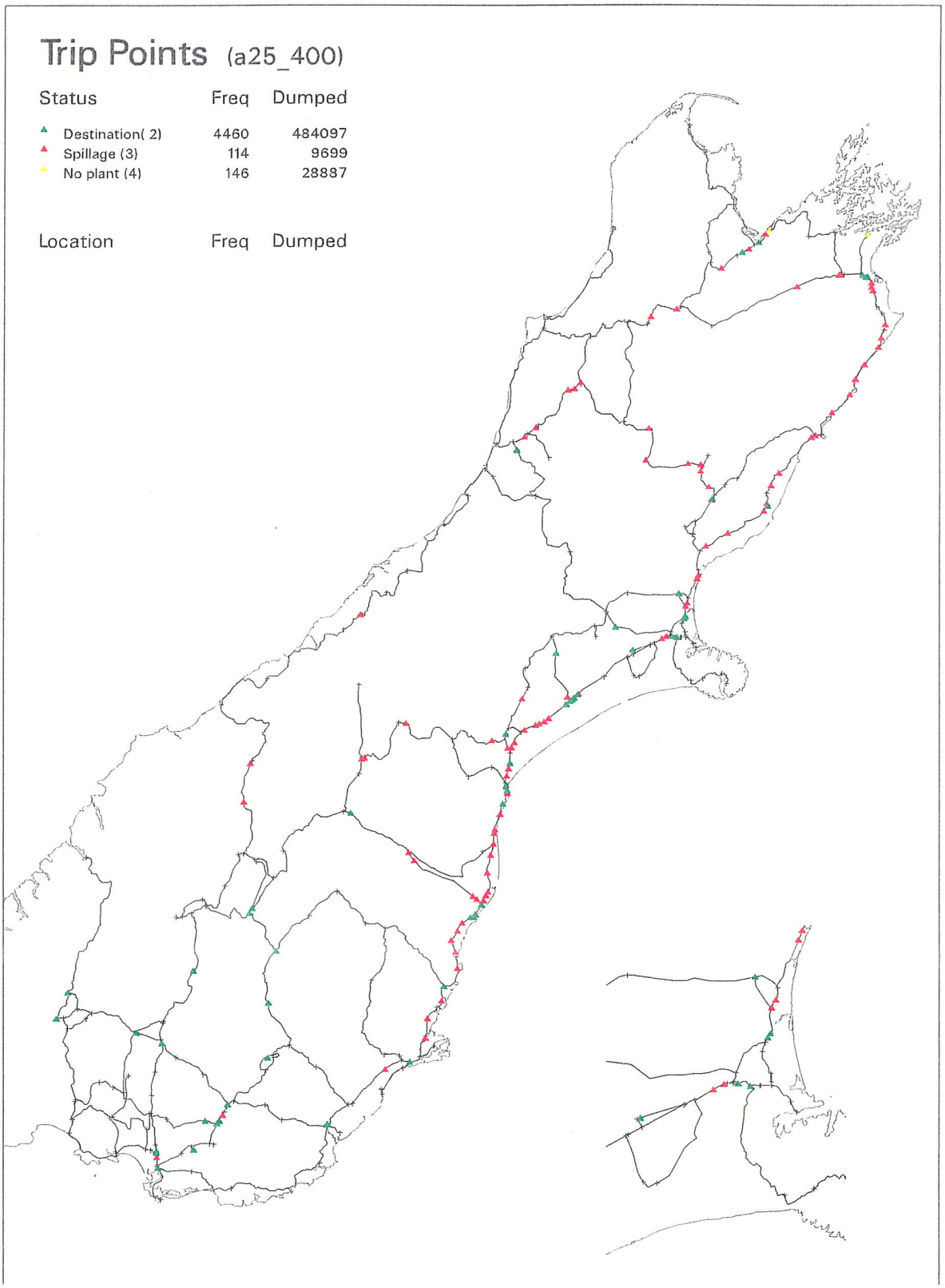
Spillage Map a25_200 (25% 'not stood' 200 litre tanks)



Spillage Map a25_300 (25% 'not stood' 300 litre tanks)



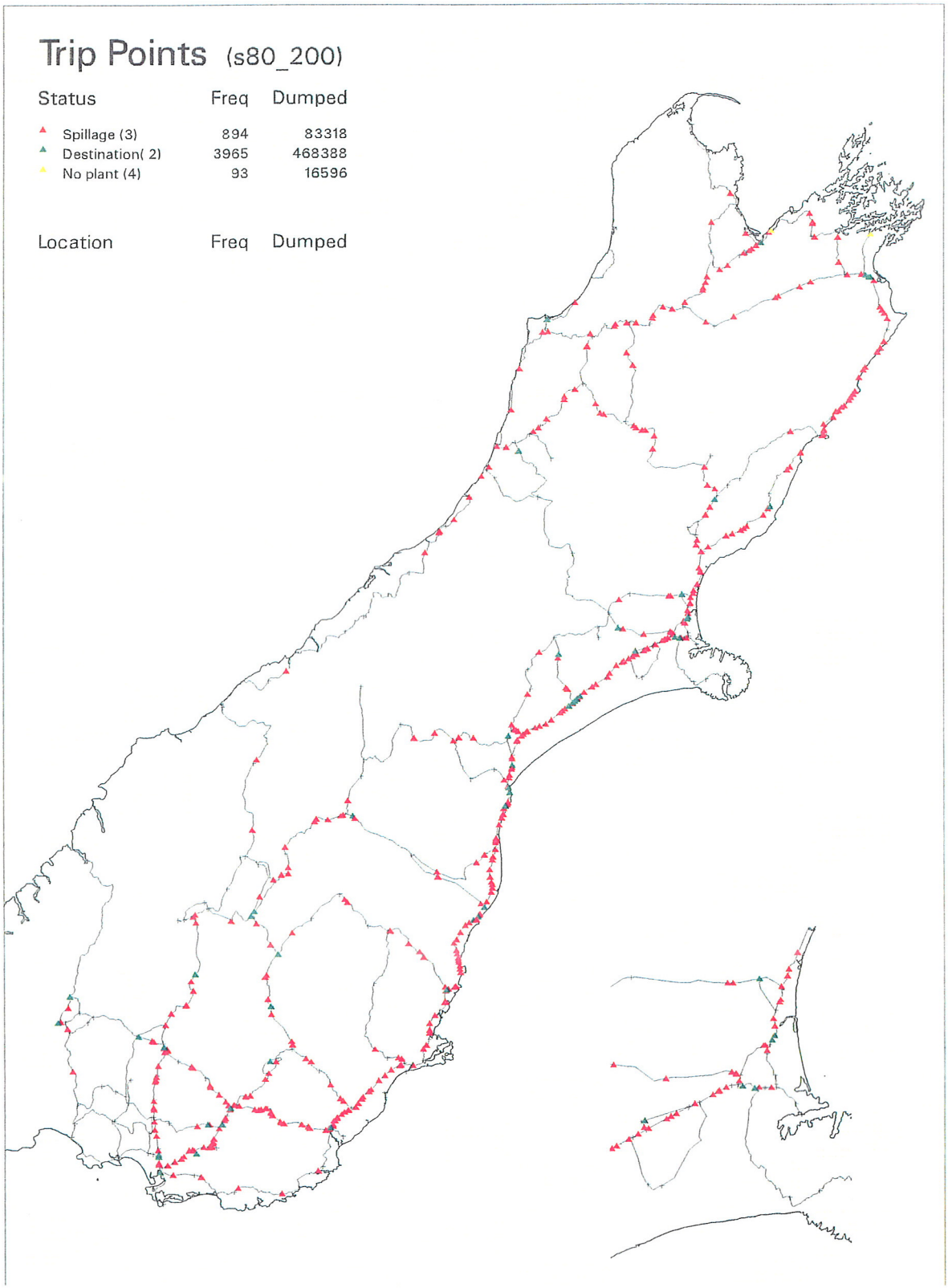
Spillage Map a25_400 (25% 'not stood' 400 litre tanks)



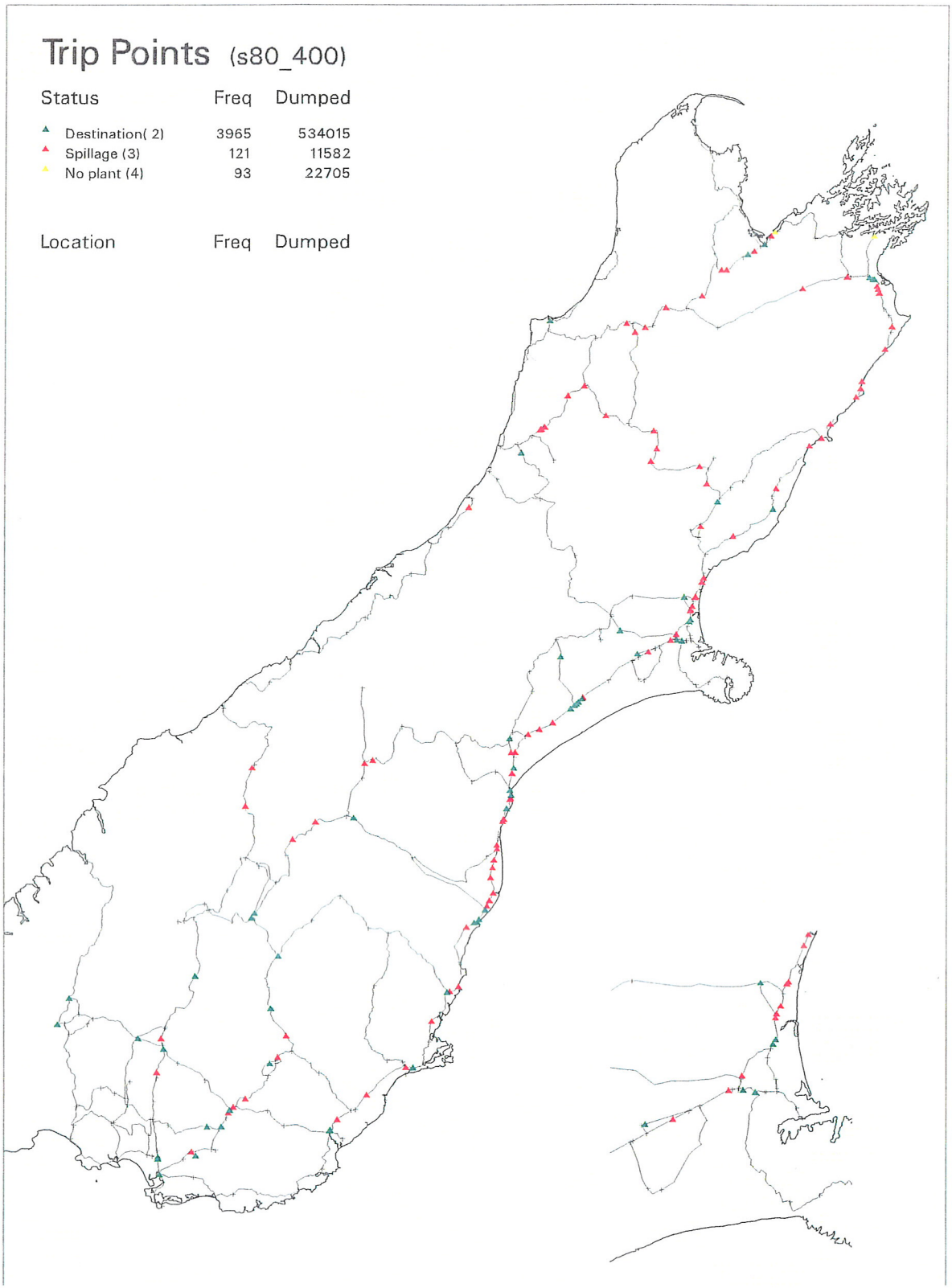
SPILLAGE MAPS
'SPRING-SUMMER' MODEL

80% 'not stood'	s80_200
	s80_400
25% 'not stood'	s25_300
	s25_400

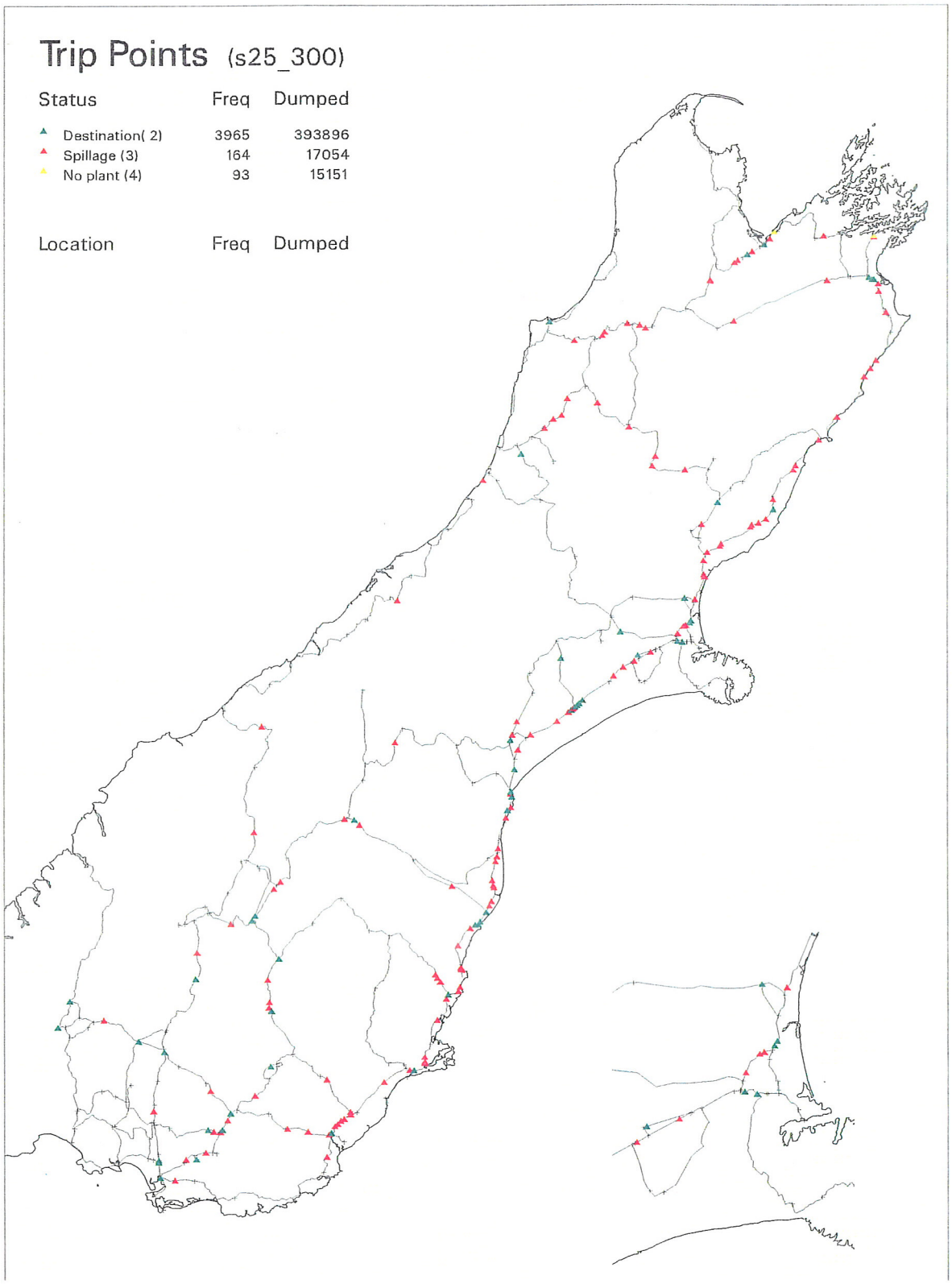
Spillage Map s80_200 (80% 'not stood' 200 litre tanks)



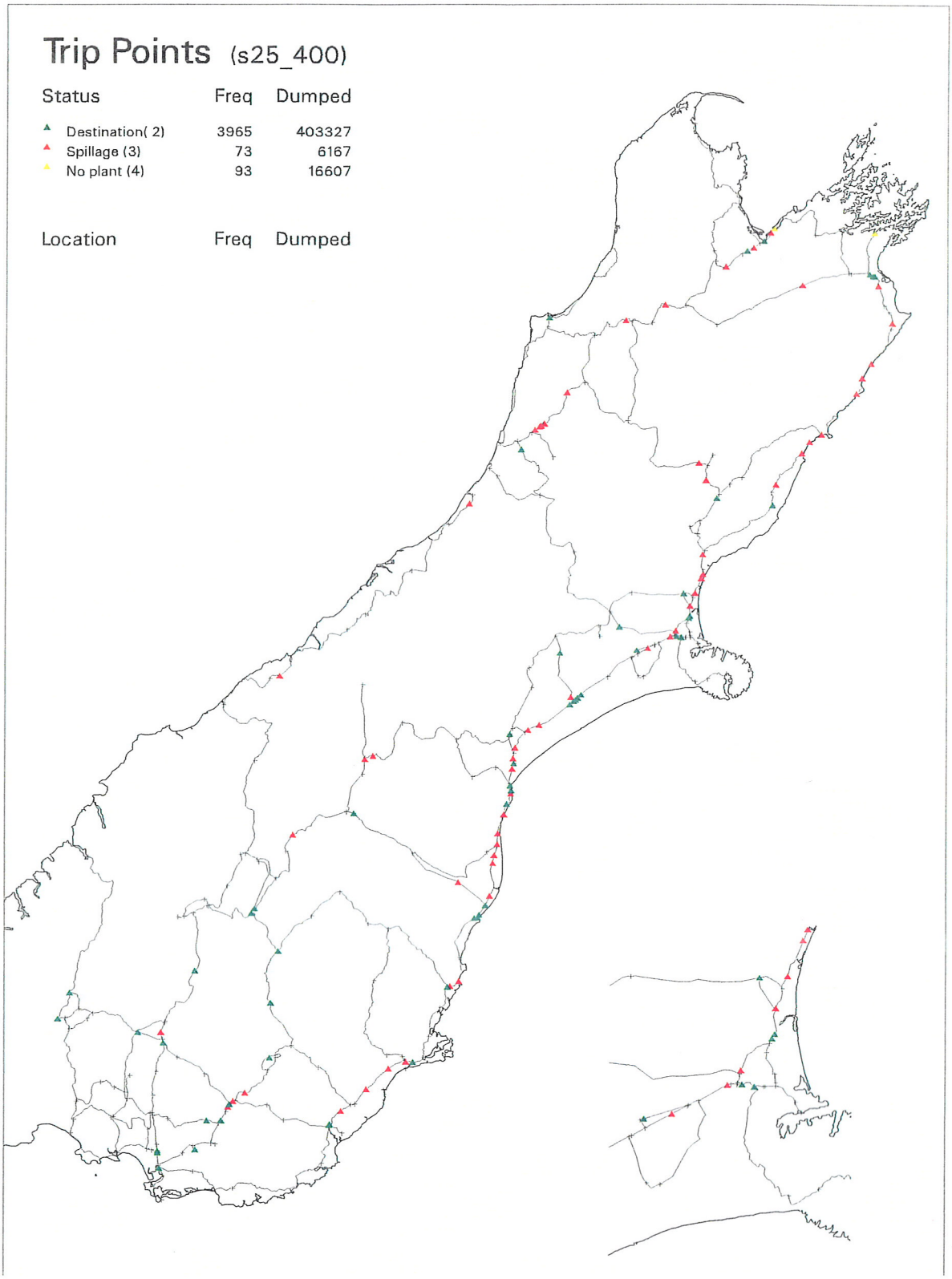
Spillage Map s80_400 (80% 'not stood' 400 litre tanks)



Spillage Map s25_300 (25% 'not stood' 300 litre tanks)



Spillage Map s25_400 (25% 'not stood' 400 litre tanks)



COMPARISON OF SPILLAGE MAPS

FOR THE

'SPRING-SUMMER' MODEL

ANALYSIS OF 'SPRING-SUMMER' SPILLAGE MAPS

INCREASE OF EFFLUENT STORAGE CAPACITY

(200 – 400 LITRES)

spring-summer model	200 Litres		300 Litres		400 Litres		Increase of effluent containment from 200 Litres to 400 Litres		
80%	**FREQ**	**LITRES**	**FREQ**	**LITRES**	**FREQ**	**LITRES**	**200 >> 300**	**300 >> 400**	**200 >> 400**
							Reduction		
Spillage	894	83,318	312	31,984	121	11,582	**62%**	**64%**	**86%**
							Increase		
Destination	3,965	468,388	3,965	515,911	3,965	534,015	**9%**	**3%**	**12%**
							Increase		
Picton & Nelson Ports	93	16,596	93	20,407	93	22,705	**19%**	**10%**	**27%**
TOTAL	**4,952**	**568,302**	**4,370**	**568,302**	**4,179**	**568,302**			
50%	**FREQ**	**LITRES**	**FREQ**	**LITRES**	**FREQ**	**LITRES**	**200 >> 300**	**300 >> 400**	**200 >> 400**
							Reduction		
Spillage	627	58,971	220	22,935	101	8,092	**61%**	**65%**	**86%**
							Increase		
Destination	3,965	410,198	3,965	443,459	3,965	456,698	**8%**	**3%**	**10%**
							Increase		
Picton & Nelson Ports	93	15,474	93	18,249	93	19,853	**15%**	**8%**	**22%**
TOTAL	**4,685**	**484,643**	**4,278**	**484,643**	**4,159**	**484,643**			
25%	**FREQ**	**LITRES**	**FREQ**	**LITRES**	**FREQ**	**LITRES**	**200 >> 300**	**300 >> 400**	**200 >> 400**
							Reduction		
Spillage	477	44,729	164	17,054	73	6,167	**95%**	**64%**	**98%**
							Increase		
Destination	3,965	368,373	3,965	393,896	3,965	403,327	**89%**	**2%**	**89%**
							Increase		
Picton & Nelson Ports	93	12,999	93	15,151	93	16,607	**14%**	**9%**	**22%**
TOTAL	**4,535**	**426,101**	**4,222**	**426,101**	**4,131**	**426,101**			

ANALYSIS OF 'SPRING-SUMMER' SPILLAGE MAPS

FROM CURRENT TO BEST PRACTICE

spring-summer model	80%		50%		25%		Adoption of better practice throughout all stakeholder groups		
200 Litres	**FREQ**	**LITRES**	**FREQ**	**LITRES**	**FREQ**	**LITRES**	80% >> 50%	50% >> 25%	80% >> 25%
							Reduction		
Spillage	894	83,318	627	58,971	477	44,729	29%	24%	46%
Destination	3,965	468,388	3,965	410,198	3,965	368,373	12%	10%	21%
Picton & Nelson Ports	93	16,596	93	15,474	93	12,999	7%	16%	22%
TOTAL	**4,952**	**568,302**	**4,685**	**484,643**	**4,535**	**426,101**	15%	12%	25%
300 Litres	**FREQ**	**LITRES**	**FREQ**	**LITRES**	**FREQ**	**LITRES**	80% >> 50%	50% >> 25%	80% >> 25%
							Reduction		
Spillage	312	31,984	220	22,935	164	17,054	28%	26%	47%
Destination	3,965	515,911	3,965	443,459	3,965	393,896	14%	11%	24%
Picton & Nelson Ports	93	20,407	93	18,249	93	15,151	11%	17%	26%
TOTAL	**4,370**	**568,302**	**4,278**	**484,643**	**4,222**	**426,101**	15%	12%	25%
400 Litres	**FREQ**	**LITRES**	**FREQ**	**LITRES**	**FREQ**	**LITRES**	80% >> 50%	50% >> 25%	80% >> 25%
							Reduction		
Spillage	121	11,582	101	8,092	73	6,167	30%	24%	47%
Destination	3,965	534,015	3,965	456,698	3,965	403,327	14%	12%	24%
Picton & Nelson Ports	93	22,705	93	19,853	93	16,607	13%	16%	27%
TOTAL	**4,179**	**568,302**	**4,159**	**484,643**	**4,131**	**426,101**	15%	12%	25%

NETWORK OF DUMP SITES (SAMPLES)

FOR 400 LITRE STORAGE CAPACITY

'spring-summer' & 'summer-autumn' model
including Arthur's Pass (AP)
and associated costs

NETWORK FOR MINIMUM SPILLAGE

a25_400_27AP **s25_400_27AP**

a25_400_27

a80_400_27AP

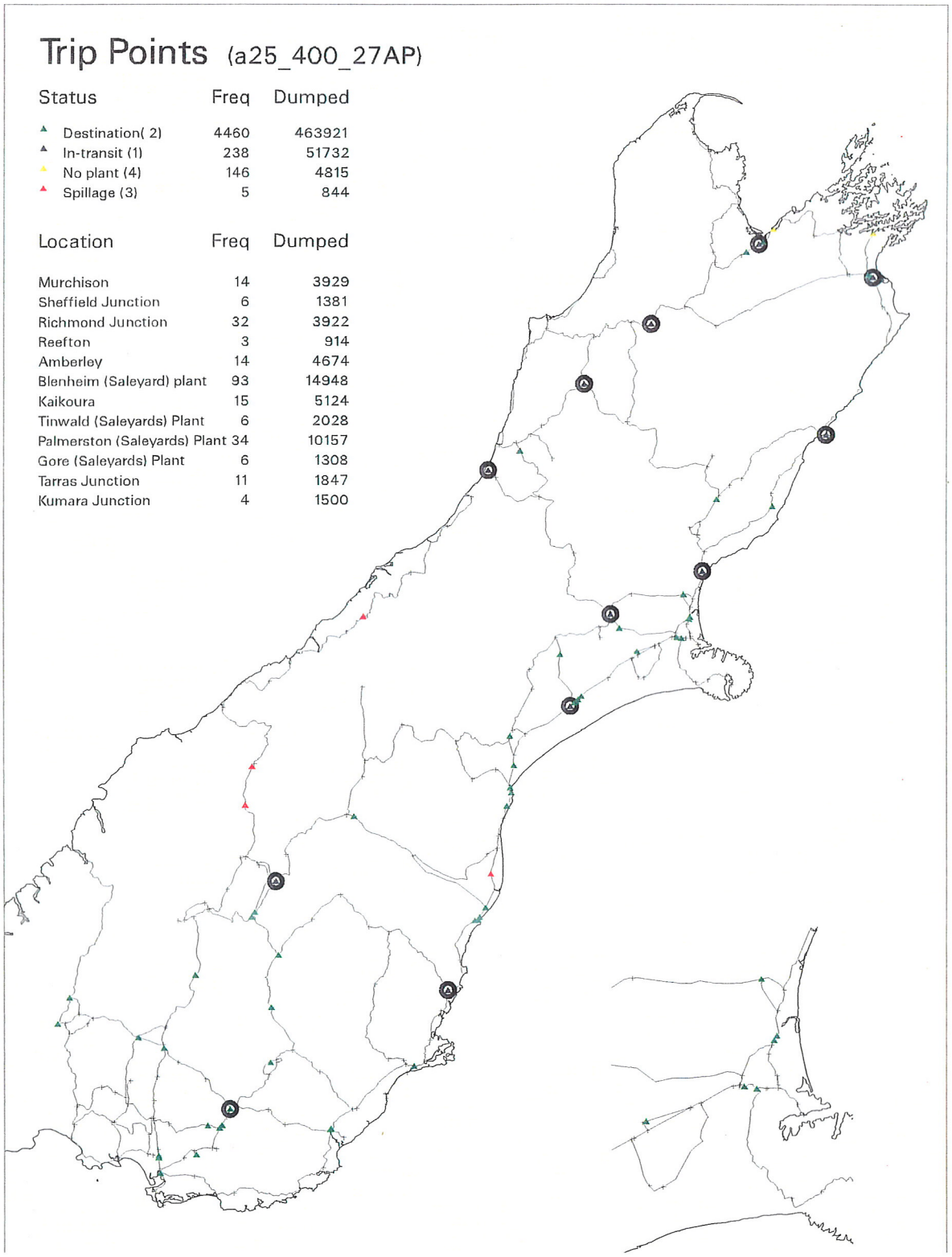
RECOMMENDED NETWORK

a25_400_34AP **s25_400_34AP**

a25_400_34

a80_400_35AP

a25_400_27AP (25% 'not stood' 400 litre tanks AP open)



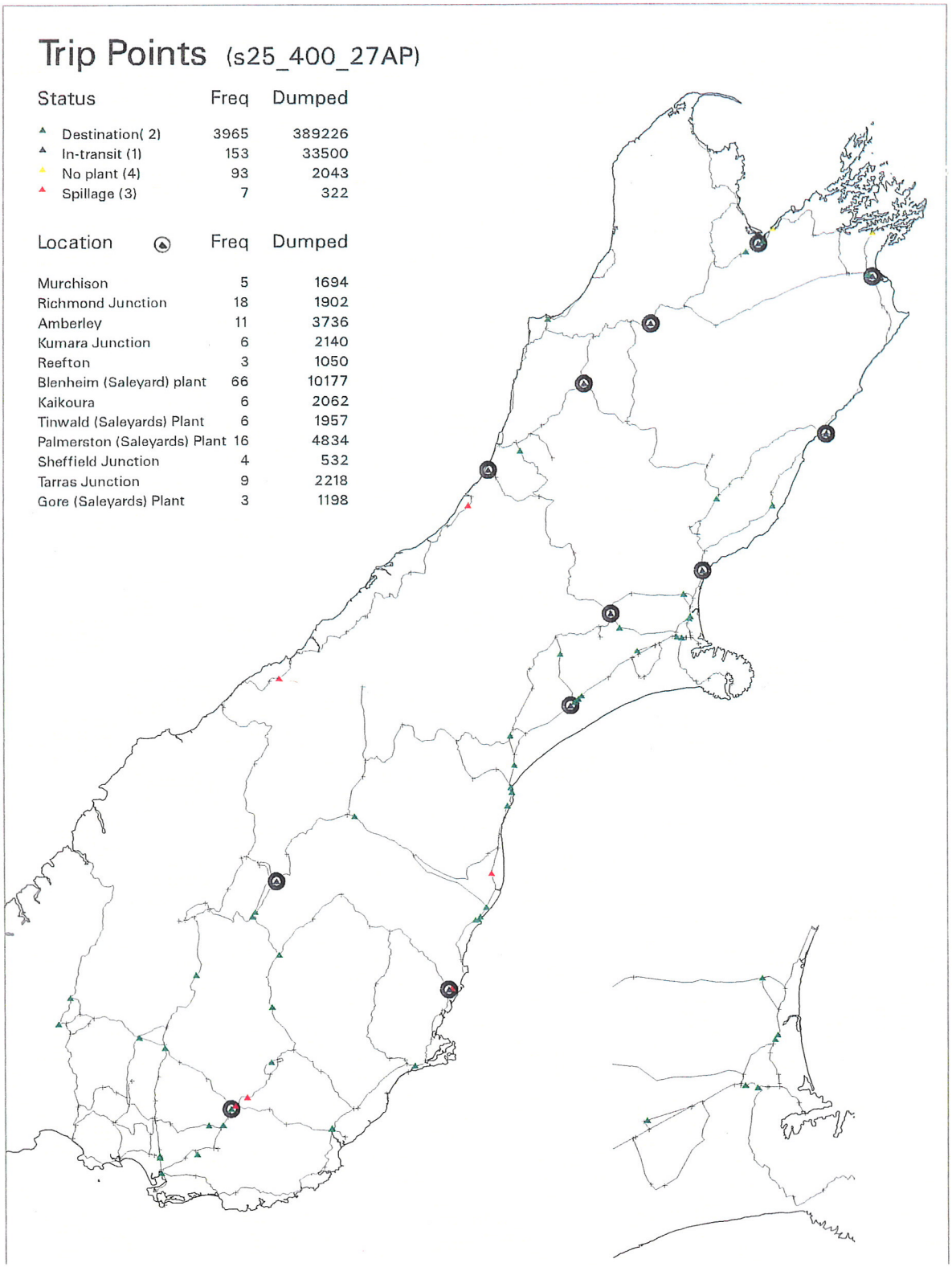
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	VOLUME DUMPED
1	CMP SEAFIELD (ASHB)	189	24,446
2	CMP BLENHEIM	82	15,803
3	PPCS BELFAST	121	19,684
4	PHOENIX MEAT (KOKIRI	59	10,495
5	Murchison	14	3,929
6	SALEYARD BRIGHTWATER	32	3,848
7	SALEYARD CH-CH	99	9,320
8	ABATTOIR ASHBURTON	62	7,243
9	PPCS MARLBOROUGH	127	12,990
10	RICHMOND (NELS. BAYS	96	13,447
11	ALLIANCE PUKEURI	317	40,685
12	CULVERDEN	11	2,200
13	DARFIELD	6	1,094
14	Sheffield Junction	6	1,381
15	GERALDINE	9	1,380
16	PICTON PORT	121	4,421
17	Spillage	5	844
18	SALEYARD BLENHEIM	32	3,933
19	Richmond Junction	32	3,922
20	NELSON PORT	25	394
21	ASHBURTON TOWNSHIP	10	1,875
22	Reefton	3	914
23	Amberley	14	4,674
24	BALCLUTHA TOWNSHIP	1	310
25	METHVEN	11	1,940
26	Blenheim (Saleyard) plant	93	14,948
27	PPCS CANTERBURY	170	15,108
28	OAMARU	2	355
29	Kaikoura	15	5,124
30	SALEYARD TINWALD	61	5,612
31	ALLIANCE SOCKBURN	136	10,106
32	ABATTOIR MALVERN	89	8,317
33	PPCS FAIRTON (ASHB)	226	25,614
34	Tinwald (Saleyards) Plant	6	2,028
35	ALLIANCE SMITHFIELD	231	18,508
36	ALLIANCE LORNEVILLE	428	29,468
37	ALLIANCE MAKAREWA	154	8,455
38	ALLIANCE MATAURA	198	14,537
39	PPCS PAREORA	410	49,755
40	CHEVIOT	3	470
41	SALEYARD TEMUKA	64	5,374
42	ABCO MEATS (OAMARU)	97	11,500
43	SALEYARD OMARAMA	8	696
44	BAY CITY MEATS	52	5,983
45	PPCS FINEGAND	290	31,703
46	SALEYARD OAMARU	49	5,393
47	SALEYARD PALMERSTON	43	4,394
48	Palmerston (Saleyards) Plant	34	10,157
49	SALEYARD BALCLUTHA	29	2,713
50	Gore (Saleyards) Plant	6	1,308
51	BLUE SKY MEATS (MM)	118	10,640
52	WAITANE VILLAGE	58	4,934
53	HARTLAND PRIME MEAT	12	1,077
54	PRIME RANGE MEATS	102	7,470
55	Tarras Junction	11	1,847
56	SALEYARD CROMWELL	6	412
57	SALEYARD GORE	63	5,638
58	Kumara Junction	4	1,500
59	RANGIORA	1	203
60	ALEXANDRA	1	94
61	SALEYARD LORNEVILLE	74	5,994
62	ROXBURGH	2	155
63	DUNEDIN	2	106
64	TE ANAU	4	502
65	MOSSBURN	5	763
66	MATAURA	2	294
67	KINGSTON	1	279
68	HERIOT	1	140
69	MANAPOURI	2	198
70	LUMSDEN JUNCTION	2	268
		4,849	**521,312**

Annual running costs (based on operational & capital costs)

400 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	3.92	40	157	0.7	10	$1,098		$11,172		$12,270
Blenheim in-transit	1	14.95	40	598	0.7	1.5	$628			$8,967	$9,595
Blenheim Riverlands		3.93	40	157	0.7	1.5	$165				$165
Kaikoura	1	5.12	40	205	0.7	10	$1,435		$11,172		$12,607
Westport Junction											
Murchison	1	3.93	40	157	0.7	3	$330			$8,967	$9,297
Reefton	1	0.91	40	37	0.7	4	$102		$11,172		$11,275
Hanmer Junction											
Kumara Junction	1	1.50	40	60	0.7	18	$756	$13,818			$14,574
Amberley	1	4.67	40	187	0.7	5	$654		$11,172		$11,827
Sheffield Junction	1	1.38	40	55	0.7	14	$541		$11,172		$11,714
Tinwald in-transit	1	2.03	40	81	0.7	6	$341		$11,172		$11,513
Tinwald saleyard		5.61	40	224	0.7	6	$943				$943
Fairlie											
Timaru/Washdyke											
Palmerston in-transit	1	10.16	40	406	0.7	5	$1,422	$13,818			$15,240
Palmerston saleyard		4.39	40	176	0.7	5	$615				$615
Tarras Junction	1	1.85	40	74	0.7	25	$1,293	$13,818			$15,111
Cromwell in-transit											
Cromwell saleyard											
Milton Junction											
Lumsden in-transit											
Gore in-transit	1	1.31	40	52	0.7	5	$183		$11,172		$11,355
Gore saleyard		5.64	40	226	0.7	5	$789				$789
SUM	12	71.31		2,852			$11,296	$41,455	$78,205	$17,934	$148,890
								$137,594			

s25_400_27AP (25% 'not stood' 400 litre tanks AP open)



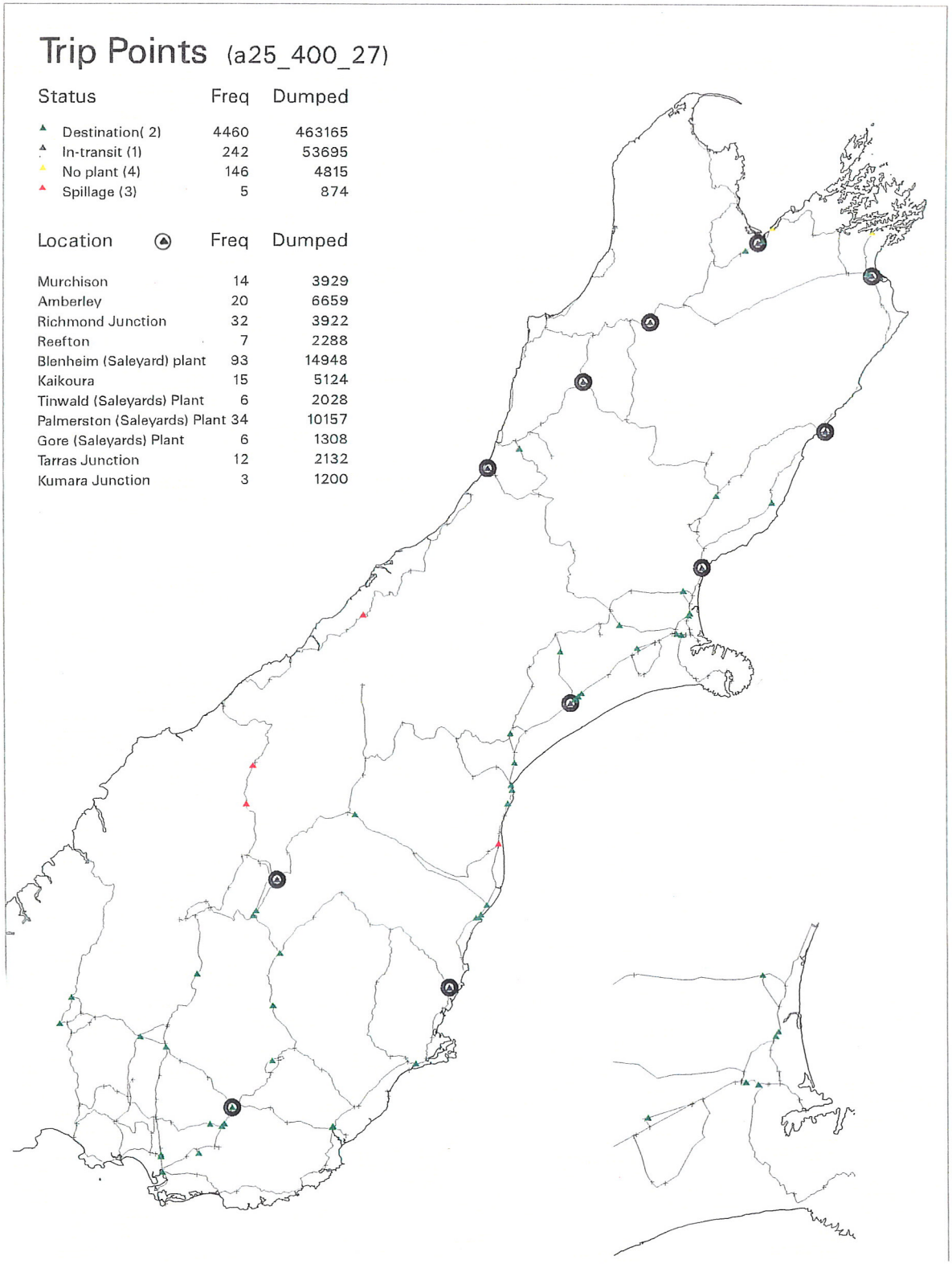
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	PHOENIX MEAT (KOKIRI	55	9,052
2	Murchison	5	1,694
3	SALEYARD BRIGHTWATER	32	4,210
4	ABATTOIR ASHBURTON	52	6,278
5	PPCS FAIRTON (ASHB)	135	11,460
6	PPCS BELFAST	77	11,248
7	RICHMOND (NELS. BAYS	71	9,582
8	ALLIANCE PUKEURI	247	31,966
9	SALEYARD CH-CH	93	8,881
10	CMP BLENHEIM	66	10,081
11	PPCS MARLBOROUGH	94	8,021
12	SALEYARD BLENHEIM	28	3,137
13	Richmond Junction	18	1,902
14	NELSON PORT	15	184
15	PICTON PORT	78	1,859
16	Amberley	11	3,736
17	CMP SEAFIELD (ASHB)	163	20,726
18	Kumara Junction	6	2,140
19	ASHBURTON TOWNSHIP	5	964
20	Reefton	3	1,050
21	BALCLUTHA TOWNSHIP	1	208
22	WESTPORT	1	150
23	PPCS CANTERBURY	97	8,234
24	Blenheim (Saleyard) plant	66	10,177
25	Kaikoura	6	2,062
26	SALEYARD TINWALD	72	6,227
27	ALLIANCE SMITHFIELD	185	12,875
28	CULVERDEN	8	1,618
29	PPCS PAREORA	212	18,517
30	OAMARU	1	133
31	ALLIANCE SOCKBURN	70	4,792
32	ABATTOIR MALVERN	68	5,966
33	CHEVIOT	5	692
34	ALLIANCE MATAURA	222	18,904
35	Tinwald (Saleyards) Plant	6	1,957
36	SALEYARD TEMUKA	61	4,578
37	PPCS FINEGAND	335	38,196
38	Palmerston (Saleyards) Plant	16	4,834
39	ALLIANCE LORNEVILLE	522	42,506
40	Sheffield Junction	4	532
41	ALLIANCE MAKAREWA	263	19,516
42	ABCO MEATS (OAMARU)	94	10,259
43	BAY CITY MEATS	39	4,729
44	Spillage	7	322
45	SALEYARD OMARAMA	16	1,185
46	SALEYARD OAMARU	40	4,296
47	Tarras Junction	9	2,218
48	SALEYARD PALMERSTON	45	4,777
49	Gore (Saleyards) Plant	3	1,198
50	WAITANE VILLAGE	67	5,239
51	SALEYARD BALCLUTHA	26	2,929
52	BLUE SKY MEATS (MM)	99	7,720
53	SALEYARD CROMWELL	8	512
54	HARTLAND PRIME MEAT	18	1,301
55	PRIME RANGE MEATS	93	7,121
56	SALEYARD GORE	63	7,018
57	SALEYARD LORNEVILLE	80	7,682
58	DARFIELD	2	253
59	GERALDINE	3	435
60	METHVEN	9	1,296
61	RANGIORA	2	540
62	ALEXANDRA	1	168
63	ROXBURGH	2	155
64	DUNEDIN	2	106
65	TE ANAU	4	1,009
66	MOSSBURN	5	704
67	KINGSTON	1	135
68	HERIOT	1	290
69	MANAPOURI	2	381
70	LUMSDEN JUNCTION	2	268
		4,218	**425,091**

Annual running costs (based on operational & capital costs)

400 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	1.90	40	76	0.7	10	$533		$11,172		$11,705
Blenheim In-transit	1	10.18	40	407	0.7	1.5	$427			$8,967	$9,395
Blenheim Riverlands		3.14	40	125	0.7	1.5	$132				$132
Kaikoura	1	2.06	40	82	0.7	10	$577		$11,172		$11,750
Westport Junction											
Murchison	1	1.69	40	68	0.7	3	$142			$8,967	$9,109
Reefton	1	1.05	40	42	0.7	4	$118		$11,172		$11,290
Hamner Junction											
Kumara Junction	1	2.14	40	86	0.7	18	$1,079	$13,818			$14,897
Amberley	1	3.74	40	149	0.7	5	$523		$11,172		$11,695
Sheffield Junction	1	0.53	40	21	0.7	14	$209		$11,172		$11,381
Tinwald In-transit	1	1.96	40	78	0.7	6	$329		$11,172		$11,501
Tinwald saleyard		6.23	40	249	0.7	6	$1,046				$1,046
Fairlie											
Timaru/Washdyke											
Palmerston In-transit	1	4.83	40	193	0.7	5	$577	$13,818			$14,495
Palmerston saleyard		4.78	40	191	0.7	5	$669				$669
Tarras Junction	1	2.22	40	89	0.7	25	$1,553	$13,818			$15,371
Cromwell In-transit											
Cromwell saleyard											
Milton Junction											
Lumsden In-transit											
Gore In-transit	1	1.20	40	48	0.7	5	$168		$11,172		$11,340
Gore saleyard		7.02	40	281	0.7	5	$983				$983
SUM	12	54.66		2,186			$9,162	$41,455	$78,205	$17,934	$146,757
								$137,594			

a25_400_27 (25% 'not stood' 400 litre tanks AP *not* open)



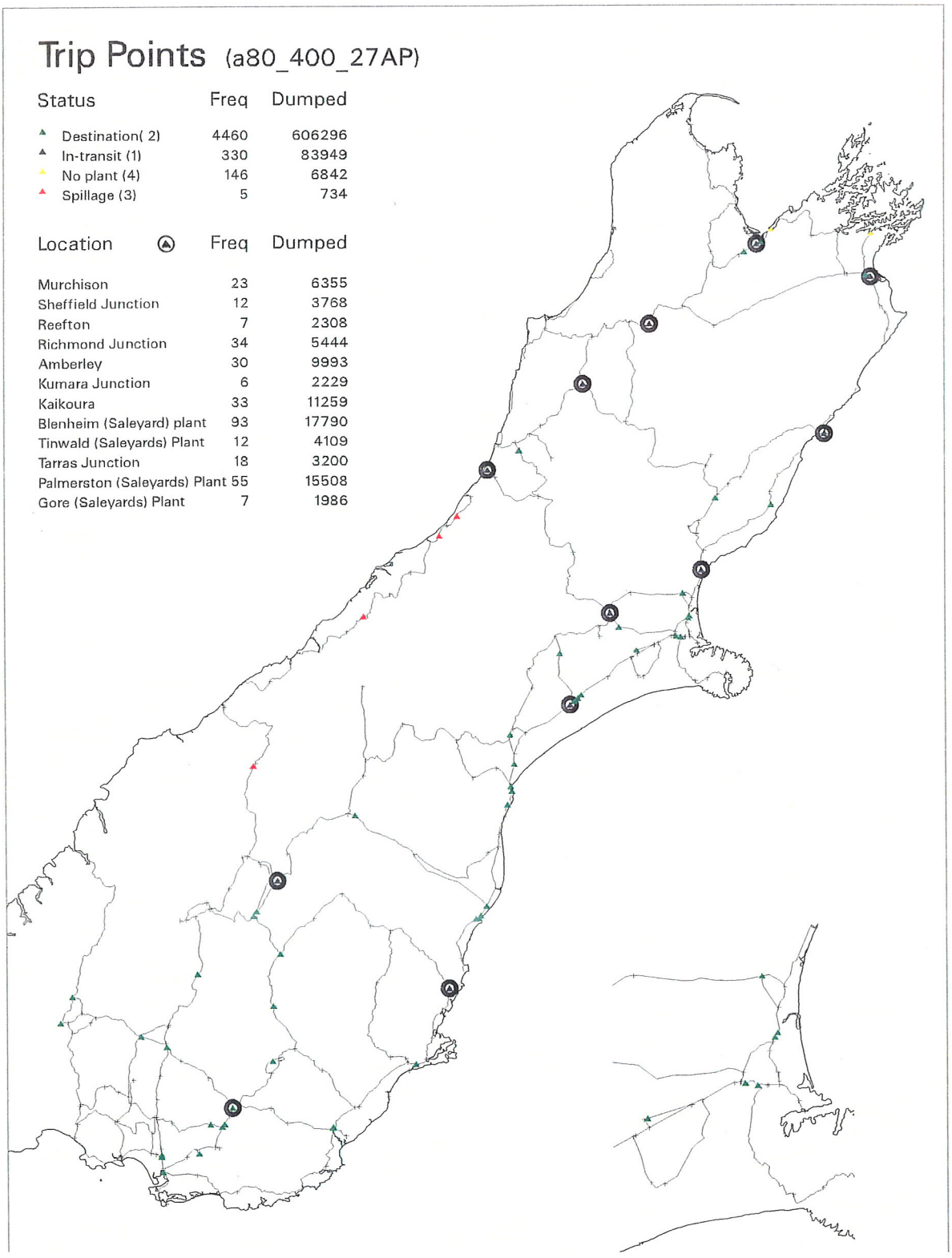
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	CMP SEAFIELD (ASHB)	189	24,648
2	CMP BLENHEIM	82	15,803
3	PPCS BELFAST	121	19,369
4	PHOENIX MEAT (KOKIRI	59	9,943
5	Murchison	14	3,929
6	SALEYARD BRIGHTWATER	32	3,848
7	SALEYARD CH-CH	99	9,352
8	Amberley	20	6,659
9	ABATTOIR ASHBURTON	62	6,989
10	PPCS MARLBOROUGH	127	12,990
11	RICHMOND (NELS. BAYS	96	13,447
12	ALLIANCE PUKEURI	317	40,702
13	CULVERDEN	11	2,200
14	DARFIELD	6	1,162
15	GERALDINE	9	1,419
16	PICTON PORT	121	4,421
17	Spillage	5	874
18	SALEYARD BLENHEIM	32	3,933
19	Richmond Junction	32	3,922
20	NELSON PORT	25	394
21	ASHBURTON TOWNSHIP	10	1,882
22	Reefton	7	2,288
23	BALCLUTHA TOWNSHIP	1	310
24	METHVEN	11	1,940
25	Blenheim (Saleyard) plant	93	14,948
26	PPCS CANTERBURY	170	15,108
27	OAMARU	2	355
28	Kaikoura	15	5,124
29	SALEYARD TINWALD	61	5,612
30	ALLIANCE SOCKBURN	136	10,106
31	ABATTOIR MALVERN	89	8,317
32	PPCS FAIRTON (ASHB)	226	25,614
33	Tinwald (Saleyards) Plant	6	2,028
34	ALLIANCE SMITHFIELD	231	18,508
35	ALLIANCE LORNEVILLE	428	29,468
36	ALLIANCE MAKAREWA	154	8,455
37	ALLIANCE MATAURA	198	14,537
38	PPCS PAREORA	410	49,755
39	CHEVIOT	3	470
40	SALEYARD TEMUKA	64	5,374
41	ABCO MEATS (OAMARU)	97	11,500
42	SALEYARD OMARAMA	8	696
43	BAY CITY MEATS	52	5,983
44	PPCS FINEGAND	290	31,703
45	SALEYARD OAMARU	49	5,393
46	SALEYARD PALMERSTON	43	4,394
47	Palmerston (Saleyards) Plant	34	10,157
48	SALEYARD BALCLUTHA	29	2,713
49	Gore (Saleyards) Plant	6	1,308
50	BLUE SKY MEATS (MM)	118	10,640
51	WAITANE VILLAGE	58	4,934
52	HARTLAND PRIME MEAT	12	1,077
53	PRIME RANGE MEATS	102	7,470
54	Tarras Junction	12	2,132
55	SALEYARD CROMWELL	6	412
56	SALEYARD GORE	63	5,638
57	Kumara Junction	3	1,200
58	RANGIORA	1	203
59	ALEXANDRA	1	94
60	SALEYARD LORNEVILLE	74	5,994
61	ROXBURGH	2	155
62	DUNEDIN	2	106
63	TE ANAU	4	502
64	MOSSBURN	5	763
65	MATAURA	2	294
66	KINGSTON	1	279
67	HERIOT	1	140
68	MANAPOURI	2	198
69	LUMSDEN JUNCTION	2	268
		4,853	**522,549**

Annual running costs (based on operational & capital costs)

400 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	3.92	40	157	0.7	10	$1,098		$11,172		$12,270
Blenheim In-transit	1	14.95	40	598	0.7	1.5	$628			$8,967	$9,595
Blenheim Riverlands		3.93	40	157	0.7	1.5	$165				$165
Kaikoura	1	5.12	40	205	0.7	10	$1,435		$11,172		$12,607
Westport Junction											
Murchison	1	3.93	40	157	0.7	3	$330			$8,967	$9,297
Reefton	1	2.29	40	92	0.7	4	$256		$11,172		$11,428
Hanmer Junction											
Kumara Junction	1	1.20	40	48	0.7	18	$605	$13,818			$14,423
Amberley	1	6.66	40	266	0.7	5	$932		$11,172		$12,104
Sheffield Junction											
Tinwald In-transit	1	2.03	40	81	0.7	6	$341		$11,172		$11,513
Tinwald saleyard		5.61	40	224	0.7	6	$943				$943
Fairlie											
Timaru/Washdyke											
Palmerston In-transit	1	10.16	40	406	0.7	5	$1,422	$13,818			$15,240
Palmerston saleyard		4.39	40	176	0.7	5	$615				$615
Tarras Junction	1	2.13	40	85	0.7	25	$1,492	$13,818			$15,311
Cromwell In-transit											
Cromwell saleyard											
Milton Junction											
Lumsden In-transit											
Gore In-transit	1	1.31	40	52	0.7	5	$183		$11,172		$11,355
Gore saleyard		5.64	40	226	0.7	5	$789				$789
SUM	11	73.27		2,931			$11,235	$41,455	$67,033	$17,934	$137,657
								$126,422			

a80_400_27AP (80% 'not stood' 400 litre tanks AP open)



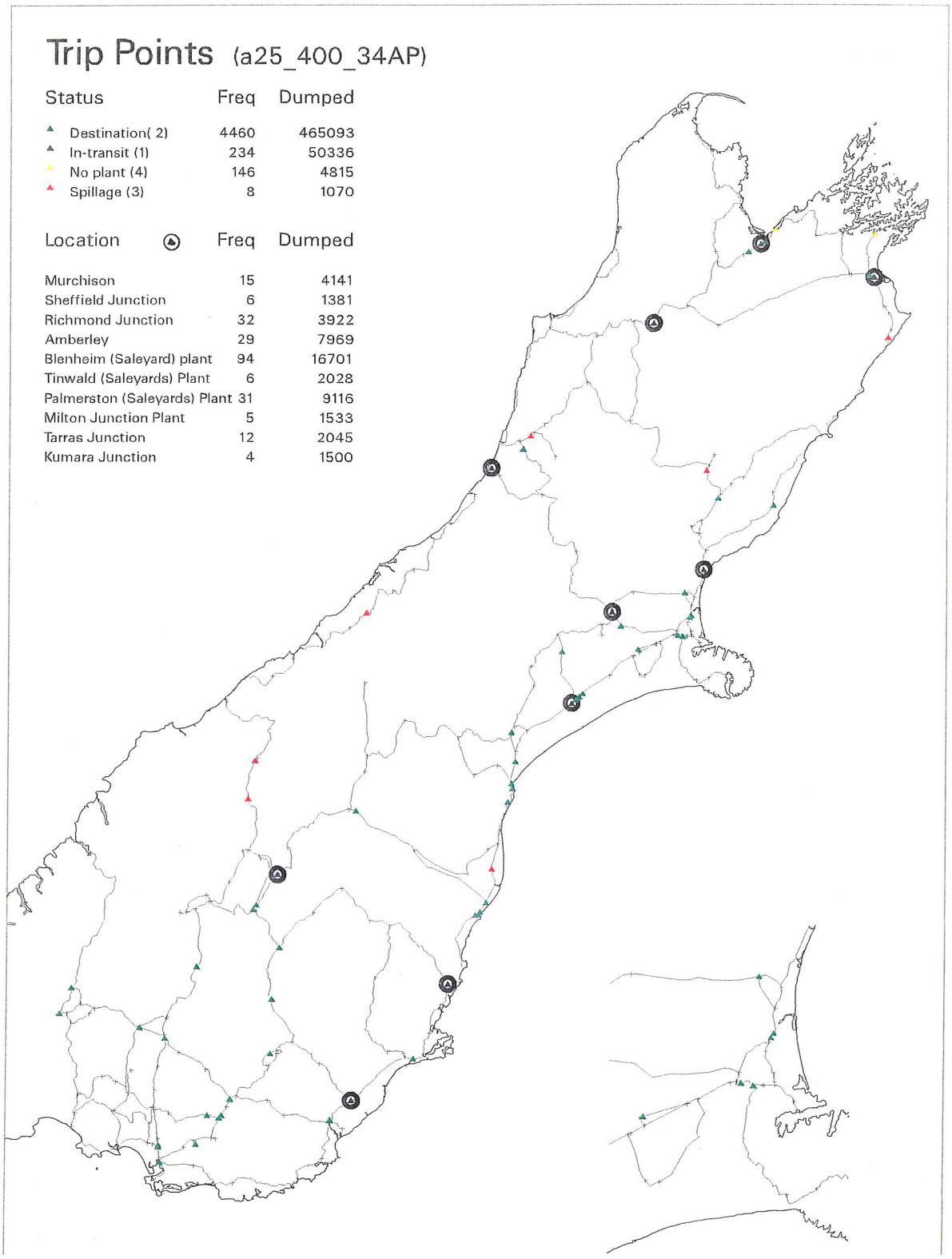
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	CMP SEAFIELD (ASHB)	189	28,986
2	CMP BLENHEIM	82	16,479
3	PPCS BELFAST	121	23,810
4	PHOENIX MEAT (KOKIRI	59	12,114
5	Murchison	23	6,355
6	SALEYARD BRIGHTWATER	32	5,358
7	SALEYARD CH-CH	99	12,539
8	Sheffield Junction	12	3,768
9	ABATTOIR ASHBURTON	62	8,409
10	PPCS MARLBOROUGH	127	16,887
11	RICHMOND (NELS. BAYS	96	18,113
12	ALLIANCE PUKEURI	317	53,831
13	Reefton	7	2,308
14	CULVERDEN	11	2,436
15	DARFIELD	6	1,376
16	GERALDINE	9	1,475
17	PICTON PORT	121	6,347
18	Spillage	5	734
19	SALEYARD BLENHEIM	32	4,530
20	Richmond Junction	34	5,444
21	NELSON PORT	25	495
22	Amberley	30	9,993
23	Kumara Junction	6	2,229
24	ASHBURTON TOWNSHIP	10	2,184
25	BALCLUTHA TOWNSHIP	1	310
26	METHVEN	11	2,180
27	Kaikoura	33	11,259
28	Blenheim (Saleyard) plant	93	17,790
29	PPCS CANTERBURY	170	20,738
30	OAMARU	2	381
31	SALEYARD TINWALD	61	8,010
32	ALLIANCE SOCKBURN	136	13,621
33	ABATTOIR MALVERN	89	11,664
34	PPCS FAIRTON (ASHB)	226	33,782
35	Tinwald (Saleyards) Plant	12	4,109
36	ALLIANCE SMITHFIELD	231	27,232
37	ALLIANCE LORNEVILLE	428	39,338
38	ALLIANCE MAKAREWA	154	11,524
39	ALLIANCE MATAURA	198	19,543
40	PPCS PAREORA	410	67,180
41	CHEVIOT	3	652
42	SALEYARD TEMUKA	64	7,467
43	ABCO MEATS (OAMARU)	97	15,166
44	SALEYARD OMARAMA	8	1,008
45	BAY CITY MEATS	52	7,489
46	Tarras Junction	18	3,200
47	PPCS FINEGAND	290	40,688
48	SALEYARD OAMARU	49	7,331
49	SALEYARD PALMERSTON	43	6,135
50	Palmerston (Saleyards) Plant	55	15,508
51	SALEYARD BALCLUTHA	29	3,571
52	Gore (Saleyards) Plant	7	1,986
53	BLUE SKY MEATS (MM)	118	13,364
54	WAITANE VILLAGE	58	6,174
55	HARTLAND PRIME MEAT	12	1,471
56	PRIME RANGE MEATS	102	10,089
57	SALEYARD CROMWELL	6	612
58	SALEYARD GORE	63	8,061
59	RANGIORA	1	279
60	ALEXANDRA	1	168
61	SALEYARD LORNEVILLE	74	8,234
62	ROXBURGH	2	187
63	DUNEDIN	2	196
64	TE ANAU	4	1,026
65	MOSSBURN	5	1,111
66	MATAURA	2	482
67	KINGSTON	1	279
68	HERIOT	1	290
69	MANAPOURI	2	380
70	LUMSDEN JUNCTION	2	356
		4,941	**697,821**

Annual running costs (based on operational & capital costs)

400 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
80%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	5.44	40	218	0.7	10	$1,524		$11,172		$12,697
Blenheim In-transit	1	17.79	40	712	0.7	1.5	$747			$8,967	$9,714
Blenheim Riverlands		4.53	40	181	0.7	1.5	$190				$190
Kaikoura	1	11.26	40	450	0.7	10	$3,153		$11,172		$14,325
Westport Junction											
Murchison	1	6.36	40	254	0.7	3	$534			$8,967	$9,501
Reefton	1	2.31	40	92	0.7	4	$258		$11,172		$11,431
Hanner Junction											
Kumara Junction	1	2.23	40	89	0.7	18	$1,123	$13,818			$14,942
Amberley	1	9.99	40	400	0.7	5	$1,399		$11,172		$12,571
Sheffield Junction	1	3.77	40	151	0.7	14	$1,477		$11,172		$12,649
Tinwald In-transit	1	4.11	40	164	0.7	6	$690		$11,172		$11,863
Tinwald saleyard		8.01	40	320	0.7	6	$1,346				$1,346
Fairlie											
Timaru/Washdyke											
Palmerston In-transit	1	15.51	40	620	0.7	5	$2,171	$13,818			$15,989
Palmerston saleyard		6.14	40	245	0.7	5	$859				$859
Tarras Junction	1	3.20	40	128	0.7	25	$2,240	$13,818			$16,058
Cromwell In-transit											
Cromwell saleyard											
Milton Junction											
Lumsden In-transit											
Gore In-transit	1	1.99	40	79	0.7	5	$278		$11,172		$11,450
Gore saleyard		8.06	40	322	0.7	5	$1,129				$1,129
SUM	12	110.69		4,427			$19,119	$41,455	$78,205	$17,934	$156,713
								$137,594			

a25_400_34AP (25% 'not stood' 400 litre tanks AP open)



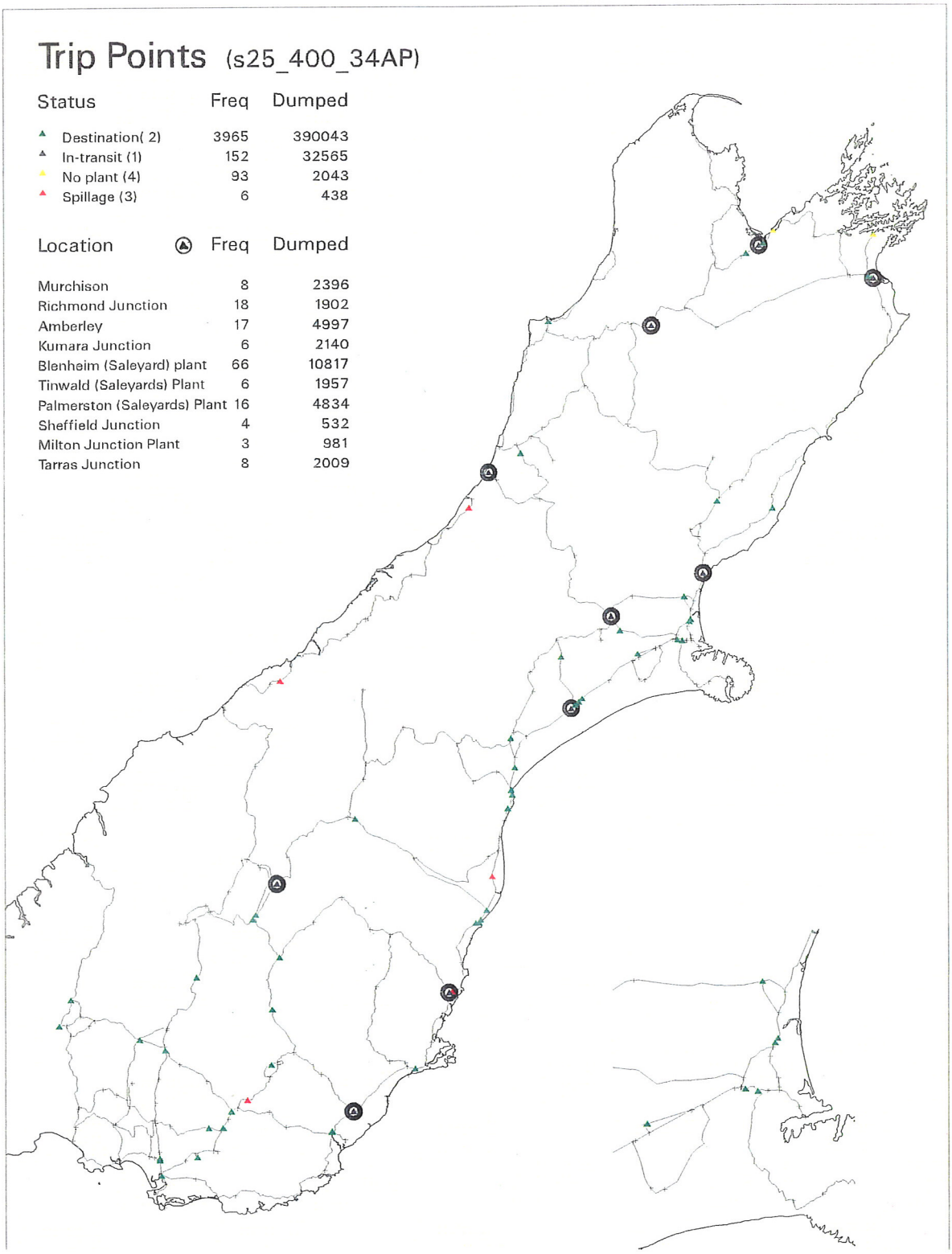
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	CMP SEAFIELD (ASHB)	189	24,446
2	CMP BLENHEIM	82	16,203
3	PPCS BELFAST	121	19,373
4	PHOENIX MEAT (KOKIRI	59	10,957
5	Murchison	15	4,141
6	SALEYARD BRIGHTWATER	32	3,848
7	SALEYARD CH-CH	99	9,320
8	ABATTOIR ASHBURTON	62	7,243
9	PPCS MARLBOROUGH	127	12,990
10	RICHMOND (NELS. BAYS	96	13,447
11	ALLIANCE PUKEURI	317	40,876
12	CULVERDEN	11	2,200
13	DARFIELD	6	1,094
14	Sheffield Junction	6	1,381
15	GERALDINE	9	1,380
16	PICTON PORT	121	4,421
17	Spillage	8	1,070
18	SALEYARD BLENHEIM	32	3,933
19	Richmond Junction	32	3,922
20	NELSON PORT	25	394
21	ASHBURTON TOWNSHIP	10	1,875
22	Amberley	29	7,969
23	BALCLUTHA TOWNSHIP	1	310
24	METHVEN	11	1,940
25	Blenheim (Saleyard) plant	94	16,701
26	PPCS CANTERBURY	170	15,108
27	OAMARU	2	355
28	SALEYARD TINWALD	61	5,612
29	ALLIANCE SOCKBURN	136	10,106
30	ABATTOIR MALVERN	89	8,317
31	PPCS FAIRTON (ASHB)	226	25,614
32	Tinwald (Saleyards) Plant	6	2,028
33	ALLIANCE SMITHFIELD	231	18,508
34	ALLIANCE LORNEVILLE	428	29,537
35	ALLIANCE MAKAREWA	154	8,455
36	ALLIANCE MATAURA	198	14,537
37	PPCS PAREORA	410	49,755
38	CHEVIOT	3	470
39	SALEYARD TEMUKA	64	5,374
40	ABCO MEATS (OAMARU)	97	11,667
41	SALEYARD OMARAMA	8	696
42	BAY CITY MEATS	52	5,983
43	PPCS FINEGAND	290	31,703
44	SALEYARD OAMARU	49	5,393
45	SALEYARD PALMERSTON	43	4,394
46	Palmerston (Saleyards) Plant	31	9,116
47	SALEYARD BALCLUTHA	29	2,713
48	Milton Junction Plant	5	1,533
49	BLUE SKY MEATS (MM)	118	10,640
50	Tarras Junction	12	2,045
51	PPCS WAITANE (Gore)	58	5,128
52	HARTLAND PRIME MEAT	12	1,077
53	PRIME RANGE MEATS	102	7,470
54	SALEYARD CROMWELL	6	412
55	SALEYARD GORE	63	5,638
56	Kumara Junction	4	1,500
57	RANGIORA	1	203
58	ALEXANDRA	1	94
59	SALEYARD LORNEVILLE	74	5,994
60	ROXBURGH	2	155
61	DUNEDIN	2	106
62	TE ANAU	4	502
63	MOSSBURN	5	763
64	MATAURA	2	294
65	KINGSTON	1	279
66	HERIOT	1	140
67	MANAPOURI	2	198
68	LUMSDEN JUNCTION	2	268
		4,848	**521,314**

Annual running costs (based on operational & capital costs)

400 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	3.92	40	157	0.7	10	$1,098		$11,172		$12,270
Blenheim In-transit	1	16.70	40	668	0.7	1.5	$701			$8,967	$9,669
Blenheim Riverlands		3.93	40	157	0.7	1.5	$165				$165
Kaikoura											
Westport Junction											
Murchison	1	4.14	40	166	0.7	3	$348			$8,967	$9,315
Reefton											
Hanmer Junction											
Kumara Junction	1	1.50	40	60	0.7	18	$756	$13,818			$14,574
Amberley	1	7.97	40	319	0.7	5	$1,116		$11,172		$12,288
Sheffield Junction	1	1.38	40	55	0.7	14	$541		$11,172		$11,714
Tinwald In-transit	1	2.03	40	81	0.7	6	$341		$11,172		$11,513
Tinwald saleyard		5.61	40	224	0.7	6	$943				$943
Fairlie											
Timaru/Washdyke											
Palmerston In-transit	1	9.12	40	365	0.7	5	$1,276	$13,818			$15,094
Palmerston saleyard		4.39	40	176	0.7	5	$615				$615
Tarras Junction	1	2.05	40	82	0.7	25	$1,432	$13,818			$15,250
Cromwell In-transit											
Cromwell saleyard											
Milton Junction	1	1.53	40	61	0.7	3	$129	$13,818			$13,947
Lumsden In-transit											
Gore In-transit											
Gore saleyard											
SUM	10	64.28		2,571			$9,461	$55,273	$44,689	$17,934	$127,357
								$117,896			

s25_400_34AP (25% 'not stood' 400 litre tanks AP open)



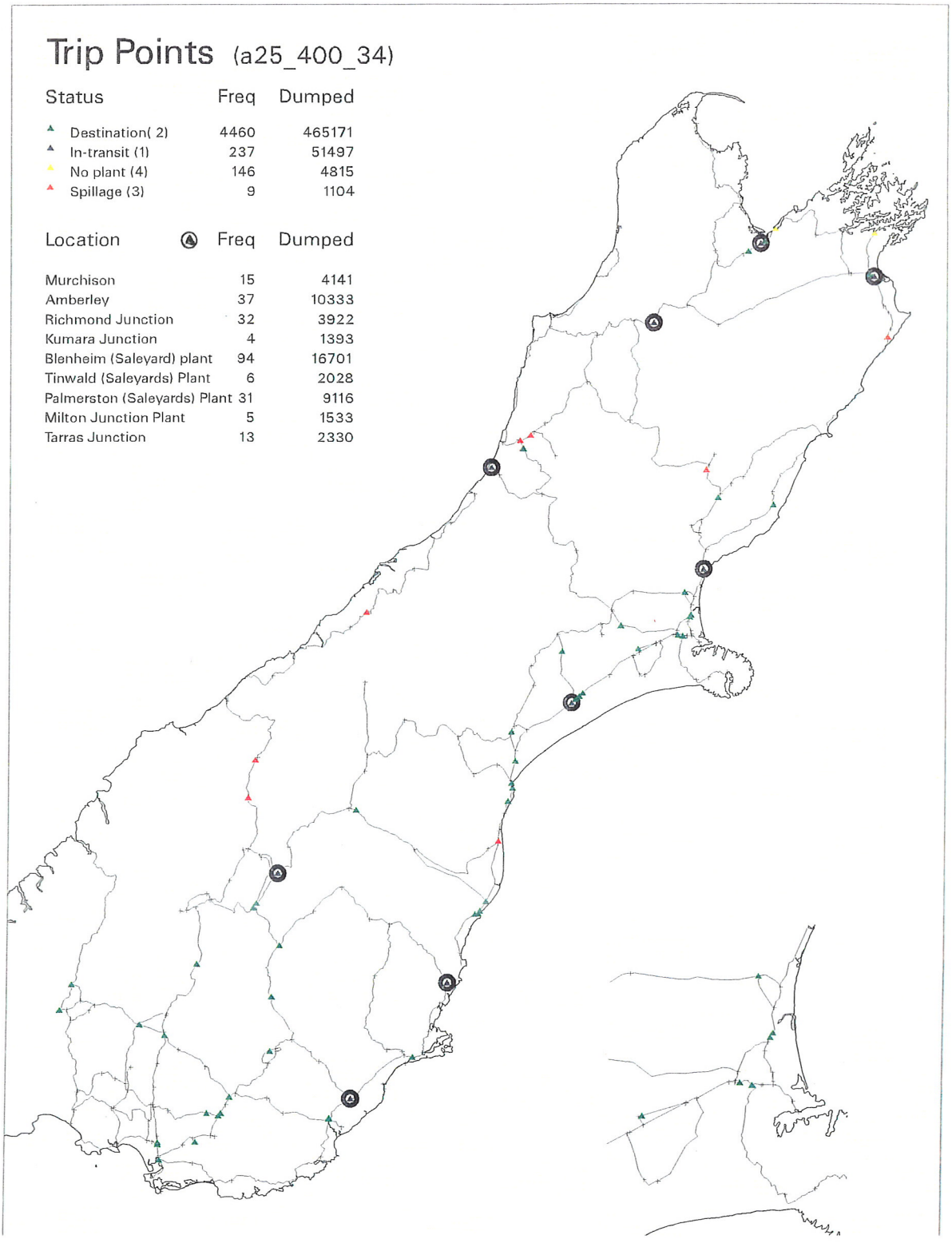
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	PHOENIX MEAT (KOKIRI	55	9,400
2	Murchison	8	2,396
3	SALEYARD BRIGHTWATER	32	4,210
4	ABATTOIR ASHBURTON	52	6,278
5	PPCS FAIRTON (ASHB)	135	11,460
6	PPCS BELFAST	77	11,248
7	RICHMOND (NELS. BAYS	71	9,582
8	ALLIANCE PUKEURI	247	31,966
9	SALEYARD CH-CH	93	8,881
10	CMP BLENHEIM	66	10,241
11	PPCS MARLBOROUGH	94	8,021
12	SALEYARD BLENHEIM	28	3,137
13	Richmond Junction	18	1,902
14	NELSON PORT	15	184
15	PICTON PORT	78	1,859
16	Amberley	17	4,997
17	CMP SEAFIELD (ASHB)	163	20,726
18	Kumara Junction	6	2,140
19	ASHBURTON TOWNSHIP	5	964
20	BALCLUTHA TOWNSHIP	1	208
21	WESTPORT	1	150
22	PPCS CANTERBURY	97	8,234
23	Blenheim (Saleyard) plant	66	10,817
24	SALEYARD TINWALD	72	6,227
25	ALLIANCE SMITHFIELD	185	12,875
26	CULVERDEN	8	1,618
27	PPCS PAREORA	212	18,517
28	OAMARU	1	133
29	ALLIANCE SOCKBURN	70	4,792
30	ABATTOIR MALVERN	68	5,966
31	CHEVIOT	5	692
32	ALLIANCE MATAURA	222	18,904
33	Tinwald (Saleyards) Plant	6	1,957
34	SALEYARD TEMUKA	61	4,578
35	PPCS FINEGAND	335	38,011
36	Palmerston (Saleyards) Plant	16	4,834
37	ALLIANCE LORNEVILLE	522	43,000
38	Sheffield Junction	4	532
39	ALLIANCE MAKAREWA	263	19,516
40	ABCO MEATS (OAMARU)	94	10,259
41	BAY CITY MEATS	39	4,729
42	Spillage	6	438
43	SALEYARD OMARAMA	16	1,185
44	SALEYARD OAMARU	40	4,296
45	Milton Junction Plant	3	981
46	SALEYARD PALMERSTON	45	4,777
47	PPCS WAITANE (Gore)	67	5,239
48	SALEYARD BALCLUTHA	26	2,929
49	Tarras Junction	8	2,009
50	BLUE SKY MEATS (MM)	99	7,720
51	SALEYARD CROMWELL	8	512
52	HARTLAND PRIME MEAT	18	1,301
53	PRIME RANGE MEATS	93	7,121
54	SALEYARD GORE	63	7,018
55	SALEYARD LORNEVILLE	80	7,682
56	DARFIELD	2	253
57	GERALDINE	3	435
58	METHVEN	9	1,296
59	RANGIORA	2	540
60	ALEXANDRA	1	168
61	ROXBURGH	2	155
62	DUNEDIN	2	106
63	TE ANAU	4	1,009
64	MOSSBURN	5	704
65	KINGSTON	1	135
66	HERIOT	1	290
67	MANAPOURI	2	381
68	LUMSDEN JUNCTION	2	268
		4,216	**425,089**

Annual running costs (based on operational & capital costs)

400 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	1.90	40	76	0.7	10	$533		$11,172		$11,705
Blenheim in-transit	1	10.82	40	433	0.7	1.5	$454			$8,967	$9,422
Blenheim Riverlands		3.14	40	125	0.7	1.5	$132				$132
Kaikoura											
Westport Junction											
Murchison	1	2.40	40	96	0.7	3	$201			$8,967	$9,168
Reefton											
Hanmer Junction											
Kumara Junction	1	2.14	40	86	0.7	18	$1,079	$13,818			$14,897
Amberley	1	5.00	40	200	0.7	5	$700		$11,172		$11,872
Sheffield Junction	1	0.53	40	21	0.7	14	$209		$11,172		$11,381
Tinwald in-transit	1	1.96	40	78	0.7	6	$329		$11,172		$11,501
Tinwald saleyard		6.23	40	249	0.7	6	$1,046				$1,046
Fairlie											
Timaru/Washdyke											
Palmerston in-transit	1	4.83	40	193	0.7	5	$677	$13,818			$14,495
Palmerston saleyard		4.78	40	191	0.7	5	$669				$669
Tarras Junction	1	2.01	40	80	0.7	25	$1,406	$13,818			$15,225
Cromwell in-transit											
Cromwell saleyard											
Milton Junction	1	0.98	40	39	0.7	3	$82	$13,818			$13,901
Lumsden in-transit											
Gore in-transit											
Gore saleyard											
SUM	10	46.71		1,868			$7,516	$55,273	$44,689	$17,934	$125,412
								$117,896			

a25_400_34 (25% 'not stood' 400 litre tanks AP *not* open)



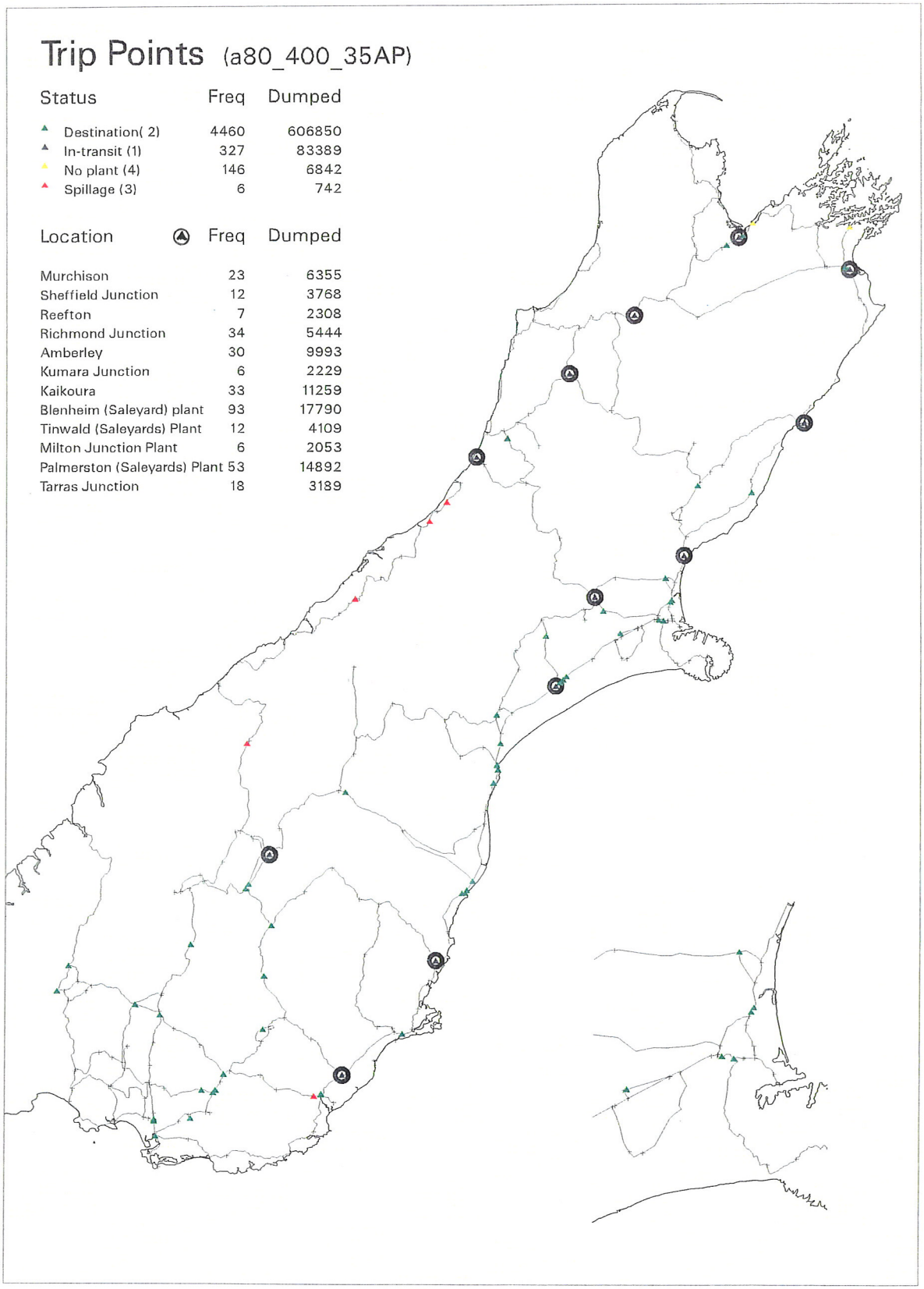
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	CMP SEAFIELD (ASHB)	189	24,742
2	CMP BLENHEIM	82	16,203
3	PPCS BELFAST	121	19,058
4	PHOENIX MEAT (KOKIRI	59	11,145
5	Murchison	15	4,141
6	SALEYARD BRIGHTWATER	32	3,848
7	SALEYARD CH-CH	99	9,352
8	Amberley	37	10,333
9	ABATTOIR ASHBURTON	62	6,989
10	PPCS MARLBOROUGH	127	12,990
11	RICHMOND (NELS. BAYS	96	13,447
12	ALLIANCE PUKEURI	317	40,893
13	CULVERDEN	11	2,200
14	DARFIELD	6	1,162
15	GERALDINE	9	1,419
16	PICTON PORT	121	4,421
17	Spillage	9	1,104
18	SALEYARD BLENHEIM	32	3,933
19	Richmond Junction	32	3,922
20	NELSON PORT	25	394
21	ASHBURTON TOWNSHIP	10	1,882
22	Kumara Junction	4	1,393
23	BALCLUTHA TOWNSHIP	1	310
24	METHVEN	11	1,940
25	Blenheim (Saleyard) plant	94	16,701
26	PPCS CANTERBURY	170	15,108
27	OAMARU	2	355
28	SALEYARD TINWALD	61	5,612
29	ALLIANCE SOCKBURN	136	10,106
30	ABATTOIR MALVERN	89	8,317
31	PPCS FAIRTON (ASHB)	226	25,614
32	Tinwald (Saleyards) Plant	6	2,028
33	ALLIANCE SMITHFIELD	231	18,508
34	ALLIANCE LORNEVILLE	428	29,537
35	ALLIANCE MAKAREWA	154	8,455
36	ALLIANCE MATAURA	198	14,537
37	PPCS PAREORA	410	49,755
38	CHEVIOT	3	470
39	SALEYARD TEMUKA	64	5,374
40	ABCO MEATS (OAMARU)	97	11,667
41	SALEYARD OMARAMA	8	696
42	BAY CITY MEATS	52	5,983
43	PPCS FINEGAND	290	31,703
44	SALEYARD OAMARU	49	5,393
45	SALEYARD PALMERSTON	43	4,394
46	Palmerston (Saleyards) Plant	31	9,116
47	SALEYARD BALCLUTHA	29	2,713
48	Milton Junction Plant	5	1,533
49	BLUE SKY MEATS (MM)	118	10,640
50	Tarras Junction	13	2,330
51	PPCS WAITANE (Gore)	58	5,128
52	HARTLAND PRIME MEAT	12	1,077
53	PRIME RANGE MEATS	102	7,470
54	SALEYARD CROMWELL	6	412
55	SALEYARD GORE	63	5,638
56	RANGIORA	1	203
57	ALEXANDRA	1	94
58	SALEYARD LORNEVILLE	74	5,994
59	ROXBURGH	2	155
60	DUNEDIN	2	106
61	TE ANAU	4	502
62	MOSSBURN	5	763
63	MATAURA	2	294
64	KINGSTON	1	279
65	HERIOT	1	140
66	MANAPOURI	2	198
67	LUMSDEN JUNCTION	2	268
		4,852	**522,587**

Annual running costs (based on operational & capital costs)

400 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	3.92	40	157	0.7	10	$1,098		$11,172		$12,270
Blenheim In-transit	1	16.70	40	668	0.7	1.5	$701			$8,967	$9,669
Blenheim Riverlands		3.93	40	157	0.7	1.5	$165				$165
Kaikoura											
Westport Junction											
Murchison	1	4.14	40	166	0.7	3	$348			$8,967	$9,315
Reefton											
Hamner Junction											
Kumara Junction	1	1.39	40	56	0.7	18	$702	$13,818			$14,520
Amberley	1	10.33	40	413	0.7	5	$1,447		$11,172		$12,619
Sheffield Junction											
Tinwald In-transit	1	2.03	40	81	0.7	6	$341		$11,172		$11,513
Tinwald saleyard		5.61	40	224	0.7	6	$943				$943
Fairlie											
Timaru/Washdyke											
Palmerston In-transit	1	9.12	40	365	0.7	5	$1,276	$13,818			$15,094
Palmerston saleyard		4.39	40	176	0.7	5	$615				$615
Tarras Junction	1	2.33	40	93	0.7	25	$1,631	$13,818			$15,449
Cromwell In-transit											
Cromwell saleyard											
Milton Junction	1	1.53	40	61	0.7	3	$129	$13,818			$13,947
Lumsden In-transit											
Gore In-transit											
Gore saleyard											
SUM	9	65.44		2,617			$9,396	$55,273	$33,517	$17,934	$116,120
								$106,724			

a80_400_35AP (80% 'not stood' 400 litre tanks AP open)



Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	CMP SEAFIELD (ASHB)	189	28,986
2	CMP BLENHEIM	82	16,479
3	PPCS BELFAST	121	23,810
4	PHOENIX MEAT (KOKIRI	59	12,114
5	Murchison	23	6,355
6	SALEYARD BRIGHTWATER	32	5,358
7	SALEYARD CH-CH	99	12,539
8	Sheffield Junction	12	3,768
9	ABATTOIR ASHBURTON	62	8,409
10	PPCS MARLBOROUGH	127	16,887
11	RICHMOND (NELS. BAYS	96	18,113
12	ALLIANCE PUKEURI	317	53,909
13	Reefton	7	2,308
14	CULVERDEN	11	2,436
15	DARFIELD	6	1,376
16	GERALDINE	9	1,475
17	PICTON PORT	121	6,347
18	Spillage	6	742
19	SALEYARD BLENHEIM	32	4,530
20	Richmond Junction	34	5,444
21	NELSON PORT	25	495
22	Amberley	30	9,993
23	Kumara Junction	6	2,229
24	ASHBURTON TOWNSHIP	10	2,184
25	BALCLUTHA TOWNSHIP	1	310
26	METHVEN	11	2,180
27	Kaikoura	33	11,259
28	Blenheim (Saleyard) plant	93	17,790
29	PPCS CANTERBURY	170	20,738
30	OAMARU	2	381
31	SALEYARD TINWALD	61	8,010
32	ALLIANCE SOCKBURN	136	13,621
33	ABATTOIR MALVERN	89	11,664
34	PPCS FAIRTON (ASHB)	226	33,782
35	Tinwald (Saleyards) Plant	12	4,109
36	ALLIANCE SMITHFIELD	231	27,232
37	ALLIANCE LORNEVILLE	428	39,407
38	ALLIANCE MAKAREWA	154	11,524
39	ALLIANCE MATAURA	198	19,543
40	PPCS PAREORA	410	67,180
41	CHEVIOT	3	652
42	SALEYARD TEMUKA	64	7,467
43	ABCO MEATS (OAMARU)	97	15,243
44	SALEYARD OMARAMA	8	1,008
45	BAY CITY MEATS	52	7,489
46	Milton Junction Plant	6	2,053
47	PPCS FINEGAND	290	40,824
48	SALEYARD OAMARU	49	7,331
49	SALEYARD PALMERSTON	43	6,135
50	Palmerston (Saleyards) Plant	53	14,892
51	SALEYARD BALCLUTHA	29	3,571
52	BLUE SKY MEATS (MM)	118	13,364
53	Tarras Junction	18	3,189
54	PPCS WAITANE (Gore)	58	6,368
55	HARTLAND PRIME MEAT	12	1,471
56	PRIME RANGE MEATS	102	10,089
57	SALEYARD CROMWELL	6	612
58	SALEYARD GORE	63	8,061
59	RANGIORA	1	279
60	ALEXANDRA	1	168
61	SALEYARD LORNEVILLE	74	8,234
62	ROXBURGH	2	187
63	DUNEDIN	2	196
64	TE ANAU	4	1,026
65	MOSSBURN	5	1,111
66	MATAURA	2	482
67	KINGSTON	1	279
68	HERIOT	1	290
69	MANAPOURI	2	380
70	LUMSDEN JUNCTION	2	356
		4,939	**697,823**

Annual running costs (based on operational & capital costs)

400 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
80%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	5.44	40	218	0.7	10	$1,524		$11,172		$12,697
Blenheim in-transit	1	17.79	40	712	0.7	1.5	$747			$8,967	$9,714
Blenheim Riverlands		4.53	40	181	0.7	1.5	$190				$190
Kaikoura	1	11.26	40	450	0.7	10	$3,153		$11,172		$14,325
Westport Junction											
Murchison	1	6.36	40	254	0.7	3	$534			$8,967	$9,501
Reefton	1	2.31	40	92	0.7	4	$258		$11,172		$11,431
Hanmer Junction											
Kumara Junction	1	2.23	40	89	0.7	18	$1,123	$13,818			$14,942
Amberley	1	9.99	40	400	0.7	5	$1,399		$11,172		$12,571
Sheffield Junction	1	3.77	40	151	0.7	14	$1,477		$11,172		$12,649
Tinwald in-transit	1	4.11	40	164	0.7	6	$690		$11,172		$11,863
Tinwald saleyard		8.01	40	320	0.7	6	$1,346				$1,346
Fairlie											
Timaru/Washdyke											
Palmerston in-transit	1	14.89	40	596	0.7	5	$2,085	$13,818			$15,903
Palmerston saleyard		6.14	40	245	0.7	5	$859				$859
Tarras Junction	1	3.19	40	128	0.7	25	$2,232	$13,818			$16,051
Cromwell in-transit											
Cromwell saleyard											
Milton Junction	1	2.05	40	82	0.7	3	$172	$13,818			$13,991
Lumsden in-transit											
Gore in-transit											
Gore saleyard											
SUM	12	102.06		4,083			$17,791	$55,273	$67,033	$17,934	$158,031
								$140,240			

NETWORK OF DUMP SITES (SAMPLES)

FOR 300 LITRE STORAGE CAPACITY

'spring-summer' & 'summer-autumn' model
including Arthur's Pass (AP)
and associated costs

NETWORK FOR MINIMUM SPILLAGE

a25_300_29AP **s25_300_29AP**

a25_300_29

a80_300_29AP

RECOMMENDED NETWORK

a25_300_30AP **s25_300_30AP**

a25_300_30

FURTHER MAPS

a80_300_11

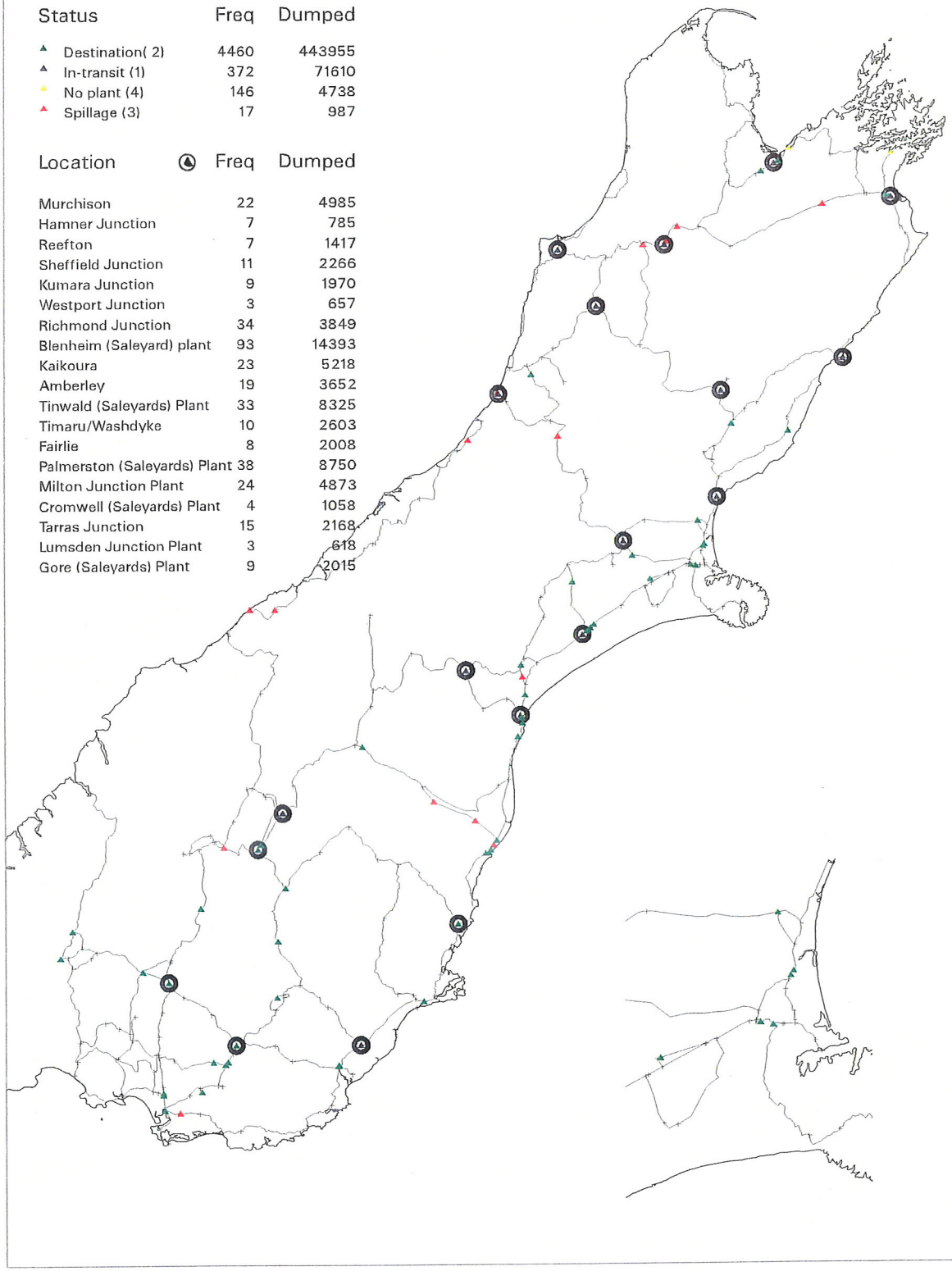
a80_300_27AP **a25_30_31AP**

a25_300_29AP (25% 'not stood' 300 litre tanks AP open)

Trip Points (a25_300_29AP)

Status	Freq	Dumped
Destination(2)	4460	443955
In-transit (1)	372	71610
No plant (4)	146	4738
Spillage (3)	17	987

Location	Freq	Dumped
Murchison	22	4985
Hamner Junction	7	785
Reefton	7	1417
Sheffield Junction	11	2266
Kumara Junction	9	1970
Westport Junction	3	657
Richmond Junction	34	3849
Blenheim (Saleyard) plant	93	14393
Kaikoura	23	5218
Amberley	19	3652
Tinwald (Saleyards) Plant	33	8325
Timaru/Washdyke	10	2603
Fairlie	8	2008
Palmerston (Saleyards) Plant	38	8750
Milton Junction Plant	24	4873
Cromwell (Saleyards) Plant	4	1058
Tarras Junction	15	2168
Lumsden Junction Plant	3	618
Gore (Saleyards) Plant	9	2015



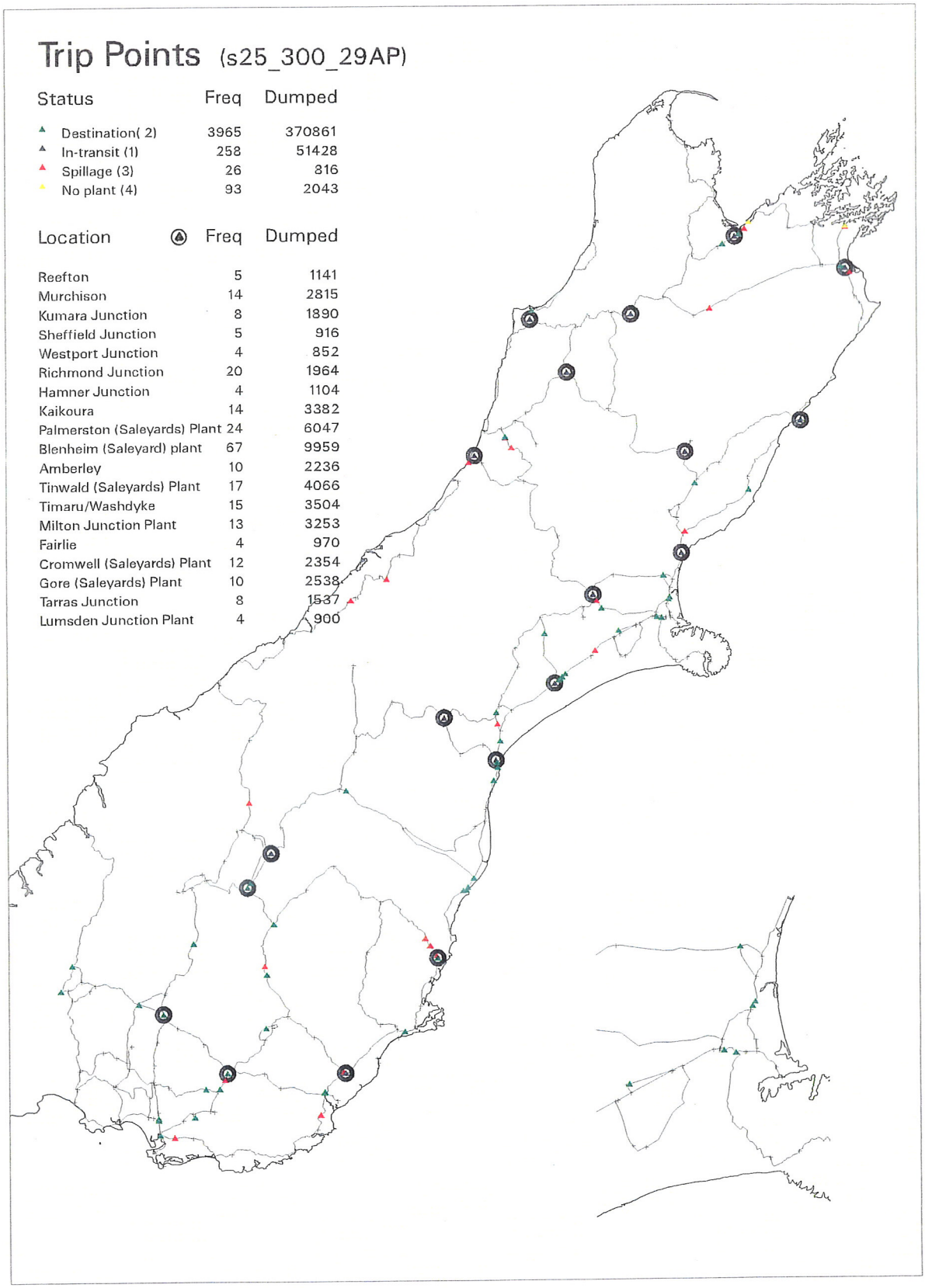
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	CMP SEAFIELD (ASHB)	189	23,481
2	Murchison	22	4,985
3	CMP BLENHEIM	82	14,150
4	Hamner Junction	7	785
5	PPCS BELFAST	121	15,610
6	PHOENIX MEAT (KOKIRI	59	9,286
7	Reefton	7	1,417
8	SALEYARD BRIGHTWATER	32	4,031
9	SALEYARD CH-CH	99	9,370
10	Sheffield Junction	11	2,266
11	ABATTOIR ASHBURTON	62	6,579
12	PPCS MARLBOROUGH	127	12,990
13	Kumara Junction	9	1,970
14	RICHMOND (NELS. BAYS	96	12,228
15	ALLIANCE PUKEURI	317	36,974
16	CULVERDEN	11	2,045
17	DARFIELD	6	808
18	GERALDINE	9	1,528
19	PICTON PORT	121	4,344
20	Westport Junction	3	657
21	SALEYARD BLENHEIM	32	3,688
22	Richmond Junction	34	3,849
23	NELSON PORT	25	394
24	ASHBURTON TOWNSHIP	10	1,875
25	Spillage	17	987
26	BALCLUTHA TOWNSHIP	1	310
27	METHVEN	11	2,172
28	Blenheim (Saleyard) plant	93	14,393
29	Kaikoura	23	5,218
30	PPCS CANTERBURY	170	14,896
31	OAMARU	2	355
32	Amberley	19	3,652
33	SALEYARD TINWALD	61	5,368
34	ALLIANCE SOCKBURN	136	9,846
35	ABATTOIR MALVERN	89	7,840
36	PPCS FAIRTON (ASHB)	226	25,209
37	Tinwald (Saleyards) Plant	33	8,325
38	ALLIANCE SMITHFIELD	231	18,266
39	ALLIANCE LORNEVILLE	428	29,068
40	ALLIANCE MAKAREWA	154	8,455
41	ALLIANCE MATAURA	198	14,249
42	PPCS PAREORA	410	49,123
43	CHEVIOT	3	470
44	Timaru/Washdyke	10	2,603
45	SALEYARD TEMUKA	64	5,374
46	ABCO MEATS (OAMARU)	97	11,219
47	SALEYARD OMARAMA	8	696
48	BAY CITY MEATS	52	5,745
49	PPCS FINEGAND	290	30,046
50	SALEYARD OAMARU	49	4,922
51	Fairlie	8	2,008
52	SALEYARD PALMERSTON	43	4,394
53	Palmerston (Saleyards) Plant	38	8,750
54	Milton Junction Plant	24	4,873
55	SALEYARD BALCLUTHA	29	2,415
56	BLUE SKY MEATS (MM)	118	10,189
57	Cromwell (Saleyards) Plant	4	1,058
58	WAITANE VILLAGE	58	5,092
59	HARTLAND PRIME MEAT	12	1,077
60	PRIME RANGE MEATS	102	7,470
61	Tarras Junction	15	2,168
62	SALEYARD CROMWELL	6	412
63	Lumsden Junction Plant	3	618
64	SALEYARD GORE	63	5,638
65	RANGIORA	1	203
66	ALEXANDRA	1	94
67	SALEYARD LORNEVILLE	74	5,994
68	ROXBURGH	2	155
69	DUNEDIN	2	106
70	Gore (Saleyards) Plant	9	2,015
71	TE ANAU	4	502
72	MOSSBURN	5	763
73	MATAURA	2	294
74	KINGSTON	1	279
75	HERIOT	1	140
76	MANAPOURI	2	198
77	LUMSDEN JUNCTION	2	268
		4,995	**521,290**

Annual running costs (based on operational & capital costs)

300 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	3.85	40	154	0.7	10	$1,078		$11,172		$12,250
Blenheim In-transit	1	14.39	40	576	0.7	1.5	$605			$8,967	$9,572
Blenheim Riverlands		3.69	40	148	0.7	1.5	$155				$155
Kaikoura	1	5.22	40	209	0.7	10	$1,461		$11,172		$12,633
Westport Junction	1	0.66	40	26	0.7	10	$184	$13,818			$14,002
Murchison	1	4.99	40	199	0.7	3	$419			$8,967	$9,386
Reefton	1	1.42	40	57	0.7	4	$159		$11,172		$11,331
Hanmer Junction	1	0.79	40	31	0.7	10	$220	$13,818			$14,038
Kumara Junction	1	1.97	40	79	0.7	18	$993	$13,818			$14,811
Amberley	1	3.65	40	146	0.7	5	$511		$11,172		$11,683
Sheffield Junction	1	2.27	40	91	0.7	14	$888		$11,172		$12,060
Tinwald In-transit	1	8.33	40	333	0.7	6	$1,399		$11,172		$12,571
Tinwald saleyard		5.37	40	215	0.7	6	$902				$902
Fairlie	1	2.01	40	80	0.7	5	$281		$11,172		$11,453
Timaru/Washdyke	1	2.60	40	104	0.7	3	$219		$11,172		$11,391
Palmerston In-transit	1	8.75	40	350	0.7	5	$1,225	$13,818			$15,043
Palmerston saleyard		4.39	40	176	0.7	5	$615				$615
Terrace Junction	1	2.17	40	87	0.7	25	$1,518	$13,818			$15,336
Cromwell In-transit	1	1.06	40	42	0.7	5	$148		$11,172		$11,320
Cromwell saleyard		0.41	12	5	0.7	5	$17				$17
Milton Junction	1	4.87	40	195	0.7	3	$409	$13,818			$14,228
Lumsden In-transit	1	0.62	40	25	0.7	5	$87		$11,172		$11,259
Gore In-transit	1	2.02	40	81	0.7	5	$282		$11,172		$11,454
Gore saleyard		5.64	40	226	0.7	5	$789				$789
SUM	19	91.11		3,633			$14,562	$82,909	$122,894	$17,934	$238,300
								$223,738			

s25_300_29AP (25% 'not stood' 300 litre tanks AP open)



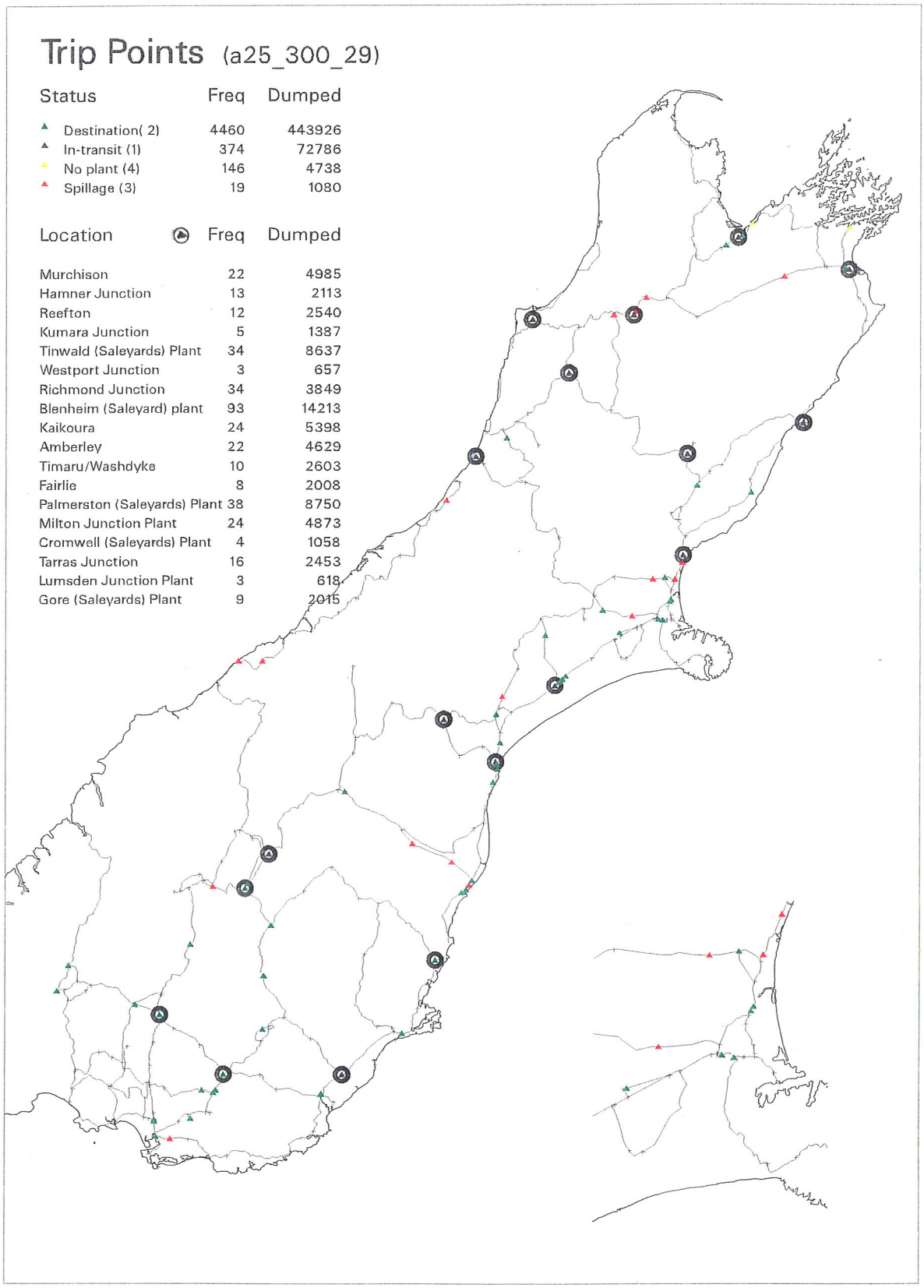
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	PHOENIX MEAT (KOKIRI	55	8,160
2	Reefton	5	1,141
3	Murchison	14	2,815
4	SALEYARD BRIGHTWATER	32	3,491
5	Kumara Junction	8	1,890
6	Sheffield Junction	5	916
7	ABATTOIR ASHBURTON	52	5,969
8	PPCS FAIRTON (ASHB)	135	11,460
9	PPCS BELFAST	77	9,789
10	Spillage	26	816
11	RICHMOND (NELS. BAYS	71	9,158
12	ALLIANCE PUKEURI	247	28,070
13	SALEYARD CH-CH	93	8,753
14	Westport Junction	4	852
15	CMP BLENHEIM	66	9,838
16	PPCS MARLBOROUGH	94	7,541
17	SALEYARD BLENHEIM	28	2,831
18	Richmond Junction	20	1,964
19	NELSON PORT	15	184
20	PICTON PORT	78	1,859
21	Hamner Junction	4	1,104
22	CMP SEAFIELD (ASHB)	163	20,475
23	ASHBURTON TOWNSHIP	5	964
24	Kaikoura	14	3,382
25	Palmerston (Saleyards) Plant	24	6,047
26	BALCLUTHA TOWNSHIP	1	30
27	WESTPORT	1	150
28	PPCS CANTERBURY	97	8,024
29	Blenheim (Saleyard) plant	67	9,959
30	Amberley	10	2,236
31	SALEYARD TINWALD	72	6,027
32	ALLIANCE SMITHFIELD	185	12,875
33	CULVERDEN	8	1,327
34	PPCS PAREORA	212	17,987
35	OAMARU	1	133
36	ALLIANCE SOCKBURN	70	4,792
37	ABATTOIR MALVERN	68	5,713
38	CHEVIOT	5	692
39	ALLIANCE MATAURA	222	18,126
40	Tinwald (Saleyards) Plant	17	4,066
41	Timaru/Washdyke	15	3,504
42	SALEYARD TEMUKA	61	4,578
43	PPCS FINEGAND	335	36,254
44	ALLIANCE LORNEVILLE	522	42,308
45	ALLIANCE MAKAREWA	263	18,985
46	ABCO MEATS (OAMARU)	94	9,203
47	BAY CITY MEATS	39	4,378
48	Milton Junction Plant	13	3,253
49	SALEYARD OMARAMA	16	1,185
50	SALEYARD OAMARU	40	4,296
51	Fairlie	4	970
52	Cromwell (Saleyards) Plant	12	2,354
53	SALEYARD PALMERSTON	45	4,236
54	WAITANE VILLAGE	67	4,966
55	SALEYARD BALCLUTHA	26	2,449
56	BLUE SKY MEATS (MM)	99	7,266
57	Gore (Saleyards) Plant	10	2,538
58	SALEYARD CROMWELL	8	512
59	HARTLAND PRIME MEAT	18	1,301
60	PRIME RANGE MEATS	93	7,121
61	SALEYARD GORE	63	6,404
62	SALEYARD LORNEVILLE	80	7,462
63	DARFIELD	2	253
64	GERALDINE	3	568
65	METHVEN	9	1,528
66	Tarras Junction	8	1,537
67	RANGIORA	2	267
68	ALEXANDRA	1	168
69	ROXBURGH	2	155
70	DUNEDIN	2	106
71	TE ANAU	4	759
72	MOSSBURN	5	704
73	Lumsden Junction Plant	4	900
74	KINGSTON	1	135
75	HERIOT	1	290
76	MANAPOURI	2	381
77	LUMSDEN JUNCTION	2	268
		4,342	**425,148**

Annual running costs (based on operational & capital costs)

300 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	1.96	40	79	0.7	10	$550		$11,172		$11,722
Blenheim In-transit	1	9.96	40	398	0.7	1.5	$418			$8,967	$9,385
Blenheim Riverlands		2.83	40	113	0.7	1.5	$119				$119
Kaikoura	1	3.38	40	135	0.7	10	$947		$11,172		$12,119
Westport Junction	1	0.85	40	34	0.7	10	$239	$13,818			$14,057
Murchison	1	2.82	40	113	0.7	3	$236			$8,967	$9,204
Reefton	1	1.14	40	46	0.7	4	$128		$11,172		$11,300
Hamner Junction	1	1.10	40	44	0.7	10	$309	$13,818			$14,127
Kumara Junction	1	1.89	40	76	0.7	18	$953	$13,818			$14,771
Amberley	1	2.24	40	89	0.7	5	$313		$11,172		$11,485
Sheffield Junction	1	0.92	40	37	0.7	14	$359		$11,172		$11,531
Tinwald In-transit	1	4.07	40	163	0.7	6	$683		$11,172		$11,855
Tinwald saleyard		6.03	40	241	0.7	6	$1,013				$1,013
Fairlie	1	0.97	40	39	0.7	5	$136		$11,172		$11,308
Timaru/Washdyke	1	3.50	40	140	0.7	3	$294		$11,172		$11,467
Palmerston In-transit	1	6.05	40	242	0.7	5	$847	$13,818			$14,665
Palmerston saleyard		4.24	40	169	0.7	5	$593				$593
Tarras Junction	1	1.54	40	61	0.7	25	$1,076	$13,818			$14,894
Cromwell In-transit	1	2.35	40	94	0.7	5	$330		$11,172		$11,502
Cromwell saleyard		0.51	12	6	0.7	5	$22				$22
Milton Junction	1	3.25	40	130	0.7	3	$273	$13,818			$14,091
Lumsden In-transit	1	0.90	40	36	0.7	5	$126		$11,172		$11,298
Gore In-transit	1	2.54	40	102	0.7	5	$355		$11,172		$11,528
Gore saleyard		6.40	40	256	0.7	5	$897				$897
SUM	19	71.44		2,843			$11,214	$82,909	$122,894	$17,934	$234,952
								$223,738			

a25_300_29 (25% 'not stood' 300 litre tanks AP *not* open)



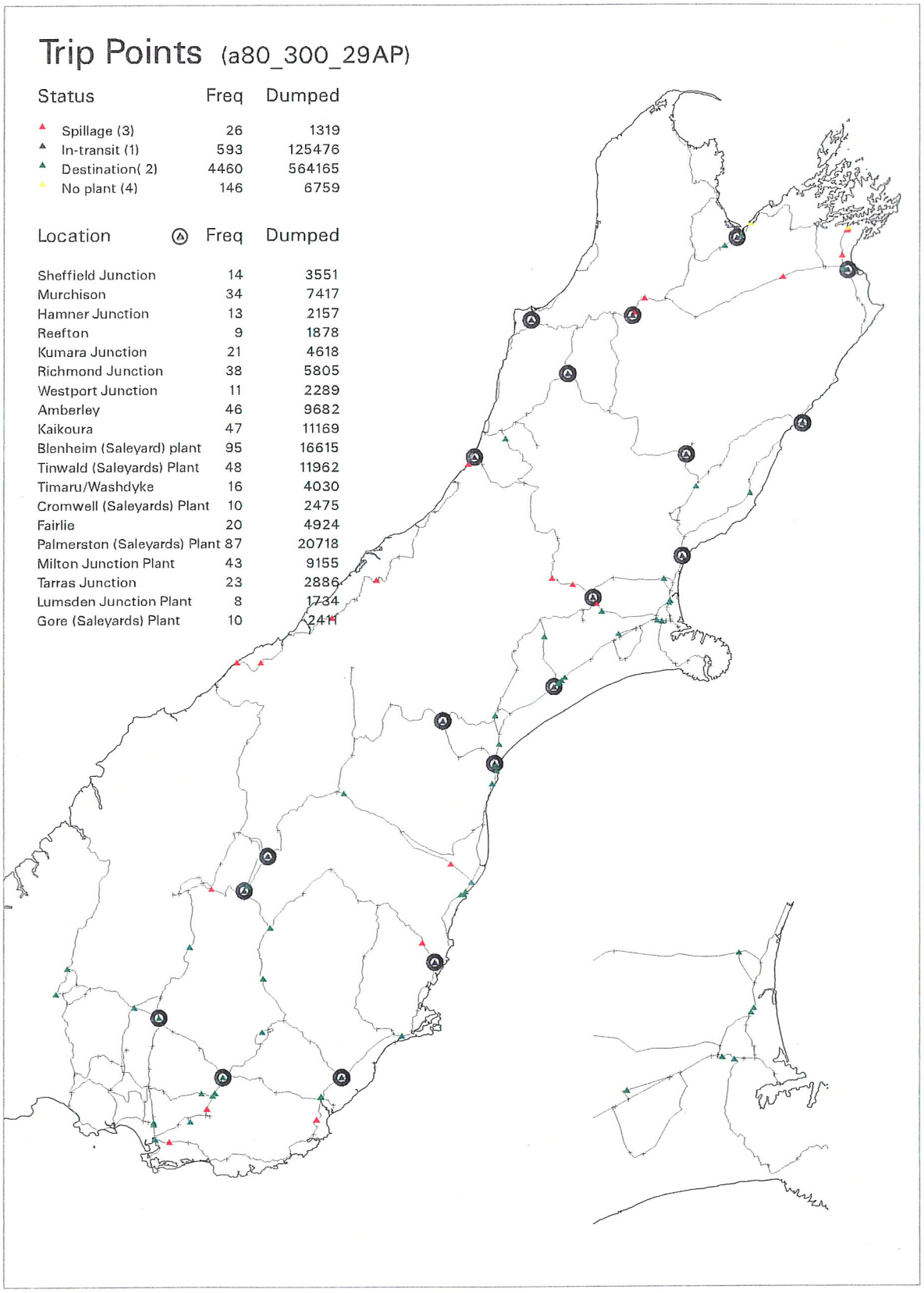
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	CMP SEAFIELD (ASHB)	189	23,522
2	Murchison	22	4,985
3	CMP BLENHEIM	82	14,150
4	Hamner Junction	13	2,113
5	PPCS BELFAST	121	16,021
6	PHOENIX MEAT (KOKIRI	59	8,655
7	Reefton	12	2,540
8	SALEYARD BRIGHTWATER	32	4,031
9	SALEYARD CH-CH	99	9,402
10	ABATTOIR ASHBURTON	62	6,653
11	PPCS MARLBOROUGH	127	12,990
12	RICHMOND (NELS. BAYS	96	12,228
13	ALLIANCE PUKEURI	317	36,991
14	Kumara Junction	5	1,387
15	CULVERDEN	11	2,045
16	DARFIELD	6	876
17	Tinwald (Saleyards) Plant	34	8,637
18	GERALDINE	9	1,480
19	PICTON PORT	121	4,344
20	Westport Junction	3	657
21	SALEYARD BLENHEIM	32	3,688
22	Richmond Junction	34	3,849
23	NELSON PORT	25	394
24	ASHBURTON TOWNSHIP	10	1,882
25	Spillage	19	1,080
26	BALCLUTHA TOWNSHIP	1	310
27	METHVEN	11	2,172
28	Blenheim (Saleyard) plant	93	14,213
29	Kaikoura	24	5,398
30	PPCS CANTERBURY	170	14,896
31	OAMARU	2	355
32	Amberley	22	4,629
33	SALEYARD TINWALD	61	5,368
34	ALLIANCE SOCKBURN	136	9,846
35	ABATTOIR MALVERN	89	7,840
36	PPCS FAIRTON (ASHB)	226	25,209
37	ALLIANCE SMITHFIELD	231	18,266
38	ALLIANCE LORNEVILLE	428	29,068
39	ALLIANCE MAKAREWA	154	8,455
40	ALLIANCE MATAURA	198	14,249
41	PPCS PAREORA	410	49,123
42	CHEVIOT	3	470
43	Timaru/Washdyke	10	2,603
44	SALEYARD TEMUKA	64	5,374
45	ABCO MEATS (OAMARU)	97	11,219
46	SALEYARD OMARAMA	8	696
47	BAY CITY MEATS	52	5,745
48	PPCS FINEGAND	290	30,046
49	SALEYARD OAMARU	49	4,922
50	Fairlie	8	2,008
51	SALEYARD PALMERSTON	43	4,394
52	Palmerston (Saleyards) Plant	38	8,750
53	Milton Junction Plant	24	4,873
54	SALEYARD BALCLUTHA	29	2,415
55	BLUE SKY MEATS (MM)	118	10,189
56	Cromwell (Saleyards) Plant	4	1,058
57	PPCS WAITANE (Gore)	58	5,092
58	HARTLAND PRIME MEAT	12	1,077
59	PRIME RANGE MEATS	102	7,470
60	Tarras Junction	16	2,453
61	SALEYARD CROMWELL	6	412
62	Lumsden Junction Plant	3	618
63	SALEYARD GORE	63	5,638
64	RANGIORA	1	203
65	ALEXANDRA	1	94
66	SALEYARD LORNEVILLE	74	5,994
67	ROXBURGH	2	155
68	DUNEDIN	2	106
69	Gore (Saleyards) Plant	9	2,015
70	TE ANAU	4	502
71	MOSSBURN	5	763
72	MATAURA	2	294
73	KINGSTON	1	279
74	HERIOT	1	140
75	MANAPOURI	2	198
76	LUMSDEN JUNCTION	2	268
		4,999	**522,530**

Annual running costs (based on operational & capital costs)

300 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	3.85	40	154	0.7	10	$1,078		$11,172		$12,250
Blenheim in-transit	1	14.21	40	569	0.7	1.5	$597			$8,967	$9,564
Blenheim Riverlands		3.69	40	148	0.7	1.5	$155				$155
Kaikoura	1	5.40	40	216	0.7	10	$1,511		$11,172		$12,684
Westport Junction	1	0.66	40	26	0.7	10	$184	$13,818			$14,002
Murchison	1	4.99	40	199	0.7	3	$419			$8,967	$9,386
Reefton	1	2.54	40	102	0.7	4	$284		$11,172		$11,457
Hamner Junction	1	2.11	40	85	0.7	10	$592	$13,818			$14,410
Kumara Junction	1	1.39	40	55	0.7	18	$699	$13,818			$14,517
Hokitika			40	0	0.7	5	$0				$0
Amberley	1	4.63	40	185	0.7	5	$648		$11,172		$11,820
Sheffield Junction			40	0	0.7	14	$0				$0
Hornby South			40	0	0.7	10	$0				$0
Tinwald in-transit	1	8.64	40	345	0.7	6	$1,451		$11,172		$12,623
Tinwald saleyard		5.37	40	215	0.7	6	$902				$902
Fairlie	1	2.01	40	80	0.7	5	$281		$11,172		$11,453
Timaru/Washdyke	1	2.60	40	104	0.7	3	$219		$11,172		$11,391
Palmerston in-transit	1	8.75	40	350	0.7	5	$1,225	$13,818			$15,043
Palmerston saleyard		4.39	40	176	0.7	5	$615				$615
Terras Junction	1	2.45	40	98	0.7	25	$1,717	$13,818			$15,535
Cromwell in-transit	1	1.58	40	63	0.7	5	$221		$11,172		$11,393
Cromwell saleyard		0.41	12	5	0.7	5	$17				$17
Dunedin Fairfield			40	0	0.7		$0				$0
Milton Junction	1	4.87	40	195	0.7	3	$409	$13,818			$14,228
Lumsden in-transit	1	0.62	40	25	0.7	5	$87		$11,172		$11,259
Gore in-transit	1	2.02	40	81	0.7	5	$282		$11,172		$11,454
Gore saleyard		5.64	40	226	0.7	5	$789				$789
SUM	18	92.81		3,701			$14,383	$82,909	$111,722	$17,934	$226,948
								$212,566			

a80_300_29AP (80% 'not stood' 300 litre tanks AP open)



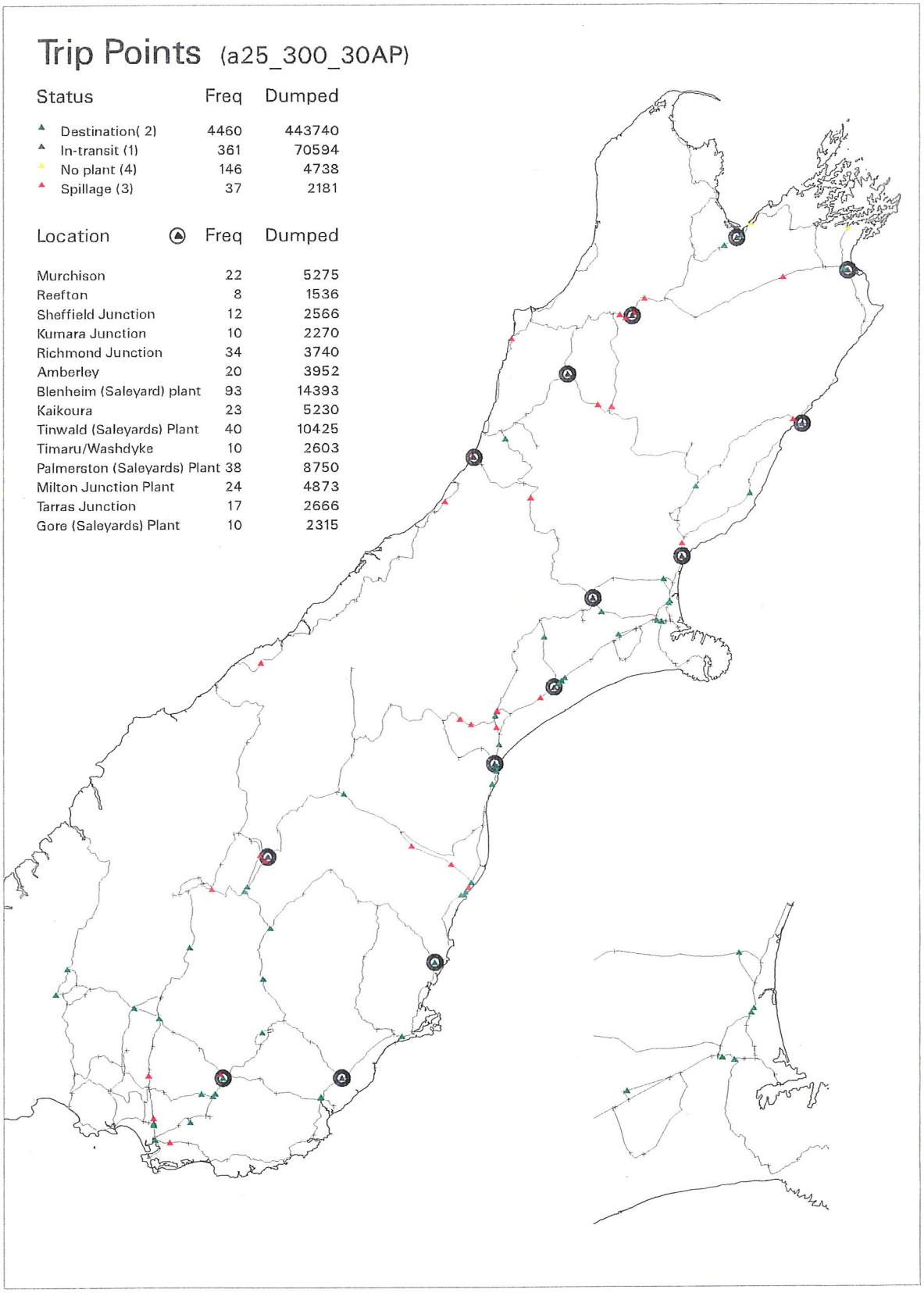
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	Spillage	26	1,319
2	Sheffield Junction	14	3,551
3	CMP SEAFIELD (ASHB)	189	26,501
4	Murchison	34	7,417
5	CMP BLENHEIM	82	14,122
6	Hamner Junction	13	2,157
7	PPCS BELFAST	121	18,398
8	PHOENIX MEAT (KOKIRI	59	10,319
9	Reefton	9	1,878
10	SALEYARD BRIGHTWATER	32	4,961
11	SALEYARD CH-CH	99	12,313
12	Kumara Junction	21	4,618
13	ABATTOIR ASHBURTON	62	8,014
14	PPCS MARLBOROUGH	127	16,055
15	Richmond Junction	38	5,805
16	RICHMOND (NELS. BAYS	96	15,333
17	ALLIANCE PUKEURI	317	45,955
18	CULVERDEN	11	2,198
19	DARFIELD	6	1,053
20	GERALDINE	9	1,623
21	PICTON PORT	121	6,264
22	Westport Junction	11	2,289
23	SALEYARD BLENHEIM	32	4,191
24	NELSON PORT	25	495
25	ASHBURTON TOWNSHIP	10	2,187
26	BALCLUTHA TOWNSHIP	1	310
27	METHVEN	11	2,378
28	Amberley	46	9,682
29	Kaikoura	47	11,169
30	Blenheim (Saleyard) plant	95	16,615
31	PPCS CANTERBURY	170	20,446
32	OAMARU	2	494
33	SALEYARD TINWALD	61	7,464
34	ALLIANCE SOCKBURN	136	13,361
35	ABATTOIR MALVERN	89	10,637
36	PPCS FAIRTON (ASHB)	226	31,939
37	Tinwald (Saleyards) Plant	48	11,962
38	ALLIANCE SMITHFIELD	231	26,469
39	ALLIANCE LORNEVILLE	428	38,719
40	ALLIANCE MAKAREWA	154	11,524
41	ALLIANCE MATAURA	198	19,153
42	PPCS PAREORA	410	62,115
43	Timaru/Washdyke	16	4,030
44	CHEVIOT	3	652
45	SALEYARD TEMUKA	64	7,467
46	ABCO MEATS (OAMARU)	97	14,232
47	SALEYARD OMARAMA	8	1,008
48	BAY CITY MEATS	52	6,816
49	Cromwell (Saleyards) Plant	10	2,475
50	PPCS FINEGAND	290	38,499
51	Fairlie	20	4,924
52	SALEYARD OAMARU	49	6,515
53	SALEYARD PALMERSTON	43	6,135
54	Palmerston (Saleyards) Plant	87	20,718
55	Milton Junction Plant	43	9,155
56	SALEYARD BALCLUTHA	29	3,273
57	BLUE SKY MEATS (MM)	118	12,441
58	WAITANE VILLAGE	58	6,332
59	HARTLAND PRIME MEAT	12	1,471
60	PRIME RANGE MEATS	102	9,681
61	Tarras Junction	23	2,886
62	SALEYARD CROMWELL	6	612
63	Lumsden Junction Plant	8	1,734
64	SALEYARD GORE	63	8,061
65	RANGIORA	1	279
66	ALEXANDRA	1	168
67	SALEYARD LORNEVILLE	74	8,234
68	ROXBURGH	2	187
69	DUNEDIN	2	196
70	Gore (Saleyards) Plant	10	2,411
71	TE ANAU	4	776
72	MOSSBURN	5	1,111
73	MATAURA	2	482
74	KINGSTON	1	279
75	HERIOT	1	290
76	MANAPOURI	2	380
77	LUMSDEN JUNCTION	2	356
		5,225	**697,719**

Annual running costs (based on operational & capital costs)

300 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
80%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	5.81	40	232	0.7	10	$1,625		$11,172		$12,798
Blenheim In-transit	1	16.62	40	665	0.7	1.5	$698			$8,967	$9,665
Blenheim Riverlands		4.19	40	168	0.7	1.5	$176				$176
Kaikoura	1	11.17	40	447	0.7	10	$3,127		$11,172		$14,300
Westport Junction	1	2.29	40	92	0.7	10	$641	$13,818			$14,459
Murchison	1	7.42	40	297	0.7	3	$623			$8,967	$9,590
Reefton	1	1.88	40	75	0.7	4	$210		$11,172		$11,383
Hanmer Junction	1	2.16	40	86	0.7	10	$604	$13,818			$14,422
Kumara Junction	1	4.62	40	185	0.7	18	$2,327	$13,818			$16,146
Amberley	1	9.68	40	387	0.7	5	$1,355		$11,172		$12,528
Sheffield Junction	1	3.55	40	142	0.7	14	$1,392		$11,172		$12,564
Tinwald In-transit	1	11.96	40	478	0.7	6	$2,010		$11,172		$13,182
Tinwald saleyard		7.46	40	299	0.7	6	$1,254				$1,254
Fairlie	1	4.92	40	197	0.7	5	$689		$11,172		$11,862
Timaru/Washdyke	1	4.03	40	161	0.7	3	$339		$11,172		$11,511
Palmerston In-transit	1	20.72	40	829	0.7	5	$2,901	$13,818			$16,719
Palmerston saleyard		6.14	40	245	0.7	5	$859				$859
Tarras Junction	1	2.89	40	115	0.7	25	$2,020	$13,818			$15,838
Cromwell In-transit	1	2.48	40	99	0.7	5	$347		$11,172		$11,519
Cromwell saleyard		0.61	12	7	0.7	5	$26				$26
Milton Junction	1	9.16	40	366	0.7	3	$769	$13,818			$14,587
Lumsden In-transit	1	1.73	40	69	0.7	5	$243		$11,172		$11,415
Gore In-transit	1	2.41	40	96	0.7	5	$338		$11,172		$11,510
Gore saleyard		8.06	40	322	0.7	5	$1,129				$1,129
SUM	19	151.94		6,060			$25,701	$82,909	$122,894	$17,934	$249,439
								$223,738			

a25_300_30AP (25% 'not stood' 300 litre tanks AP open)



Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	CMP SEAFIELD (ASHB)	189	23,481
2	Murchison	22	5,275
3	CMP BLENHEIM	82	14,150
4	Reefton	8	1,536
5	PPCS BELFAST	121	15,603
6	PHOENIX MEAT (KOKIRI	59	9,202
7	SALEYARD BRIGHTWATER	32	4,031
8	SALEYARD CH-CH	99	9,147
9	Sheffield Junction	12	2,566
10	ABATTOIR ASHBURTON	62	6,479
11	PPCS MARLBOROUGH	127	12,990
12	Kumara Junction	10	2,270
13	RICHMOND (NELS. BAYS	96	12,447
14	ALLIANCE PUKEURI	317	36,974
15	CULVERDEN	11	2,045
16	DARFIELD	6	687
17	GERALDINE	9	1,528
18	PICTON PORT	121	4,344
19	Spillage	37	2,181
20	SALEYARD BLENHEIM	32	3,688
21	Richmond Junction	34	3,740
22	NELSON PORT	25	394
23	ASHBURTON TOWNSHIP	10	1,875
24	Amberley	20	3,952
25	BALCLUTHA TOWNSHIP	1	310
26	METHVEN	11	2,172
27	Blenheim (Saleyard) plant	93	14,393
28	Kaikoura	23	5,230
29	PPCS CANTERBURY	170	14,896
30	OAMARU	2	355
31	SALEYARD TINWALD	61	5,275
32	ALLIANCE SOCKBURN	136	9,846
33	ABATTOIR MALVERN	89	7,731
34	PPCS FAIRTON (ASHB)	226	25,209
35	Tinwald (Saleyards) Plant	40	10,425
36	ALLIANCE SMITHFIELD	231	18,266
37	ALLIANCE LORNEVILLE	428	29,462
38	ALLIANCE MAKAREWA	154	8,455
39	ALLIANCE MATAURA	198	14,249
40	PPCS PAREORA	410	49,123
41	CHEVIOT	3	470
42	Timaru/Washdyke	10	2,603
43	SALEYARD TEMUKA	64	5,374
44	ABCO MEATS (OAMARU)	97	11,219
45	SALEYARD OMARAMA	8	696
46	BAY CITY MEATS	52	5,745
47	PPCS FINEGAND	290	30,046
48	SALEYARD OAMARU	49	4,922
49	SALEYARD PALMERSTON	43	4,394
50	Palmerston (Saleyards) Plant	38	8,750
51	Milton Junction Plant	24	4,873
52	SALEYARD BALCLUTHA	29	2,415
53	BLUE SKY MEATS (MM)	118	10,062
54	Tarras Junction	17	2,666
55	WAITANE VILLAGE	58	5,128
56	HARTLAND PRIME MEAT	12	1,077
57	PRIME RANGE MEATS	102	7,470
58	SALEYARD CROMWELL	6	412
59	SALEYARD GORE	63	5,638
60	RANGIORA	1	203
61	ALEXANDRA	1	94
62	SALEYARD LORNEVILLE	74	5,994
63	ROXBURGH	2	155
64	DUNEDIN	2	106
65	Gore (Saleyards) Plant	10	2,315
66	TE ANAU	4	502
67	MOSSBURN	5	763
68	MATAURA	2	294
69	KINGSTON	1	279
70	HERIOT	1	140
71	MANAPOURI	2	198
72	LUMSDEN JUNCTION	2	268
		5,004	**521,253**

Annual running costs (based on operational & capital costs)

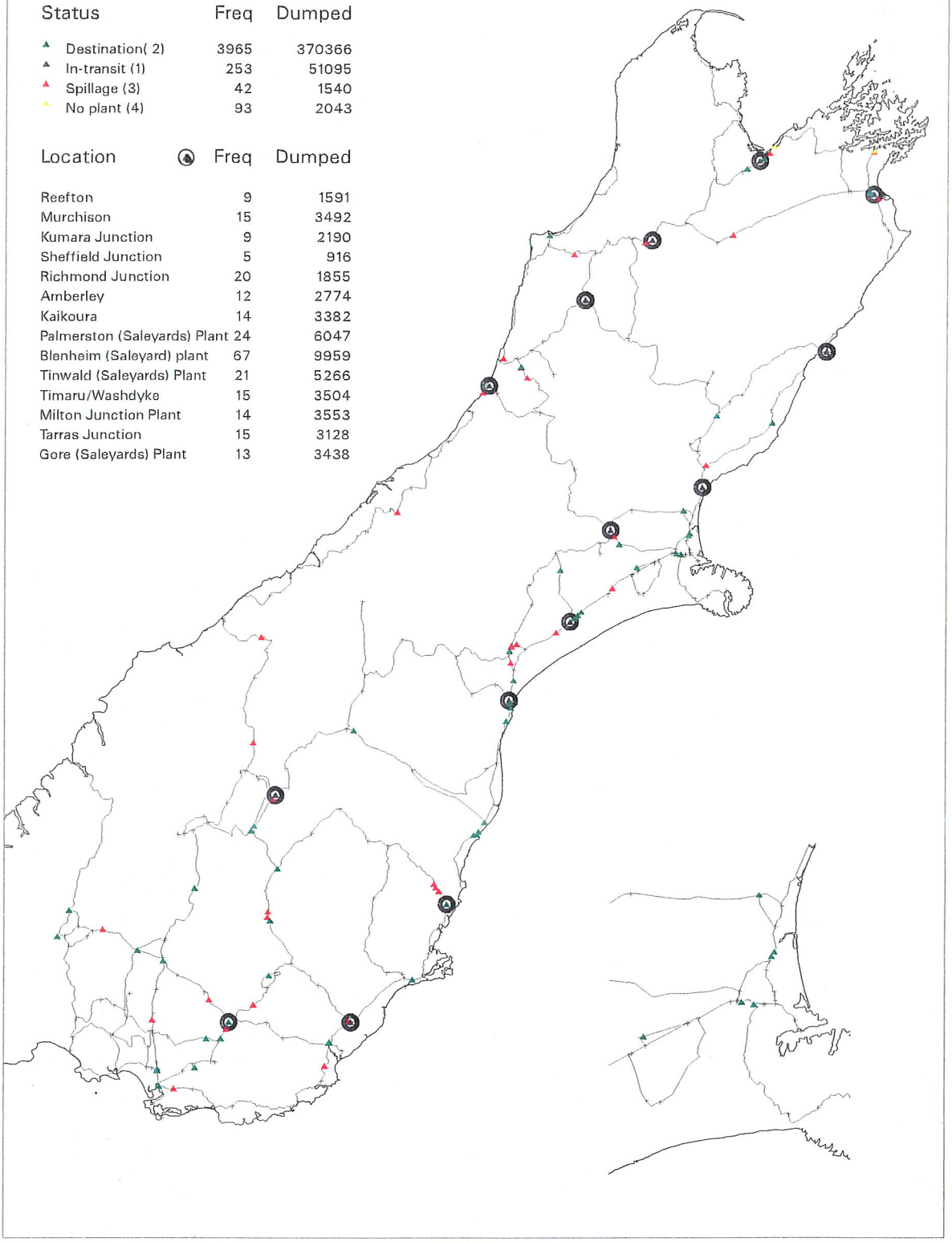
300 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs		B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a					
running costs									$13,818	$11,172	$8,967	
Richmond Junction	1	3.74	40	150	0.7	10	$1,047			$11,172		$12,219
Blenheim In-transit	1	14.39	40	576	0.7	1.5	$605				$8,967	$9,572
Blenheim Riverlands		3.69	40	148	0.7	1.5	$155					$155
Kaikoura	1	5.23	40	209	0.7	10	$1,464			$11,172		$12,637
Westport Junction												
Murchison	1	5.28	40	211	0.7	3	$443				$8,967	$9,410
Reefton	1	1.54	40	61	0.7	4	$172			$11,172		$11,344
Hamner Junction												
Kumara Junction	1	2.27	40	91	0.7	18	$1,144		$13,818			$14,962
Amberley	1	3.95	40	158	0.7	5	$553			$11,172		$11,725
Sheffield Junction	1	2.57	40	103	0.7	14	$1,006			$11,172		$12,178
Tinwald In-transit	1	10.43	40	417	0.7	6	$1,751			$11,172		$12,924
Tinwald saleyard		5.28	40	211	0.7	6	$886					$886
Fairlie												
Timaru/Washdyke	1	2.60	40	104	0.7	3	$219			$11,172		$11,391
Palmerston In-transit	1	8.75	40	350	0.7	5	$1,225		$13,818			$15,043
Palmerston saleyard		4.39	40	176	0.7	5	$615					$615
Tarras Junction	1	2.67	40	107	0.7	25	$1,866		$13,818			$15,684
Cromwell In-transit												
Cromwell saleyard												
Milton Junction	1	4.87	40	195	0.7	3	$409		$13,818			$14,228
Lumsden In-transit												
Gore In-transit	1	2.32	40	93	0.7	5	$324			$11,172		$11,496
Gore saleyard		5.64	40	226	0.7	5	$789					$789
SUM	14	89.59		3,584			$14,675		$55,273	$89,378	$17,934	$177,260
									$162,585			

s25_300_30AP (25% 'not stood' 300 litre tanks AP open)

Trip Points (s25_300_30AP)

Status	Freq	Dumped
Destination(2)	3965	370366
In-transit (1)	253	51095
Spillage (3)	42	1540
No plant (4)	93	2043

Location	Freq	Dumped
Reefton	9	1591
Murchison	15	3492
Kumara Junction	9	2190
Sheffield Junction	5	916
Richmond Junction	20	1855
Amberley	12	2774
Kaikoura	14	3382
Palmerston (Saleyards) Plant	24	6047
Blenheim (Saleyard) plant	67	9959
Tinwald (Saleyards) Plant	21	5266
Timaru/Washdyke	15	3504
Milton Junction Plant	14	3553
Tarras Junction	15	3128
Gore (Saleyards) Plant	13	3438



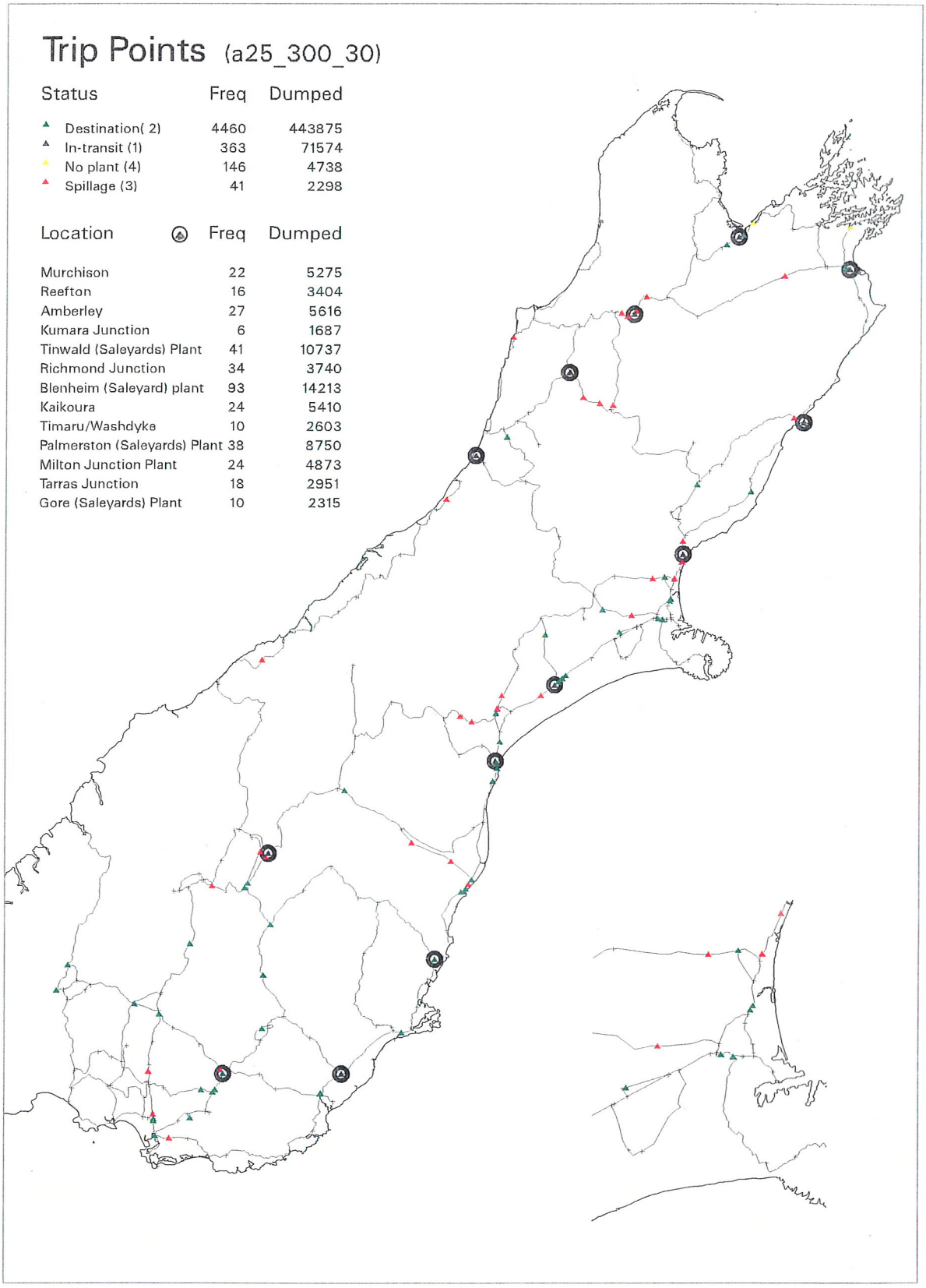
Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	PHOENIX MEAT (KOKIRI	55	8,160
2	Reefton	9	1,591
3	Murchison	15	3,492
4	SALEYARD BRIGHTWATER	32	3,491
5	Kumara Junction	9	2,190
6	Sheffield Junction	5	916
7	ABATTOIR ASHBURTON	52	5,969
8	PPCS FAIRTON (ASHB)	135	11,460
9	PPCS BELFAST	77	9,956
10	Spillage	42	1,540
11	RICHMOND (NELS. BAYS	71	9,158
12	ALLIANCE PUKEURI	247	28,070
13	SALEYARD CH-CH	93	8,753
14	CMP BLENHEIM	66	9,838
15	PPCS MARLBOROUGH	94	7,541
16	SALEYARD BLENHEIM	28	2,831
17	Richmond Junction	20	1,855
18	NELSON PORT	15	184
19	PICTON PORT	78	1,859
20	Amberley	12	2,774
21	CMP SEAFIELD (ASHB)	163	20,040
22	ASHBURTON TOWNSHIP	5	964
23	Kaikoura	14	3,382
24	Palmerston (Saleyards) Plant	24	6,047
25	BALCLUTHA TOWNSHIP	1	30
26	WESTPORT	1	150
27	PPCS CANTERBURY	97	8,024
28	Blenheim (Saleyard) plant	67	9,959
29	SALEYARD TINWALD	72	5,918
30	ALLIANCE SMITHFIELD	185	12,875
31	CULVERDEN	8	1,327
32	PPCS PAREORA	212	17,987
33	OAMARU	1	133
34	ALLIANCE SOCKBURN	70	4,792
35	ABATTOIR MALVERN	68	5,713
36	CHEVIOT	5	692
37	ALLIANCE MATAURA	222	17,823
38	Tinwald (Saleyards) Plant	21	5,266
39	Timaru/Washdyke	15	3,504
40	SALEYARD TEMUKA	61	4,578
41	PPCS FINEGAND	335	36,132
42	ALLIANCE LORNEVILLE	522	42,342
43	ALLIANCE MAKAREWA	263	19,016
44	ABCO MEATS (OAMARU)	94	9,203
45	BAY CITY MEATS	39	4,378
46	Milton Junction Plant	14	3,553
47	SALEYARD OMARAMA	16	1,185
48	SALEYARD OAMARU	40	4,296
49	Tarras Junction	15	3,128
50	SALEYARD PALMERSTON	45	4,236
51	WAITANE VILLAGE	67	4,966
52	SALEYARD BALCLUTHA	26	2,475
53	BLUE SKY MEATS (MM)	99	7,153
54	Gore (Saleyards) Plant	13	3,438
55	SALEYARD CROMWELL	8	512
56	HARTLAND PRIME MEAT	18	1,301
57	PRIME RANGE MEATS	93	7,121
58	SALEYARD GORE	63	6,404
59	SALEYARD LORNEVILLE	80	7,639
60	DARFIELD	2	253
61	GERALDINE	3	568
62	METHVEN	9	1,528
63	RANGIORA	2	196
64	ALEXANDRA	1	168
65	ROXBURGH	2	155
66	DUNEDIN	2	106
67	TE ANAU	4	982
68	MOSSBURN	5	704
69	KINGSTON	1	135
70	HERIOT	1	290
71	MANAPOURI	2	381
72	LUMSDEN JUNCTION	2	268
		4,353	**425,044**

Annual running costs (based on operational & capital costs)

300 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	1.86	40	74	0.7	10	$519		$11,172		$11,692
Blenheim in-transit	1	9.96	40	398	0.7	1.5	$418			$8,967	$9,385
Blenheim Riverlands		2.83	40	113	0.7	1.5	$119				$119
Kaikoura	1	3.38	40	135	0.7	10	$947		$11,172		$12,119
Westport Junction											
Murchison	1	3.49	40	140	0.7	3	$293			$8,967	$9,261
Reefton	1	1.59	40	64	0.7	4	$178		$11,172		$11,350
Hanmer Junction											
Kumara Junction	1	2.19	40	88	0.7	18	$1,104	$13,818			$14,922
Amberley	1	2.77	40	111	0.7	5	$388		$11,172		$11,561
Sheffield Junction	1	0.92	40	37	0.7	14	$359		$11,172		$11,531
Tinwald in-transit	1	5.27	40	211	0.7	6	$885		$11,172		$12,057
Tinwald saleyard		5.92	40	237	0.7	6	$994				$994
Fairlie											
Timaru/Washdyke	1	3.50	40	140	0.7	3	$294		$11,172		$11,467
Palmerston in-transit	1	6.05	40	242	0.7	5	$847	$13,818			$14,665
Palmerston saleyard		4.24	40	169	0.7	5	$593				$593
Tarras Junction	1	3.13	40	125	0.7	25	$2,190	$13,818			$16,008
Cromwell in-transit											
Cromwell saleyard											
Milton Junction	1	3.55	40	142	0.7	3	$298	$13,818			$14,117
Lumsden in-transit											
Gore in-transit	1	3.44	40	138	0.7	5	$481		$11,172		$11,654
Gore saleyard		6.40	40	256	0.7	5	$897				$897
SUM	14	70.48		2,819			$11,805	$55,273	$89,378	$17,934	$174,390
								$162,585			

a25_300_30 (25% 'not stood' 300 litre tanks AP *not* open)



Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	CMP SEAFIELD (ASHB)	189	23,522
2	Murchison	22	5,275
3	CMP BLENHEIM	82	14,150
4	Reefton	16	3,404
5	PPCS BELFAST	121	16,014
6	PHOENIX MEAT (KOKIRI	59	8,500
7	SALEYARD BRIGHTWATER	32	4,031
8	SALEYARD CH-CH	99	9,179
9	Amberley	27	5,616
10	ABATTOIR ASHBURTON	62	6,494
11	PPCS MARLBOROUGH	127	12,990
12	RICHMOND (NELS. BAYS	96	12,447
13	ALLIANCE PUKEURI	317	36,991
14	Kumara Junction	6	1,687
15	CULVERDEN	11	2,045
16	DARFIELD	6	1,049
17	Tinwald (Saleyards) Plant	41	10,737
18	GERALDINE	9	1,480
19	PICTON PORT	121	4,344
20	Spillage	41	2,298
21	SALEYARD BLENHEIM	32	3,688
22	Richmond Junction	34	3,740
23	NELSON PORT	25	394
24	ASHBURTON TOWNSHIP	10	1,882
25	BALCLUTHA TOWNSHIP	1	310
26	METHVEN	11	2,172
27	Blenheim (Saleyard) plant	93	14,213
28	Kaikoura	24	5,410
29	PPCS CANTERBURY	170	14,896
30	OAMARU	2	355
31	SALEYARD TINWALD	61	5,275
32	ALLIANCE SOCKBURN	136	9,846
33	ABATTOIR MALVERN	89	7,731
34	PPCS FAIRTON (ASHB)	226	25,209
35	ALLIANCE SMITHFIELD	231	18,266
36	ALLIANCE LORNEVILLE	428	29,462
37	ALLIANCE MAKAREWA	154	8,455
38	ALLIANCE MATAURA	198	14,249
39	PPCS PAREORA	410	49,123
40	CHEVIOT	3	470
41	Timaru/Washdyke	10	2,603
42	SALEYARD TEMUKA	64	5,374
43	ABCO MEATS (OAMARU)	97	11,219
44	SALEYARD OMARAMA	8	696
45	BAY CITY MEATS	52	5,745
46	PPCS FINEGAND	290	30,046
47	SALEYARD OAMARU	49	4,922
48	SALEYARD PALMERSTON	43	4,394
49	Palmerston (Saleyards) Plant	38	8,750
50	Milton Junction Plant	24	4,873
51	SALEYARD BALCLUTHA	29	2,415
52	BLUE SKY MEATS (MM)	118	10,062
53	Tarras Junction	18	2,951
54	PPCS WAITANE (Gore)	58	5,128
55	HARTLAND PRIME MEAT	12	1,077
56	PRIME RANGE MEATS	102	7,470
57	SALEYARD CROMWELL	6	412
58	SALEYARD GORE	63	5,638
59	RANGIORA	1	203
60	ALEXANDRA	1	94
61	SALEYARD LORNEVILLE	74	5,994
62	ROXBURGH	2	155
63	DUNEDIN	2	106
64	Gore (Saleyards) Plant	10	2,315
65	TE ANAU	4	502
66	MOSSBURN	5	763
67	MATAURA	2	294
68	KINGSTON	1	279
69	HERIOT	1	140
70	MANAPOURI	2	198
71	LUMSDEN JUNCTION	2	268
		5,010	**522,485**

Annual running costs (based on operational & capital costs)

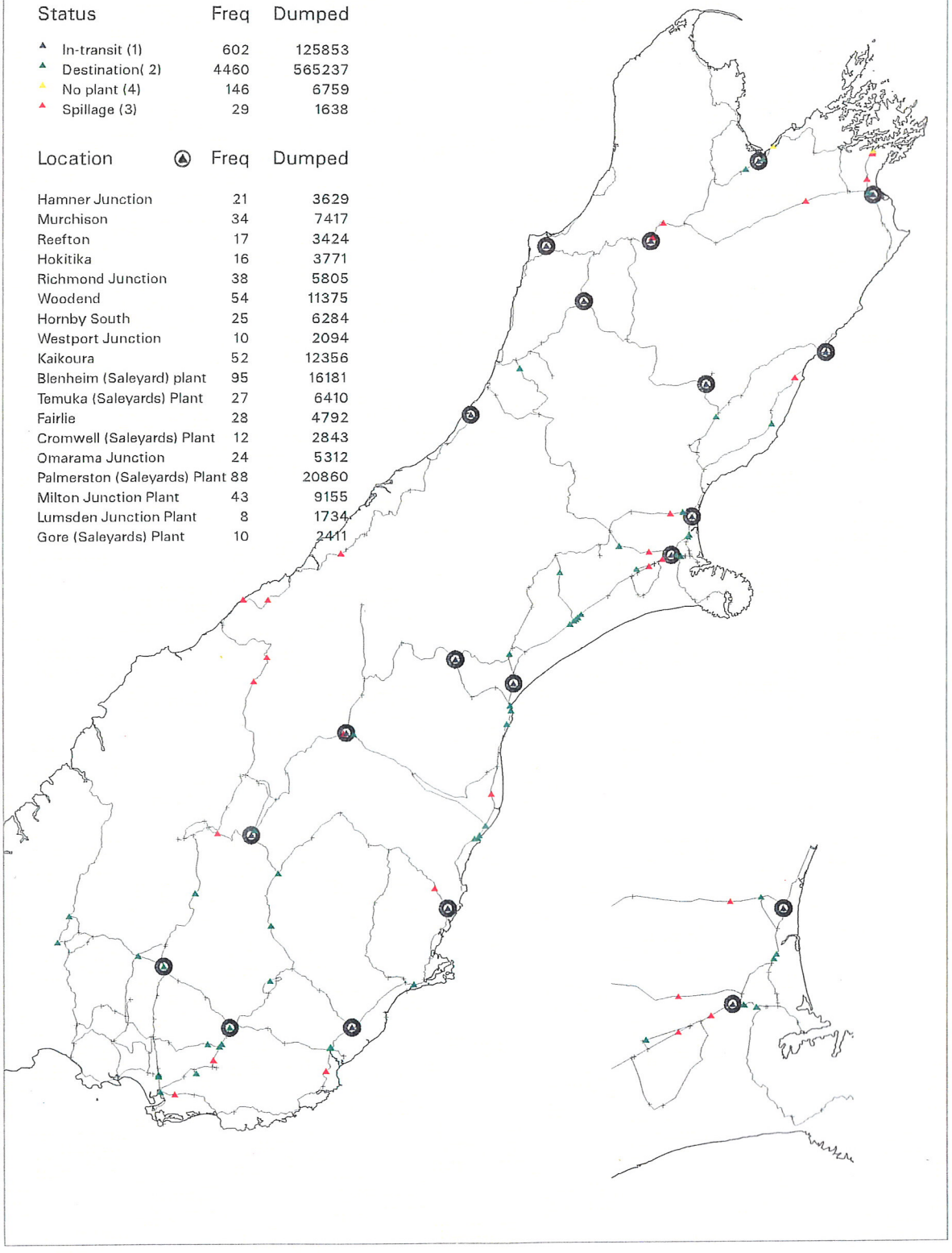
300 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	3.74	40	150	0.7	10	$1,047		$11,172		$12,219
Blenheim In-transit	1	14.21	40	569	0.7	1.5	$597			$8,967	$9,564
Blenheim Riverlands		3.69	40	148	0.7	1.5	$155				$155
Kaikoura	1	5.41	40	216	0.7	10	$1,515		$11,172		$12,687
Westport Junction											
Murchison	1	5.28	40	211	0.7	3	$443			$8,967	$9,410
Reefton	1	3.40	40	136	0.7	4	$381		$11,172		$11,553
Hamner Junction											
Kumara Junction	1	1.69	40	67	0.7	18	$850	$13,818			$14,668
Amberley	1	5.62	40	225	0.7	5	$786		$11,172		$11,958
Sheffield Junction											
Tinwald In-transit	1	10.74	40	429	0.7	6	$1,804		$11,172		$12,976
Tinwald saleyard		5.28	40	211	0.7	6	$886				$886
Fairlie											
Timaru/Washdyke	1	2.60	40	104	0.7	3	$219		$11,172		$11,391
Palmerston In-transit	1	8.75	40	350	0.7	5	$1,225	$13,818			$15,043
Palmerston saleyard		4.39	40	176	0.7	5	$615				$615
Tarras Junction	1	2.95	40	118	0.7	25	$2,066	$13,818			$15,884
Cromwell In-transit											
Cromwell saleyard											
Milton Junction	1	4.87	40	195	0.7	3	$409	$13,818			$14,228
Lumsden In-transit											
Gore In-transit	1	2.32	40	93	0.7	5	$324		$11,172		$11,496
Gore saleyard		5.64	40	226	0.7	5	$789				$789
SUM	13	90.57		3,623			$14,112	$55,273	$78,205	$17,934	$165,525
								$151,413			

a80_300_11 (80% 'not stood' 300 litre tanks AP *not* open)

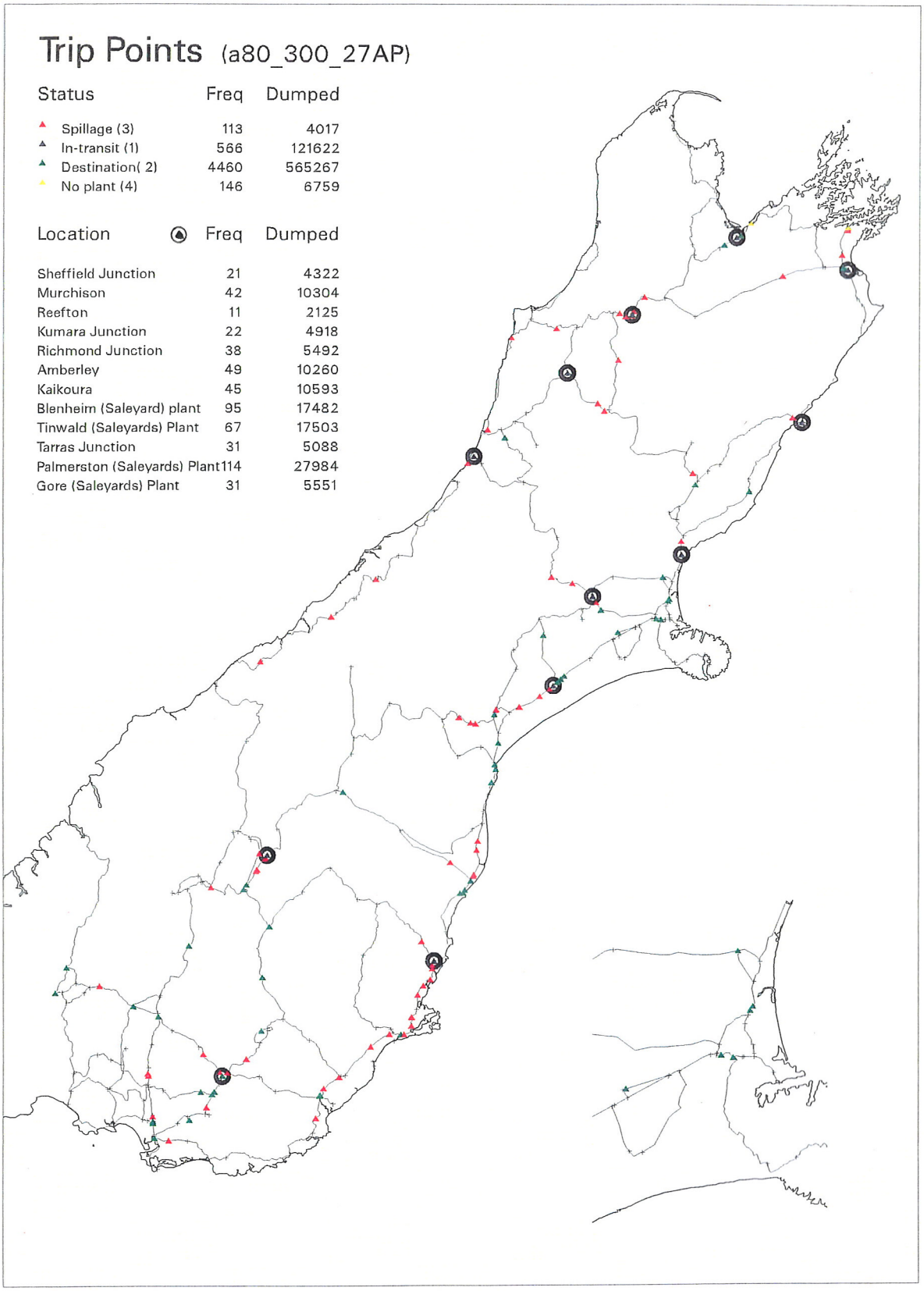
Trip Points (a80_300_11)

Status	Freq	Dumped
In-transit (1)	602	125853
Destination(2)	4460	565237
No plant (4)	146	6759
Spillage (3)	29	1638

Location	Freq	Dumped
Hamner Junction	21	3629
Murchison	34	7417
Reefton	17	3424
Hokitika	16	3771
Richmond Junction	38	5805
Woodend	54	11375
Hornby South	25	6284
Westport Junction	10	2094
Kaikoura	52	12356
Blenheim (Saleyard) plant	95	16181
Temuka (Saleyards) Plant	27	6410
Fairlie	28	4792
Cromwell (Saleyards) Plant	12	2843
Omarama Junction	24	5312
Palmerston (Saleyards) Plant	88	20860
Milton Junction Plant	43	9155
Lumsden Junction Plant	8	1734
Gore (Saleyards) Plant	10	2411



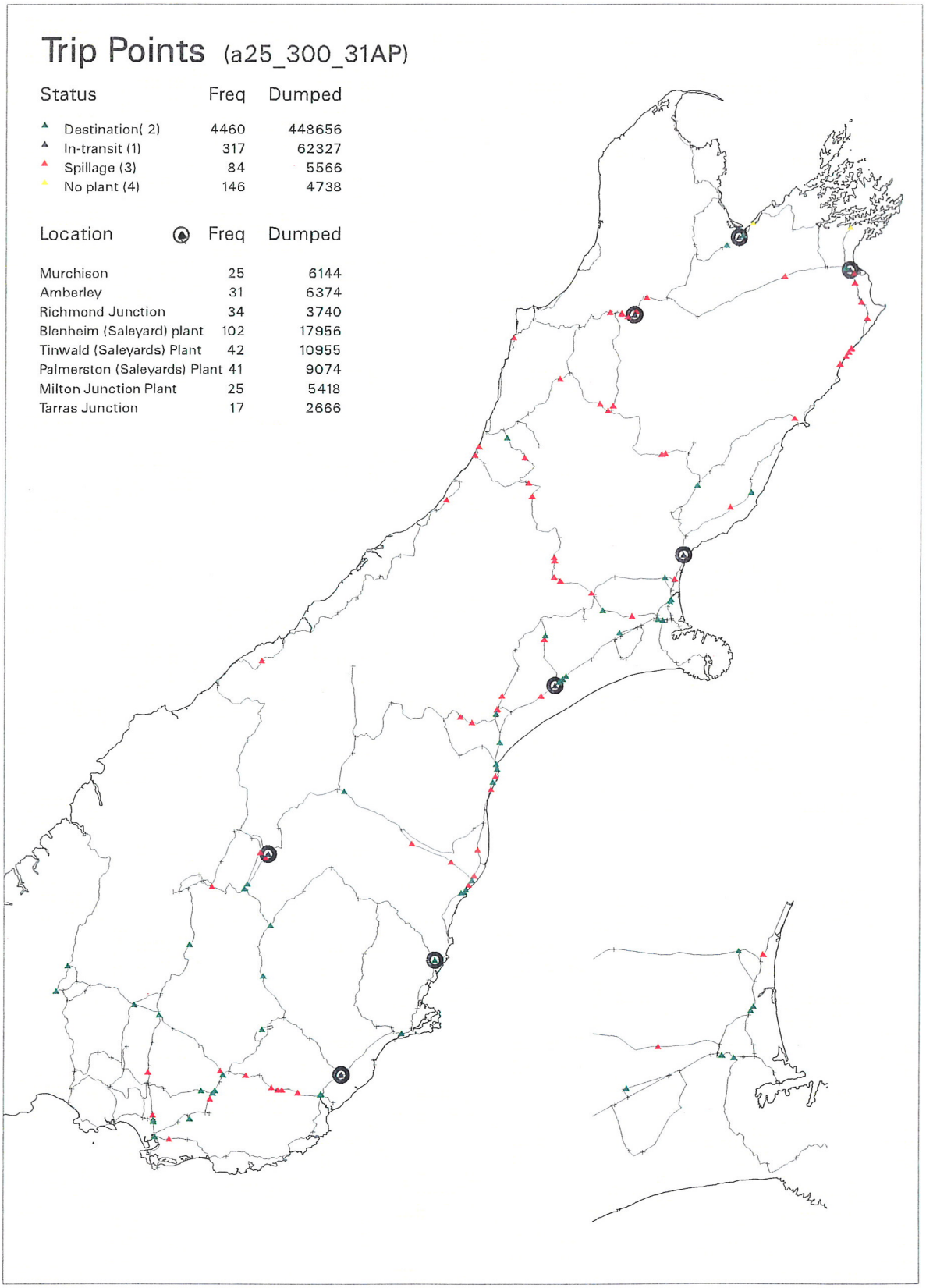
a80_300_27AP (25% 'not stood' 300 litre tanks AP open)



Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	Spillage	113	4,017
2	Sheffield Junction	21	4,322
3	CMP SEAFIELD (ASHB)	189	25,783
4	Murchison	42	10,304
5	CMP BLENHEIM	82	14,472
6	Reefton	11	2,125
7	PPCS BELFAST	121	18,026
8	PHOENIX MEAT (KOKIRI	59	10,510
9	SALEYARD BRIGHTWATER	32	4,853
10	SALEYARD CH-CH	99	11,981
11	Kumara Junction	22	4,918
12	ABATTOIR ASHBURTON	62	7,914
13	PPCS MARLBOROUGH	127	16,055
14	Richmond Junction	38	5,492
15	RICHMOND (NELS. BAYS	96	15,160
16	ALLIANCE PUKEURI	317	47,090
17	CULVERDEN	11	2,140
18	DARFIELD	6	932
19	GERALDINE	9	1,475
20	PICTON PORT	121	6,264
21	SALEYARD BLENHEIM	32	4,083
22	NELSON PORT	25	495
23	Amberley	49	10,260
24	ASHBURTON TOWNSHIP	10	2,187
25	BALCLUTHA TOWNSHIP	1	310
26	METHVEN	11	2,305
27	Kaikoura	45	10,593
28	Blenheim (Saleyard) plant	95	17,482
29	PPCS CANTERBURY	170	20,446
30	OAMARU	2	494
31	SALEYARD TINWALD	61	7,169
32	ALLIANCE SOCKBURN	136	13,361
33	ABATTOIR MALVERN	89	10,528
34	PPCS FAIRTON (ASHB)	226	31,939
35	Tinwald (Saleyards) Plant	67	17,503
36	ALLIANCE SMITHFIELD	231	26,597
37	ALLIANCE LORNEVILLE	428	39,422
38	ALLIANCE MAKAREWA	154	11,524
39	ALLIANCE MATAURA	198	19,080
40	PPCS PAREORA	410	62,714
41	CHEVIOT	3	652
42	SALEYARD TEMUKA	64	7,467
43	ABCO MEATS (OAMARU)	97	14,083
44	SALEYARD OMARAMA	8	1,008
45	BAY CITY MEATS	52	6,703
46	Tarras Junction	31	5,088
47	PPCS FINEGAND	290	38,866
48	SALEYARD OAMARU	49	6,708
49	SALEYARD PALMERSTON	43	6,135
50	Palmerston (Saleyards) Plant	114	27,984
51	SALEYARD BALCLUTHA	29	3,543
52	BLUE SKY MEATS (MM)	118	12,345
53	WAITANE VILLAGE	58	6,368
54	HARTLAND PRIME MEAT	12	1,471
55	Gore (Saleyards) Plant	31	5,551
56	PRIME RANGE MEATS	102	9,734
57	SALEYARD CROMWELL	6	612
58	SALEYARD GORE	63	8,061
59	RANGIORA	1	279
60	ALEXANDRA	1	168
61	SALEYARD LORNEVILLE	74	8,234
62	ROXBURGH	2	187
63	DUNEDIN	2	196
64	TE ANAU	4	999
65	MOSSBURN	5	1,111
66	MATAURA	2	482
67	KINGSTON	1	279
68	HERIOT	1	290
69	MANAPOURI	2	380
70	LUMSDEN JUNCTION	2	356
		5,285	**697,665**

a25_300_31AP (25% 'not stood' 300 litre tanks AP open)



Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	CMP SEAFIELD (ASHB)	189	23,780
2	Murchison	25	6,144
3	CMP BLENHEIM	82	13,909
4	Spillage	84	5,566
5	Amberley	31	6,374
6	PPCS BELFAST	121	15,779
7	PHOENIX MEAT (KOKIRI	59	11,310
8	SALEYARD BRIGHTWATER	32	3,848
9	SALEYARD CH-CH	99	8,668
10	ABATTOIR ASHBURTON	62	6,711
11	PPCS MARLBOROUGH	127	12,990
12	RICHMOND (NELS. BAYS	96	12,355
13	ALLIANCE PUKEURI	317	37,935
14	CULVERDEN	11	2,164
15	DARFIELD	6	981
16	GERALDINE	9	1,729
17	PICTON PORT	121	4,344
18	SALEYARD BLENHEIM	32	3,521
19	Richmond Junction	34	3,740
20	NELSON PORT	25	394
21	ASHBURTON TOWNSHIP	10	1,875
22	BALCLUTHA TOWNSHIP	1	310
23	METHVEN	11	2,172
24	Blenheim (Saleyard) plant	102	17,956
25	PPCS CANTERBURY	170	14,896
26	OAMARU	2	355
27	SALEYARD TINWALD	61	5,275
28	ALLIANCE SOCKBURN	136	9,846
29	ABATTOIR MALVERN	89	7,731
30	PPCS FAIRTON (ASHB)	226	25,209
31	Tinwald (Saleyards) Plant	42	10,955
32	ALLIANCE SMITHFIELD	231	18,266
33	ALLIANCE LORNEVILLE	428	29,462
34	ALLIANCE MAKAREWA	154	8,455
35	ALLIANCE MATAURA	198	14,249
36	PPCS PAREORA	410	49,123
37	CHEVIOT	3	470
38	SALEYARD TEMUKA	64	5,374
39	ABCO MEATS (OAMARU)	97	11,416
40	SALEYARD OMARAMA	8	696
41	BAY CITY MEATS	52	5,745
42	PPCS FINEGAND	290	31,048
43	SALEYARD OAMARU	49	4,922
44	SALEYARD PALMERSTON	43	4,394
45	Palmerston (Saleyards) Plant	41	9,074
46	Milton Junction Plant	25	5,418
47	SALEYARD BALCLUTHA	29	2,415
48	BLUE SKY MEATS (MM)	118	10,551
49	Tarras Junction	17	2,666
50	PPCS WAITANE (Gore)	58	5,128
51	HARTLAND PRIME MEAT	12	1,077
52	PRIME RANGE MEATS	102	7,470
53	SALEYARD CROMWELL	6	412
54	SALEYARD GORE	63	5,638
55	RANGIORA	1	203
56	ALEXANDRA	1	94
57	SALEYARD LORNEVILLE	74	5,994
58	ROXBURGH	2	155
59	DUNEDIN	2	106
60	TE ANAU	4	502
61	MOSSBURN	5	763
62	MATAURA	2	294
63	KINGSTON	1	279
64	HERIOT	1	140
65	MANAPOURI	2	198
66	LUMSDEN JUNCTION	2	268
		5,007	**521,287**

Annual running costs (based on operational & capital costs)

300 Litres	SITES	Effluent discharge per week	operating weeks per year	Effluent discharge per year	Tankering Costs per m^3 and Km	Distance dump site treatment location	Total annual tankering costs	B1	B2	B3	SUM total annual running costs
25%		[m^3/ week]		[m^3/ year]	[$/(m^3* Km)]	[km]	$/a				
running costs								$13,818	$11,172	$8,967	
Richmond Junction	1	3.74	40	150	0.7	10	$1,047		$11,172		$12,219
Blenheim In-transit	1	17.96	40	718	0.7	1.5	$754			$8,967	$9,721
Blenheim Riverlands		3.52	40	141	0.7	1.5	$148				$148
Kaikoura											
Westport Junction											
Murchison	1	6.14	40	246	0.7	3	$516			$8,967	$9,483
Reefton											
Hanmer Junction											
Kumara Junction											
Amberley	1	6.37	40	255	0.7	5	$892		$11,172		$12,065
Sheffield Junction											
Tinwald in-transit	1	10.96	40	438	0.7	6	$1,840		$11,172		$13,013
Tinwald saleyard		5.28	40	211	0.7	6	$886				$886
Fairlie											
Timaru/Washdyke											
Palmerston In-transit	1	9.07	40	363	0.7	5	$1,270	$13,818			$15,089
Palmerston saleyard		4.39	40	176	0.7	5	$615				$615
Tarras Junction	1	2.67	40	107	0.7	25	$1,866	$13,818			$15,684
Cromwell In-transit											
Cromwell saleyard											
Milton Junction	1	5.42	40	217	0.7	3	$455	$13,818			$14,273
Lumsden In-transit											
Gore in-transit											
Gore saleyard											
SUM	8	75.52		3,021			$10,291	$41,455	$33,517	$17,934	$103,197
								$92,906			

NETWORK OF DUMP SITES (SAMPLES)

FOR 200 LITRE STORAGE CAPACITY

'summer-autumn' model

including Arthur's Pass (AP)

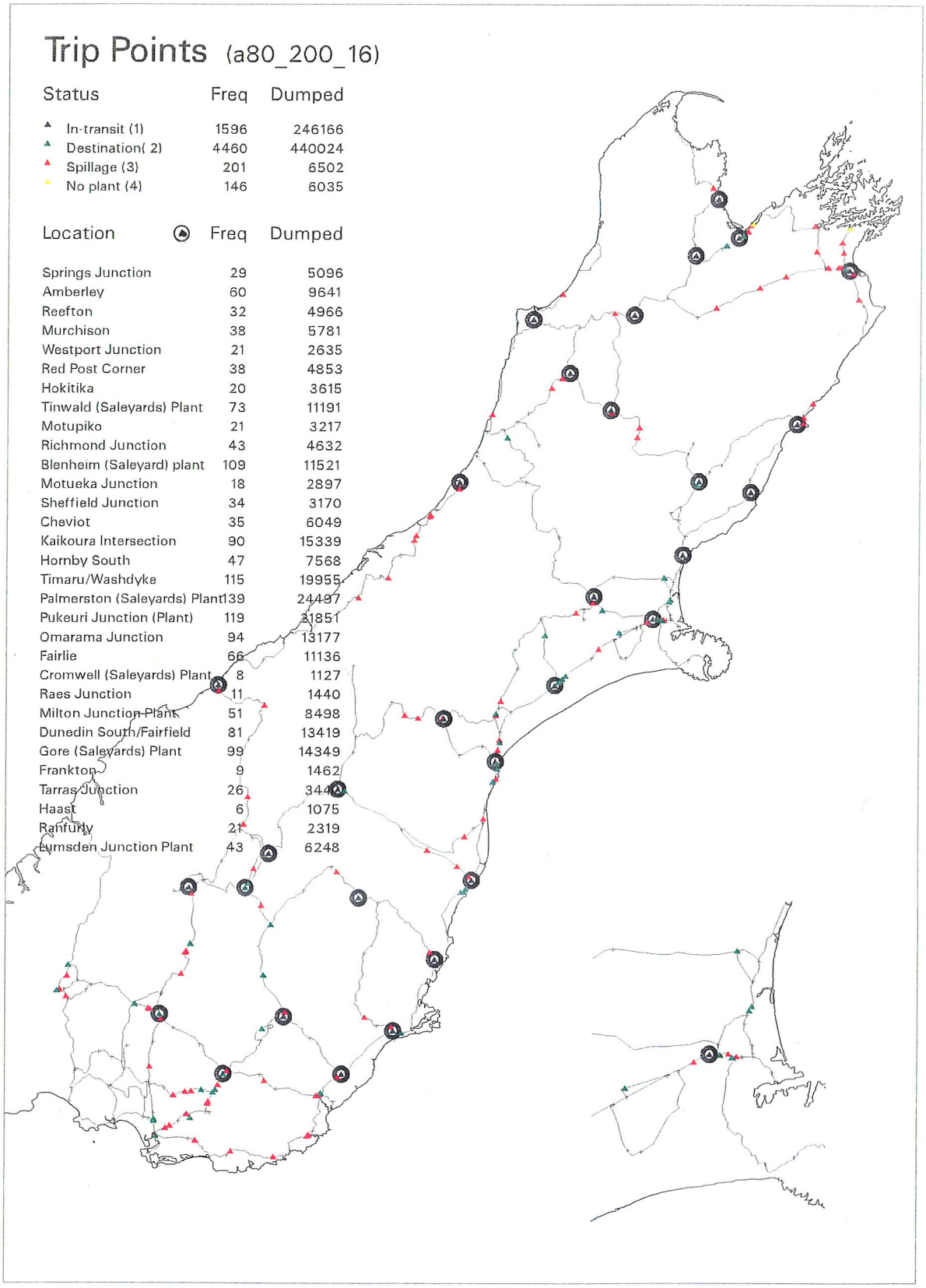
SAMPLES

a80_200_16

a25_200_29AP

a25_200_30AP

a80_200-16	31 dump sites



Effluent discharged in-transit and at various destinations

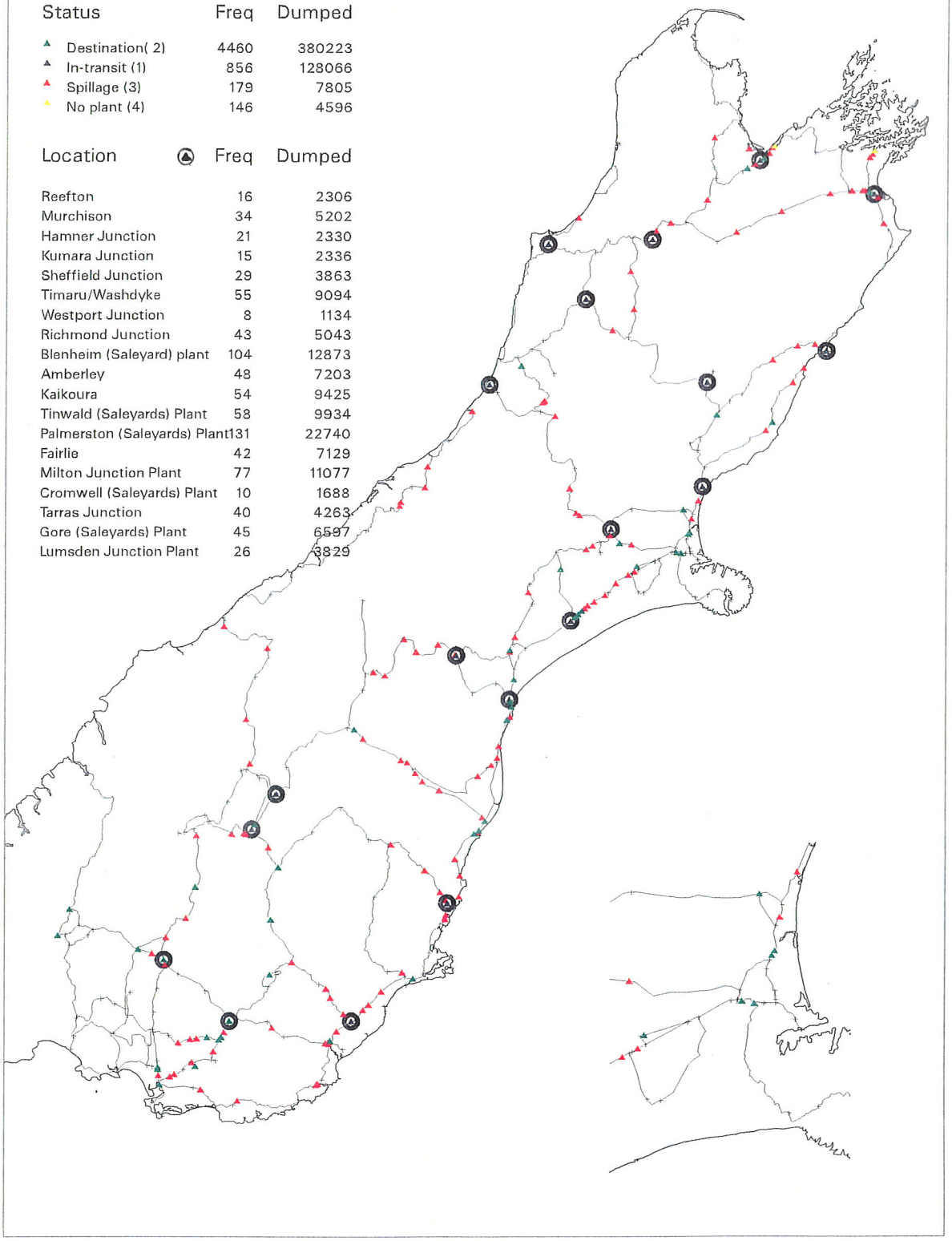
	LOCATION	FREQUENCY	SUM-DUMPED
1	Springs Junction	29	5,096
2	Amberley	60	9,641
3	CMP SEAFIELD (ASHB)	189	18,006
4	Reefton	32	4,966
5	Murchison	38	5,781
6	CMP BLENHEIM	82	11,759
7	PPCS BELFAST	121	15,263
8	PHOENIX MEAT (KOKIRI	59	6,946
9	Westport Junction	21	2,635
10	Spillage	201	6,502
11	SALEYARD BRIGHTWATER	32	3,597
12	SALEYARD CH-CH	99	10,247
13	ABATTOIR ASHBURTON	62	6,876
14	PPCS MARLBOROUGH	127	12,236
15	Red Post Corner	38	4,853
16	Hokitika	20	3,615
17	RICHMOND (NELS. BAYS	96	9,952
18	Tinwald (Saleyards) Plant	73	11,191
19	ALLIANCE PUKEURI	317	37,585
20	CULVERDEN	11	1,200
21	DARFIELD	6	814
22	GERALDINE	9	1,360
23	PICTON PORT	121	5,540
24	SALEYARD BLENHEIM	32	2,918
25	Motupiko	21	3,217
26	Richmond Junction	43	4,632
27	NELSON PORT	25	495
28	Blenheim (Saleyard) plant	109	11,521
29	ASHBURTON TOWNSHIP	10	1,408
30	Motueka Junction	18	2,897
31	BALCLUTHA TOWNSHIP	1	75
32	METHVEN	11	1,475
33	Sheffield Junction	34	3,170
34	Cheviot	35	6,049
35	Kaikoura Intersection	90	15,339
36	Hornby South	47	7,568
37	PPCS CANTERBURY	170	16,772
38	OAMARU	2	309
39	SALEYARD TINWALD	61	5,996
40	ALLIANCE SOCKBURN	136	12,034
41	ABATTOIR MALVERN	89	8,779
42	PPCS FAIRTON (ASHB)	226	19,805
43	Timaru/Washdyke	115	19,955
44	ALLIANCE SMITHFIELD	231	22,010
45	ALLIANCE LORNEVILLE	428	36,700
46	ALLIANCE MAKAREWA	154	10,929
47	ALLIANCE MATAURA	198	16,403
48	PPCS PAREORA	410	39,463
49	CHEVIOT	3	259
50	Palmerston (Saleyards) Plant	139	24,497
51	SALEYARD TEMUKA	64	5,720
52	Pukeuri Junction (Plant)	119	21,851
53	ABCO MEATS (OAMARU)	97	10,517
54	SALEYARD OMARAMA	8	991
55	Omarama Junction	94	13,177
56	Fairlie	66	11,136
57	BAY CITY MEATS	52	5,595
58	Cromwell (Saleyards) Plant	8	1,127
59	PPCS FINEGAND	290	31,082
60	SALEYARD OAMARU	49	4,419
61	Raes Junction	11	1,440
62	SALEYARD PALMERSTON	43	4,913
63	Milton Junction Plant	51	8,498
64	Dunedin South/Fairfield	81	13,419
65	SALEYARD BALCLUTHA	29	2,951
66	Gore (Saleyards) Plant	99	14,349
67	Frankton	9	1,462
68	BLUE SKY MEATS (MM)	118	11,057
69	Tarras Junction	26	3,442
70	Haast	6	1,075
71	WAITANE VILLAGE	58	5,203
72	Ranfurly	21	2,319
73	HARTLAND PRIME MEAT	12	1,231
74	PRIME RANGE MEATS	102	8,528
75	SALEYARD CROMWELL	6	612
76	Lumsden Junction Plant	43	6,248
77	SALEYARD GORE	63	5,947
78	RANGIORA	1	279
79	ALEXANDRA	1	168
80	SALEYARD LORNEVILLE	74	7,160
81	ROXBURGH	2	187
82	DUNEDIN	2	196
83	TE ANAU	4	594
84	MOSSBURN	5	409
85	MATAURA	2	120
86	KINGSTON	1	188
87	HERIOT	1	59
88	MANAPOURI	2	366
89	LUMSDEN JUNCTION	2	356
		6,403	**698,727**

a25_200_29AP 19 DUMP SITES

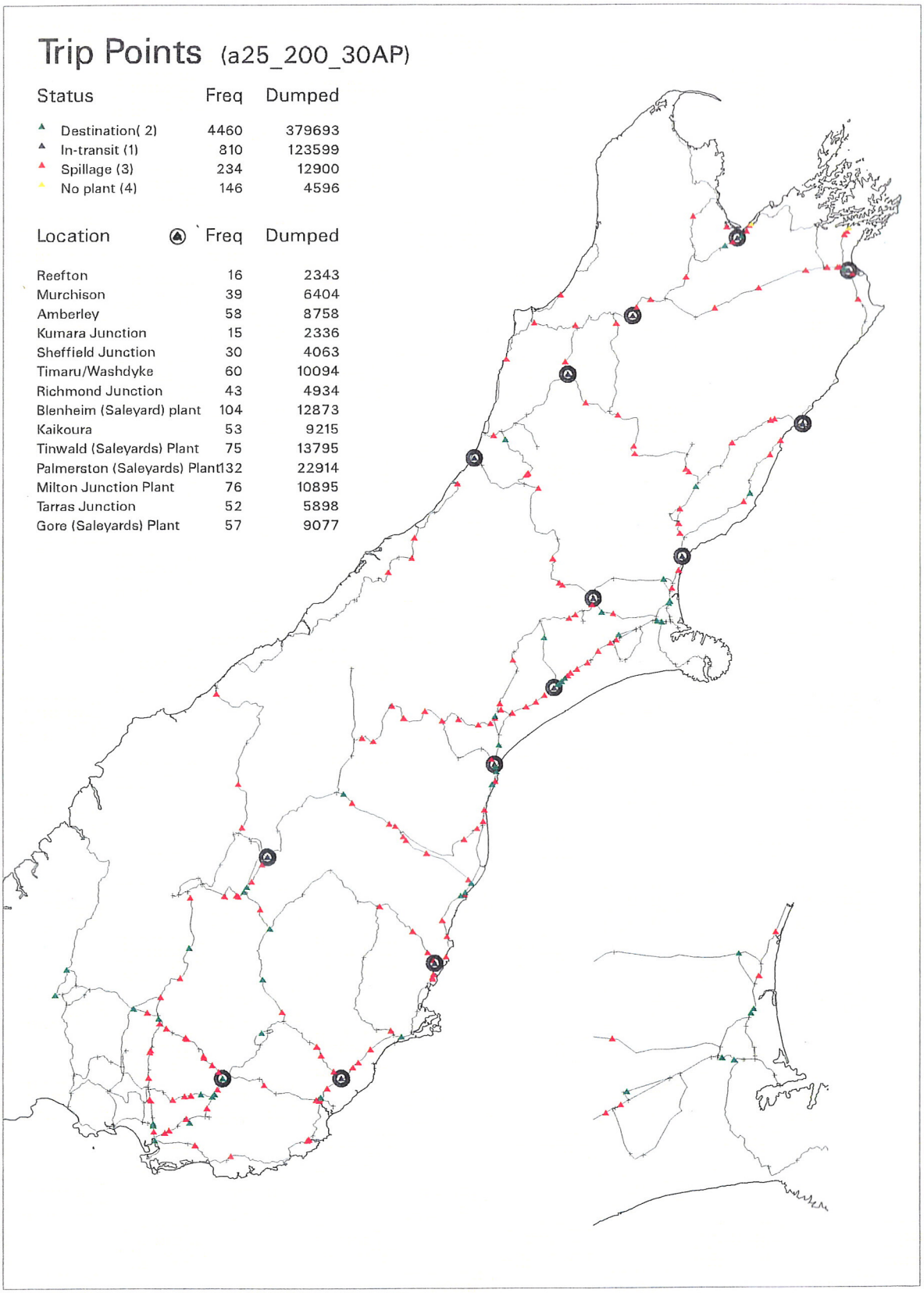
Trip Points (a25_200_29AP)

Status	Freq	Dumped
Destination(2)	4460	380223
In-transit (1)	856	128066
Spillage (3)	179	7805
No plant (4)	146	4596

Location	Freq	Dumped
Reefton	16	2306
Murchison	34	5202
Hamner Junction	21	2330
Kumara Junction	15	2336
Sheffield Junction	29	3863
Timaru/Washdyke	55	9094
Westport Junction	8	1134
Richmond Junction	43	5043
Blenheim (Saleyard) plant	104	12873
Amberley	48	7203
Kaikoura	54	9425
Tinwald (Saleyards) Plant	58	9934
Palmerston (Saleyards) Plant	131	22740
Fairlie	42	7129
Milton Junction Plant	77	11077
Cromwell (Saleyards) Plant	10	1688
Tarras Junction	40	4263
Gore (Saleyards) Plant	45	6597
Lumsden Junction Plant	26	3829



a25_200_30AP **14 dump sites**



Effluent discharged in-transit and at various destinations

	LOCATION	FREQUENCY	SUM-DUMPED
1	CMP SEAFIELD (ASHB)	189	18,947
2	Reefton	16	2,343
3	Murchison	39	6,404
4	CMP BLENHEIM	82	9,704
5	Spillage	234	12,900
6	Amberley	58	8,758
7	PPCS BELFAST	121	12,840
8	PHOENIX MEAT (KOKIRI	59	7,329
9	SALEYARD BRIGHTWATER	32	3,521
10	SALEYARD CH-CH	99	8,328
11	Kumara Junction	15	2,336
12	Sheffield Junction	30	4,063
13	ABATTOIR ASHBURTON	62	5,874
14	PPCS MARLBOROUGH	127	10,612
15	RICHMOND (NELS. BAYS	96	9,288
16	Timaru/Washdyke	60	10,094
17	ALLIANCE PUKEURI	317	32,462
18	CULVERDEN	11	1,580
19	DARFIELD	6	687
20	GERALDINE	9	1,167
21	PICTON PORT	121	4,202
22	SALEYARD BLENHEIM	32	2,527
23	Richmond Junction	43	4,934
24	NELSON PORT	25	394
25	Blenheim (Saleyard) plant	104	12,873
26	ASHBURTON TOWNSHIP	10	1,513
27	BALCLUTHA TOWNSHIP	1	134
28	METHVEN	11	1,137
29	Kaikoura	53	9,215
30	PPCS CANTERBURY	170	13,946
31	OAMARU	2	176
32	SALEYARD TINWALD	61	4,418
33	ALLIANCE SOCKBURN	136	9,005
34	ABATTOIR MALVERN	89	7,197
35	PPCS FAIRTON (ASHB)	226	20,157
36	Tinwald (Saleyards) Plant	75	13,795
37	ALLIANCE SMITHFIELD	231	17,313
38	ALLIANCE LORNEVILLE	428	28,758
39	ALLIANCE MAKAREWA	154	8,273
40	ALLIANCE MATAURA	198	12,599
41	PPCS PAREORA	410	39,643
42	CHEVIOT	3	461
43	SALEYARD TEMUKA	64	4,788
44	Palmerston (Saleyards) Plant	132	22,914
45	ABCO MEATS (OAMARU)	97	9,713
46	SALEYARD OMARAMA	8	682
47	BAY CITY MEATS	52	4,769
48	PPCS FINEGAND	290	26,418
49	SALEYARD OAMARU	49	4,197
50	SALEYARD PALMERSTON	43	3,157
51	Milton Junction Plant	76	10,895
52	SALEYARD BALCLUTHA	29	2,187
53	Tarras Junction	52	5,898
54	BLUE SKY MEATS (MM)	118	8,532
55	Gore (Saleyards) Plant	57	9,077
56	PPCS WAITANE (Gore)	58	4,336
57	HARTLAND PRIME MEAT	12	1,047
58	PRIME RANGE MEATS	102	7,250
59	SALEYARD CROMWELL	6	412
60	SALEYARD GORE	63	4,459
61	RANGIORA	1	20
62	ALEXANDRA	1	94
63	SALEYARD LORNEVILLE	74	5,452
64	ROXBURGH	2	155
65	DUNEDIN	2	106
66	TE ANAU	4	502
67	MOSSBURN	5	733
68	MATAURA	2	294
69	KINGSTON	1	188
70	HERIOT	1	140
71	MANAPOURI	2	198
72	LUMSDEN JUNCTION	2	268
		5,650	**520,788**

Analysis of operational costs (excluding capital costs)

		Installation of effluent discharge facility			Installation of effluent discharge facility + pre-treatment on-site or off-site		
		A 1	A 2	A 3	B1	B 2	B 3
		no existing roading infrastructure	existing roading infrastructure (ie. one roadside) on open road	existing roading infrastructure (ie. weighbridge) or location within a speed reduced zone (truck stop, saleyard), signage required	no existing roading infrastructure	existing roading infrastructure (ie. one roadside) on open road	existing roading infrastructure (ie. weighbridge) or location within a speed reduced zone (truck stop, saleyard), signage required
1	**Capital costs**						
1.1	**construction:**	$18,000	$18,000	$18,000	$43,000	$43,000	$43,000
1.2	**roading infrastructure:**	$58,000	$28,000	$3,000	$58,000	$28,000	$3,000
1.3	**equipment:**	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000
	Grand total:	**$86,000**	**$56,000**	**$31,000**	**$111,000**	**$81,000**	**$56,000**
2	**Running costs**						
2.1	**Fixed costs**						
2.1.1	**Repair & maintenance costs (R&M):**						
	construction: 1% of investment costs	$180	$180	$180	$430	$430	$430
	roading infrastructure: 1% of investment costs	$580	$280	$30	$580	$280	$30
	equipment: 3% of investment costs	$300	$300	$300	$300	$300	$300
	Total R&M costs:	**$1,060**	**$760**	**$510**	**$1,310**	**$1,010**	**$760**
2.2	**Variable Costs**						
2.2.1	**Operating costs**						
	checking & cleaning site (monthly rate) $100 discharge facility only	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200
	sampling $150 per month	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800
	tankering costs $0.70 / m^3 * Km						
	Total variable costs	**$3,000**	**$3,000**	**$3,000**	**$3,000**	**$3,000**	**$3,000**
	Total running costs per year (except tankering costs)	**$4,060**	**$3,760**	**$3,510**	**$4,310**	**$4,010**	**$3,760**
		excl. land purchase, excl. administrative and planning fees, excl. GST					

Analysis of costs based on separation of capital and operational costs

The following table gives an overview of capital and operational costs in a separate way. The table relates to the network of sites outlined in table 11.13 in the main part of the thesis. The capital costs are based on the mean value of B1-B3 sites ($82,667 per site) (cf. page 398), while the operational costs are the sum of the annual tankering costs for the specific network and the mean value of total running costs for B1-B3 sites ($4,027 per site, table page 398) multiplied by the number of sites. The tankering costs vary depending on the location of sites. If an in-transit site is located at a saleyard, the effluent collected at the saleyard itself (end destination) is added to the effluent discharged by trucks in-transit.

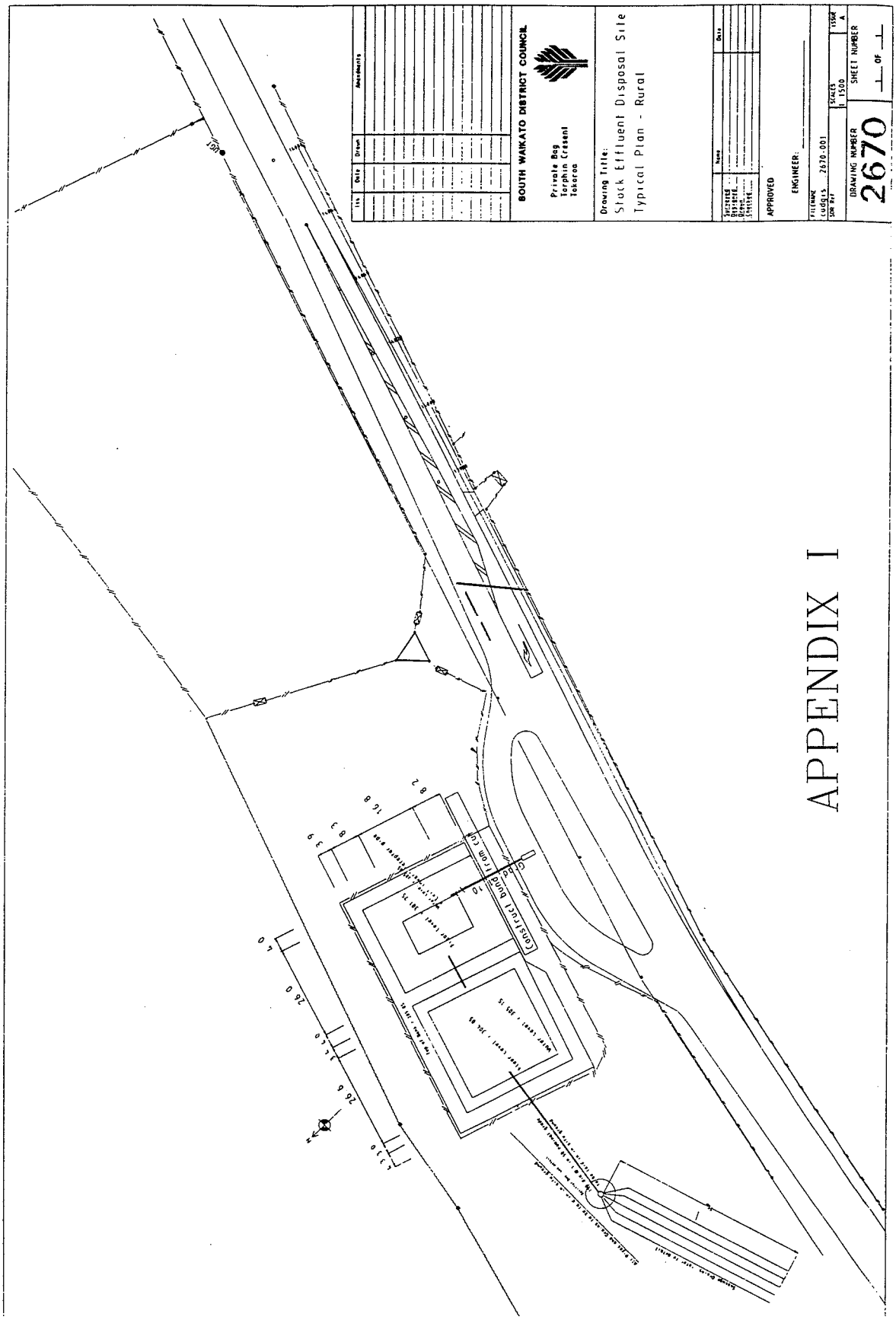
including Arthur's Pass access	optimal network for minimum spillage	recom. network allowing 12% spillage	Livestock 80% not stood			Livestock 25% not stood		
			Number of sites	Capital costs	Running costs per year	Number of sites	Capital costs	Running costs per year
300 Litre site network	a80_300_29AP a25_300_29AP		19	$15,706,673	$102,214	19	$15,706,673	$91,075
		a80_300_29AP a25_300_30AP				14	$1,157,334	$71,053
400 Litre site network	a80_400_27AP a25_400_27AP		12	$992,004	$59,616	12	$992,004	$59,620
		a80_400_35AP a25_400_34AP	12	$992,004	$66,611	10	$826,667	$49,731

APPENDIX 7

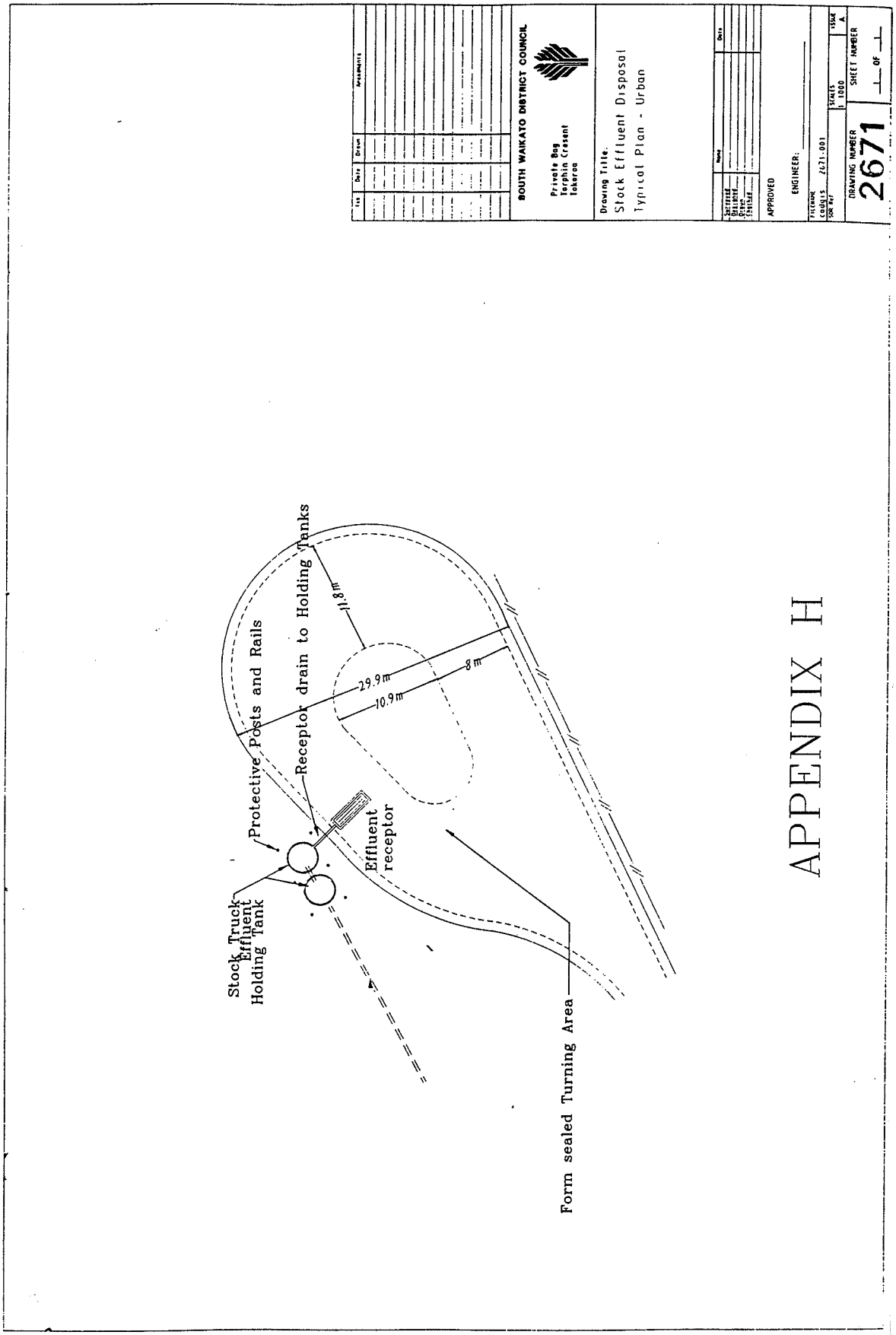
TECHNICAL DRAWINGS FROM THE WAIKATO EFFLUENT DUMP SITES

(National Stock Effluent Working Group, 1999)

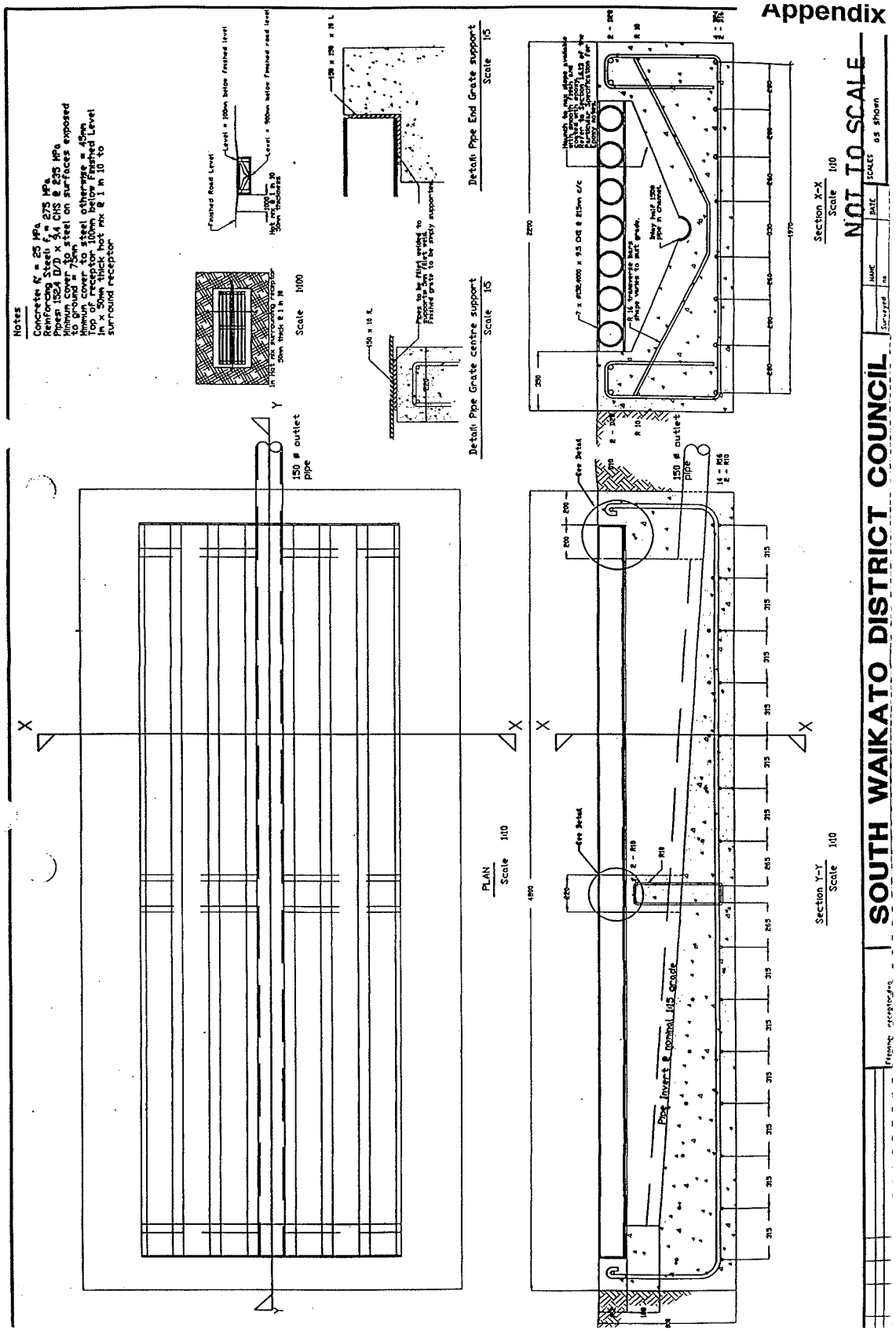
Overview plan of the Tapapa effluent discharge site including the two treatment ponds



Overview plan of the discharge site at the Putaruru saleyard



Details regarding the receptor area of a discharge site (top view & cross sections)



APPENDIX 8

COMPUTER SIMULATION MODEL
PRINTOUT OF TWO SINGLE DEMO TRIP ASSIGNMENTS

DEMO 1 405

DEMO 2 407

SINGLE TRIP SIMULATION: DEMO 1

Processing route 1

(Company-id: 1, Use defaults: 1, **Destination: ASHBURTON**)

Parameters: **cattle, empty, dry, 200L**

Getting sections...

Starting at **AHAURA** (sicov# = 32)

- There is a **plant at Reefton**, (sicov# = 32) add a trip section (41.76km from start)
- There is a **plant at Amberley**, (sicov# = 61) add a trip section (243.64km from start)

No more related records for relate SEC

Stopping at CMP SEAFIELD (ASHB), (sicov# = 116) add a trip section (364.23km from start)

Generating events

With 3 sections to test

- We are currently 0km from the start point, finding the end of leg 1 which must be within **405km** from here or 405km of the start of the trip.
- We are either at or last travelled through end of section 0
- Calculating the furtherest away usable section.

- Next potential section (1) ends at **Reefton,** 41.76km from start of trip. This is in range. And the plant is operational.

- Next potential section (2) ends at **Amberley**, 243.64km from start of trip. This is in range. And the plant is operational.

- Next potential section (3) ends at **CMP SEAFIELD (ASHB),** 364.23km from start of trip. This is in range. And the plant is operational.

- **We can get to the end of section 3.**
- There is an operational plant that we can reach at CMP SEAFIELD (ASHB)
- Our **tank contains 191.97L** of effluent that we can dump.
- We **travelled 364.23km** to get here which **leaves 40.77km left** at the current fill rate of 0.20 L/km.
- Inserted destination event, total output: 191.97L

SINGLE TRIP SIMULATION: DEMO 2

Processing route 2

(Company-id: 1, Use defaults: 1, **Destination: BLENHEIM)**

Parameters: **cattle, empty, wet, 200L**

Getting sections...

Starting at **GREYMOUTH** (sicov# = 38)

- There is a **plant at Reefton**, (sicov# = 32) add a trip section (74.45km from start).
- There is a **plant at Murchison**, (sicov# = 27) add a trip section (159.11 km from start)
-

No more related records for relate SEC

Stopping at **CMP BLENHEIM**, (sicov# = 19) add a trip section (315.97km from start)

Generating events

With 3 sections to test

- We are currently 0km from the start point, finding the end of leg 1 which must be within **132km** from here or **132km** of the start of the trip.
- We are either at or last travelled through end of section 0
- Calculating the furtherest away usable section.

- Next potential section (1) ends at Reefton, 74.45km from start of trip. This is in range. And the plant is operational.
- Next potential section (2) ends at Murchison, 159.11km from start of trip. This is 27.11km beyond our range. **We can get to the end of section 1**.
    - There is an operational plant that we can reach at **Reefton**. Our tank contains **145.45L** of effluent that we can dump. We travelled **74.45km** to get here which leaves **57.55km** left. **Inserted in-transit event.**

- The **next leg (2)** may be a combination of the previous fill rate and the new fill rates that will take effect part way through the leg.

We can travel 57.55km at (2.55km at 1.786L/km; 25km at 1 L/km; 30km at 0.833L/km >> **54.55L**) and (200L - 54.55L =) **145.45 L** on further legs (18km at 1.389L/km, 19km at 1.316L/km, 21km at 1.19L/km, 53km at 0.472L/km, 22km at 1.136L/km, 18km at 1.136L/km)

which totals 57.55km and 151km = **208.55 km**

- We are currently 74.45km from the start point, finding the end of leg 2 which must be within 208.55km from here or **283.00km** of the start of the trip.
- **Next potential section (2)** ends at **Murchison**, 159.11km from start of trip. This is in range. And the plant is operational.

- **Next potential section (3)** ends at **CMP BLENHEIM**, 315.97km from start of trip. This is 32.97km beyond our range. We can get to the end of section 2. There is an operational plant that we can reach at **Murchison**. Our tank contains **91.54L** of effluent that we can dump. We travelled (159.11km - 74.45km=) **84.66km** to get here which leaves 54.55L for **57.55km** and 25L for **18km** and 11.99L for **9.11km**. **Inserted in-transit event.**

- **The next leg (3)** may be a combination of the various rates that will take effect part way through the leg.
- We can travel further **156.86km to CMP Blenheim** (9.89km at 1.316L/km, 21km at 1.19L/km, 53km at 0.472L/km, 22km at 1.136L/km, 22km at 1.136L/km, 22km at 1.136L/km, 6.97km at 1.19L/km).

- Next potential section (3) ends at **CMP BLENHEIM**, 315.97km from start of trip. This is in range. And the plant is operational. We can get to the end of section 3.
- There is an operational plant that we can reach at CMP BLENHEIM. Our tank contains **146.32L** of effluent that we can dump. We travelled 156.86km to get here.
- Inserted destination event, total output: **383.30L**.

VITA

Jean-Paul Thull was born in Strasbourg, France on 14 November 1961 and completed his secondary education (Maths & Latin section) in Luxembourg in 1980.

He received his degree in civil engineering (Diplom-Ingenieur TH), equivalent to a Master's degree, from the German University of Karlsruhe in 1990.

He started his professional career as a part-time research assistant at the environmental consultancy firm 'Ingenieurbueo Dr Lohmeyer' in Karlsruhe in 1986. In 1989 he joined (part-time) 'wat Wasser- und Abfalltechnik Ingenieurgesellschaft mbH & Co. KG', a civil and environmental consultancy firm based in Karlsruhe, specialised in waste- & project management. He was mainly responsible for the project management of a French-German project in 1989/90. From 1990 to 1996, Jean-Paul was a full-time employee at 'wat' consultancy involved with the planning and establishment of resource consents for various projects related to solid waste management and waste treatment. He was further involved in project management and supervision of many building sites. He came to New Zealand in September 1996 to start his doctorate after having met by coincidence his main supervisor Professor Kissling during a push-bike holiday in New Zealand in February 1995.

Jean-Paul Thull is single. He grew up in Luxembourg, speaks four languages and lived in Germany from 1981 to 1996 before arriving in New Zealand.