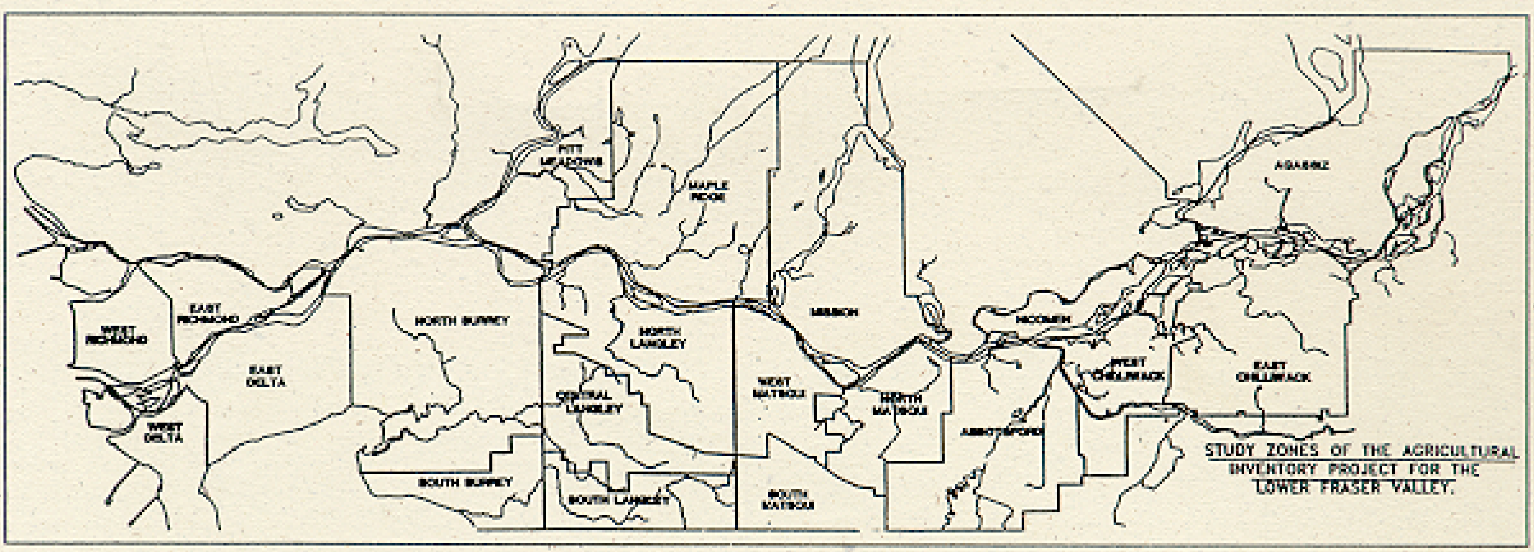
MANAGEMENT OF AGRICULTURAL WASTES IN THE LOWER FRASER VALLEY



STUDY ZONES OF THE AGRICULTURAL INVENTORY PROJECT FOR THE LOWER FRASER VALLEY.

SUMMARY REPORT - A WORKING DOCUMENT

REPORT 9

DOE FRAP 1996-30

Environment Canada / Environnement Canada
FRASER RIVER ACTION PLAN / PLAN D'ACTION DU FRASER

Fisheries and Oceans / Pêches et Océans
FRASER RIVER ACTION PLAN / PLAN D'ACTION DU FRASER

Ministry of Environment, Lands and Parks

Ministry of Agriculture, Fisheries and Food

MANAGEMENT OF AGRICULTURAL WASTES IN THE LOWER FRASER VALLEY

SUMMARY REPORT - A WORKING DOCUMENT

Presented on Behalf of:

The Management of Agricultural Wastes in the Lower Fraser Valley Program Steering Committee

REPORT 9

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March 1997

<u>Summary Report Steering Committee Members</u>

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<u>Acknowledgements</u>

Dr. Grant Kowalenko of Agriculture and Agri-Food Canada who served as a technical advisor to the committee and provided thoughtful insight and comments. Ms. Beverly Locken and Dr. Narender Nagpal of the Ministry of Environment, Lands and Parks for their active participation throughout the process.

An earlier draft of this report was prepared for the Steering Committee by Mr. P.E. Brisbin, Charcoal Creek Projects Inc., Abbotsford, B.C.

EXECUTIVE SYNOPSIS

This report presents the findings of a multi-agency program which was initiated in 1994 to investigate concerns about the environmental impacts of agricultural waste management in the Lower Fraser Valley (LFV). The LFV agricultural industry is a significant contributor to the local and provincial economy, generating gross farm receipts of $859 million in 1995.

Through several component projects the program addressed three general questions:

- **what is the current state of agricultural waste management in the Lower Fraser Valley,**
- **what are the practical options for improving nutrient management, and**
- **how might the various practical options be implemented?**

The 1991 Census for agriculture plus several livestock and poultry commodity group surveys were determined to be the best available information upon which to develop a model for an analysis of waste management in the LFV. Recent information suggests that the total amount of manure-generated nutrient has increased since 1991.

The private (to producers) and societal costs of manure management in the LFV are not well understood. Recent studies have identified pollution of streams and groundwater in some LFV agricultural areas. Nitrate contamination of groundwater, oxygen depletion, eutrophication and high ammonia levels in surface water; ammonia emissions to the atmosphere and excessive levels of potassium in soils were identified as priority issues.

The findings of this program point to two major factors likely to cause the documented contamination:

- **the application of manure and inorganic fertilizer nutrients within an Agricultural Waste Management Zone (AWMZ) in excess of crop requirements and**
- **problems associated with on-farm nutrient and other management practices.**

Budget calculations of nitrogen, phosphorus and potassium balances within twenty AWMZs using the 1991 Census data on fertilizer use, livestock numbers, and crop production showed that the total amount of nutrients applied to the agricultural land base in some zones greatly exceeded crop requirements. The nutrient surplus problem is related to the level of the importation of feed that is needed to sustain LFV livestock and poultry densities plus, the amount of inorganic fertilizers used in the valley.

The loss of nutrients from all soils is a natural process. A “zero” background soil nutrient level is not possible, especially under an agronomic nutrient management system. For discussion purposes, a background soil nitrogen limit of between 50 kg N/ha to 100 kg N/ha was viewed as being a reasonable range to compare zonal balances to. Ten zones representing 57% of the agricultural land base received a nitrogen loading in excess of 100 kg N/ha/yr. The AWMZs with the highest surplus greater than 100 kgN/ha and including 11% of the land base, were accounted for by three zones: South Langley (+108 kgN/ha), West Matsqui (+202 kgN/ha), and South Matsqui (+308 kgN/ha). The South Matsqui zone corresponds roughly with the Abbotsford aquifer. With a more restrictive background soil nitrogen level of 50 kgN/ha, 16 zones representing 78% of the cropped area exceeded that level.

The net application of phosphorus was at least two times that of the potential crop removal in 18 zones. For potassium the net application was at least two times that of the potential crop removal in 14 zones. The South Langley, West Matsqui and South Matsqui zones exceeded the potential crop removal of phosphorus by at least seven times and at least three and one-half times for potassium. Phosphorus and potassium are less likely to be leached from the soil than nitrogen.

Trends in LFV agriculture indicate that problems will intensify if an increased and ongoing effort to improve nutrient management and to find and implement solutions is not maintained. A single solution or “model” was not found elsewhere that could be applied to the LFV, hence a “made in” LFV approach is required.

Four key actions were determined to be necessary in order to achieve acceptable nutrient balances and include:

- **implementation of a Best Agricultural Waste Management Plan (BAWMP) process,**
- **ongoing evaluation of management options for individual farms and zones with excess nutrients, including the relocation of manure within or outside of the LFV,**
- **preserving the agricultural land base and broadening planning at the watershed level, and**
- **increasing education and awareness to foster changes in attitude and ensure enforcement of regulations when voluntary action is not sufficient.**

For much of the Lower Fraser Valley an acceptable nutrient balance can be achieved through improved on-farm nutrient management comprising better manure handling practices, reducing the use of inorganic fertilizers and improving feeding strategies. Excessive livestock and poultry densities create situations where the available land base is simply too small to accommodate the nutrients contained in the manure regardless of the level of on-farm management. In these cases an acceptable nutrient balance can only be achieved through the movement of manure or through the relocation of livestock or poultry to areas that have a land base that would be sufficient to use the manure nutrients . Experience elsewhere indicated that managing a manure nutrient surplus using central processing involves high capital costs and the product produced may be worth considerably less than the cost to produce it.

The model showed that under a scenario of improved on-farm management and reduced inorganic fertilizer use, the regional nitrogen balance could likely be reduced by approximately 60%, from 115 kgN/ha to 46 kgN/ha. Under that scenario, at a background soil nitrogen level of 100 kgN/ha, 5 zones representing 19% of the cropped area exceeded that level. Further decreases in the amount of excess nutrient were achieved with the inclusion of feeding strategies that reduce the quantities of nutrient excreted in manure. Three zones representing 11% of the cropped area still exceeded the 100 kgN/ha level. Changes in on-farm management had less impact on phosphorus, with the net application in 16 zones still at least two times that of the potential crop removal.

Recent studies supported through government initiatives (Canada-B.C.- Green Plan for Agriculture, Fraser River Action Plan) have resulted in a better understanding of the issues. Some new approaches to nutrient management have been developed and a positive momentum has been generated in searching for more solutions. If there is to be continued progress in attaining sustainability in agriculture and ensuring a clean environment over the next 5 to 10 years, an increased commitment from the industry and other stakeholders is required.

Without government supported programs, new approaches and resource sources will need to be considered. Resource sources might include "green" charges on produce, levies where imported goods from other areas do not meet the same environmental requirements and changes in taxation measures where stewardship actions are incorporated on-farm. The re-investment of savings from reduced inorganic fertilizer use into environmental solutions is an option. It has been estimated that collectively, producers could reduce annual expenditures in the order of 12 million dollars.

Areas with excessive livestock and poultry densities already exist - the Abbotsford aquifer recharge area being the most notable. An action plan to address problems in this area has already been developed for implementation. Similar plans should be developed for other areas showing a high nutrient excess. Further increases in livestock and poultry numbers with an associated importation of nutrients in feeds may result in an increasing area of the Lower Fraser Valley agricultural lands experiencing this situation.

With a large and diverse group of stakeholders involved in agriculture and the need for action on several fronts, coordination is critical. This could require establishing a coordinating entity to ensure priorities for research are set and best management practices are developed along with guidelines. Tracking the development of the industry is needed to proactively identify critical areas and measure progress and success where it occurs. Issues should be thoroughly addressed in community, land-use and watershed planning exercises. The ministries of Agriculture, Fisheries and Foods (MAFF) and Environment, Lands and Parks (MELP) could take the lead role to initiate and develop this process. Producers do not appear to favor local governments as the responsible entity for managing land use related to agriculture. The current role and mandate of the Agricultural Land Commission should be reviewed in the context of addressing environmental issues relevant to agriculture.

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1.0 INTRODUCTION

This report presents a summary of the key findings and recommendations of the "Management of Agricultural Wastes in the Lower Fraser Valley" program. The program was initiated by the Ministry of Environment, Lands and Parks (MELP) and included participation by the Ministry of Agriculture, Fisheries and Foods (MAFF) and through the Fraser River Action Plan, Environment Canada (DOE) and the Department of Fisheries and Oceans (DFO). Agriculture and Agri-Food Canada was involved as a key technical advisor throughout the process.

The goal of the program was to evaluate the production, treatment and disposal of agricultural wastes, primarily manure, within the context of protecting groundwater, surface water, air and soil quality. The findings provide a background against which policies and strategies for improving nutrient (manure and inorganic fertilizers) management can be developed.

The program, through several component projects (Appendix A), addressed three questions:

- **what is the current state of agricultural nutrient management,**
- **what are the practical options for improving nutrient management, and**
- **how might the various practical options be implemented.**

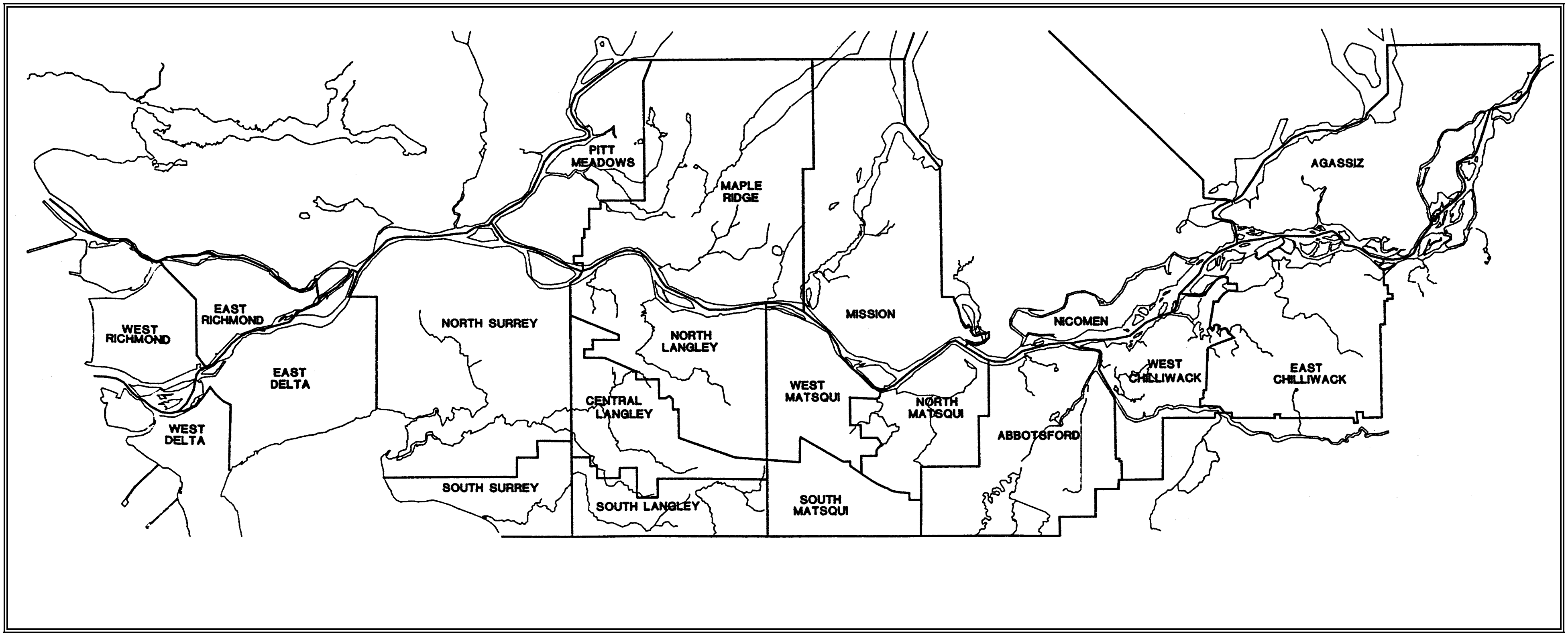
The evaluation of agricultural nutrient management is largely based on data from the 1991 Census of Agriculture and several commodity-group waste management surveys. A mass balance model was developed through consultation workshops and interviews with technical specialists, including several members of the Steering Committee. The model was used to quantify nutrient management balances for twenty agricultural waste management zones (AWMZs) and to evaluate the response to several improved management scenarios. The AWMZ boundaries were drawn primarily along municipal borders but also incorporated important watershed or groundwater recharge features (Figure 1).

Agricultural waste management practices and legislation in jurisdictions outside British Columbia were reviewed and summarized. This provided a basis for a discussion of the options which might prove useful in solving the identified nutrient management problems of the Lower Fraser Valley. A review of the literature on the social and private costs and benefits of management options was undertaken to provide some background information and insight on some of the economic considerations.

A producer workshop was held to present the findings of the nutrient modeling evaluation, local environmental assessments and identified management options. The workshop provided an initial forum for feedback from producers on their perspective of agricultural waste management problems and for identifying additional and preferred options.

The program Steering Committee then reviewed the available options for improving nutrient management, developed a matrix outlining the most promising approaches and assessed the need for a management implementation framework (Brisbin, 1996).

Figure 1 : Twenty Agricultural Waste Management Zones Used in the Management of Agricultrural Wastes in the Lower Fraser Valley Program



2.0 THE ISSUES

When evaluating the issues and options for improving agricultural waste management in the Lower Fraser Valley, it should be kept in mind that agriculture in the valley is both diverse and complex. The development of certain intensive farming practices has over time created serious agricultural pollution issues that are not encountered on the same scale elsewhere in the province. All resource users are concerned about water and air quality and it is expected that there will be continuing pressure for agriculture to improve its' environmental performance.

Many agricultural waste management practices represent potential non-point pollution sources (NPS), pollution which originates from several diffuse sources. The loading from individual sources may not always be large in a regional context, but on a localized scale contaminant concentrations may be high enough to have harmful effects (e.g. concentrations of ammonia lethal to fish in manure contaminated runoff). The combined loading of several sources can result in very significant environmental impacts (e.g. nitrate contamination of drinking water in regional aquifers).

It is important to consider and try to identify where the "balance" between the producer's private costs and the environmental costs to society lies. That "balance" may not always be easily identified and when identified, it may not necessarily be easily or quickly adjusted to an appropriate level. In the Lower Fraser Valley there are public health concerns related to groundwater quality and fisheries concerns related to surface water and habitat quality. In several areas of the Lower Fraser Valley studies have identified agricultural activities as significant contributors to reduced environmental quality (IRC 1994a; IRC 1994b; Liebscher et al 1992; Wassenaar 1994; Zebarth et al 1995). There are several situations where nitrate levels in groundwater exceed acceptable limits for drinking water and aquatic habitat degradation is seriously impacting commercially important fisheries. Tributaries of the Lower Fraser provide about 65% of the spawning habitat for Fraser River coho salmon and about 85% of the spawning habitat for Fraser River chum salmon. These aquatic systems provide an important societal (recreation, aesthetic) benefit and contribute to economically important commercial and recreational fisheries. On the other hand the current productivity of LFV agriculture is a very significant contributor to the local and provincial economy. Lower Fraser Valley agriculture generated gross farm receipts of $859 million in 1995 (BCMAFF,1996). In 1991 it represented over $3.5 billion in capital investment and paid over $126 million in wages. The Agricultural Land Reserve (ALR) administered by the Agriculture Land Commission (ALC) provides a greenbelt which could be considered an important societal benefit.

Non-point source pollution is a challenge to manage effectively. It is often the result of the impacts of several relatively small sources, making it difficult to accurately identify the individual sources and pollutant loading. In attempting to reduce NPS pollution, and more particularly nutrient loading from agriculture, there needs to be a balance between regulatory and voluntary action. As agricultural producers increase their understanding of the environmental problems and address them, there should be less need for stricter regulations and enforcement. Not unlike other industries, there will always be the need for some amount of regulation and enforcement to ensure that producers do not use inappropriate management practices.

Producers, government and the non-farming public should all work towards acquiring a better understanding of the factors associated with agricultural production and NPS pollution. There are many inter-related factors (e.g. hydrology; weather conditions; crop types; the amount, timing and methods of nutrient application) which come into play and ultimately determine the end result. Farm lands within the LFV are largely in the lower portions of watersheds. These lowland areas can be impacted by upstream non-farming activities. Innovative solutions are required to manage human activities within watersheds in a sustainable manner. An appropriate balance between our environmental, economic and social needs is required to achieve sustainability.

A number of factors including economics, population growth, technological change, international trade and government policies, have led to the current intensive farming practices evident in some areas. At the same time there is increasing pressure from other resource users and the public at large to deal with environmental issues. There are trade-offs between the desire for low cost quality food and the desire for a clean environment. The public want both low cost quality food and environmental responsibility from producers. Producers must compete with other producers, often in a global market, in order to generate an adequate income. All sectors, including producers, government and the non-farming public, must cooperate to develop workable approaches to environmentally sustainable agriculture in the Lower Fraser Valley.

While there have been significant efforts at improving agriculture's environmental performance in recent years, there is considerable scope for further improvement. There is no simple single solution. There doesn’t appear to be a working model which has been developed in any other jurisdiction which can be used as a prototype for the Lower Fraser Valley (Runka, 1995). There is clearly a need for a "made in" the Lower Fraser Valley agricultural waste management solution.

2.1 Water Quality

Agricultural activities have been implicated as the primary cause of high nitrate concentrations in several Lower Fraser Valley groundwater sources. Most notable is the Abbotsford aquifer where nitrate concentrations well in excess of drinking water standards are common. Other studies have indicated that agriculture has been a significant contributor to surface water degradation.

Agricultural nutrient management impacts aquatic habitat through three general mechanisms:

- **Introduction of toxic substances**

  Some substances, such as ammonia which is a component of manure and inorganic fertilizers, are directly toxic to fish and other aquatic organisms. Toxic substances disrupt cellular functions, resulting in the weakening or death of the exposed organism.

- **Eutrophication.**

  Nutrients, primarily phosphorus, are usually the plant growth limiting substances in unpolluted streams. Introducing too much nutrient typically results in the excessive growth of algae. An excessive growth of algae can smother spawning gravels directly or slow the movement of water resulting in sedimentation. The growth of undesirable and potentially toxic species of blue-green algae may occur.

- **Depletion of Dissolved Oxygen Concentrations in Surface Water**

  The excessive algae growth associated with eutrophication, while a net producer of dissolved oxygen during the day, can consume significant amounts of oxygen during the night when the rate of cellular respiration exceeds photosynthesis. Oxygen is also consumed when the algae die and decompose. The net result is a higher potential depletion of dissolved oxygen during the night. Dramatic decreases in oxygen concentrations during late summer and fall months occur in LFV streams and often to levels below that required to support fish. Watercourses with limited stream side vegetation (riparian area) heat up in the summer, which in turn reduces the solubility of oxygen in water. Under these conditions there is an increased need by aquatic organisms for oxygen because the metabolic rate also increases.

  The decomposition of organic carbon compounds contained in manure and the conversion of ammonia to nitrate can both contribute to the depletion of surface water dissolved oxygen.

Poor agricultural waste management practices have in some cases in the LFV compromised the usefulness of surface water as a source of irrigation and livestock water due to pathogen contamination.

2.2 Air Quality

Agriculture releases a significant amount of ammonia to the air, estimated to be 7,600 tonnes of ammonia nitrogen per year in 1991. Recent research on air quality suggests that ammonia may play a key role in the development of fine particulates with the formation of ammonium nitrate and ammonium sulphate. These fine particulates called PM2.5 are small enough to penetrate deep within the lungs and lead to serious respiratory problems. They are also very efficient in scattering light, thereby producing significant visibility concerns. Current levels of fine particulates may constitute a greater danger to health than other air quality concerns such as ground level ozone, sulphur dioxide and carbon monoxide.

It is unknown whether a reduction in the amount of agriculturally generated ammonia in the air would result in any decrease in health impacts, as the air pollutants from non-agricultural sources would still be present.

2.3 Soil Quality

Excessive applications of potassium to the soil can lead to high concentrations in forage crops. This can result in costly problems for dairy producers who subsequently feed these forages to their livestock. Problems related to excess potassium in livestock feed include increased energy consumption, kidney stress and magnesium deficiency.

This problem is evident in several areas within the Fraser Valley with magnesium being added to both dairy rations and fertilizer mixes in an effort to correct the imbalance relative to other cations. Estimates are that up to 75% of Lower Fraser Valley dairy operations suffer from herd health problems due to excessive potassium in feeds.

3.0 ASSESSING NUTRIENT MANAGEMENT

3.1 Inventory

Information from the 1991 Census of Agriculture was used to produce an inventory of the number and type of livestock and poultry, the area farmed by crop type and the probable application rates of manure and inorganic fertilizers to crops for each of the twenty AWMZs (Brisbin, 1994; Brisbin, 1995a). The results from conservation group surveys (DPCG, 1992; HPSFG, 1992; SPFG, 1993) conducted in 1990 and 1991 provided additional information on LFV manure management practices.

Census of Agriculture data is often criticized for being limited and incomplete, however it was the most comprehensive data base on livestock and poultry numbers and current land use which was readily available and which included all of the Lower Fraser Valley. Census data was collected for two farm categories; large and small farms. For this study large farms were defined as those with gross annual farm receipts of $40,000 or above and small farms as those with gross farm receipts below $40,000 per year.

The evaluations in this program focused on the large farm category. The focus on large farms does not indicate that small farms are considered to be problem free. In fact, it is likely that the non-point source nutrient loading from the hobby farm sector may be significant in some areas. This is an issue which needs to be examined further.

The comparison with conservation group inventory information indicated that the Census data generally underestimated the actual livestock and poultry numbers. The degree of under-reporting livestock and poultry numbers varied from perhaps 5% to 15% for dairy cattle, poultry and swine, to 50% - 60% for horses. Other agricultural land base data suggested that the Census data also underestimated the actual area of land used for crop production. Despite these reported shortcomings, it was concluded that the Census data provided sufficient information upon which to assess the “current” state of agricultural nutrient management in the Lower Fraser Valley. The inventory data reflected the diverse nature of agricultural activities in the LFV. It showed a wide variation in livestock types, livestock densities and cropping patterns between the twenty AWMZs.

3.2 Nutrient Model and Pathways

A “standard” farm operation was developed for each of the different farm types (e.g. dairy) in the LFV (Brisbin and Runka, 1995). A mass balance model was developed to the evaluate the flow of three major nutrients (nitrogen, phosphorus and potassium) through the farm operation, using assumptions and factors based on LFV experience and research (Brisbin, 1995b). There were numerous assumptions incorporated into the model.

The amount of manure nutrient was estimated using animal numbers and a typical manure nutrient content for each of the various animal types. The model incorporated a “standard” manure management system for each farm type as of 1991. Potential nutrient removal (nutrients which are removed in the harvested portion of the crop) was estimated using cropping inventories and expected removal through the harvested crop component.

The amounts of manure nutrient generated and that removed by the crop were combined with the inorganic fertilizer application and atmospheric deposition amounts to generate a “balance" for each of the three nutrients. In previous reports a net positive balance was referred to as a surplus and a negative balance as a deficit. A negative balance could be generated since the model estimated the potential rather than actual crop nutrient removal and the potential value could be greater than the total net amount of nutrient available. The model generated a value for each AWMZ which represents a balance over the cropped land base of the zone. Such "zonal balances" do not reflect the individual farm variability which occurs within a zone. The zonal nutrient balances should only be considered relative to one another and not as “absolute” values. They should be used to highlight the zones with the highest potential for nutrient related problems.

When assessing the significance of the estimated zonal balances, it is important to understand that losses of nutrients from soils is a natural process and cannot be entirely eliminated from agricultural systems. Some application of nutrient in excess of crop removal is standard practice in order to maintain optimal soil productivity. Therefore, a "zero” background soil nutrient balance is not considered attainable under an agronomic nutrient management system. For discussion purposes, in this work, it was considered that a suitable background soil nitrogen balance might fall in the 50 to 100 kg N/ha range. Phosphorus and potassium balances were not assessed to the same degree and no suitable numerical background soil balances were proposed.

Ensuring that nutrient use matches crop requirements while still maintaining an acceptable background soil nutrient content, combined with good manure application practices, should in most circumstances provide an adequate level of protection for the receiving environment. However, to determine whether this is actually the case from an environmental or public health perspective, monitoring the ultimate destination (surface water, groundwater, soil or air) is necessary. It should be emphasized that a small annual nutrient surplus that accumulates in the soil and is additive and over a long period of time could develop into a future problem. Environmental Guidelines provide some direction in setting acceptable manure nutrient (e.g. nitrogen) application amounts (BCMAFF 1992 - 96). However, research is still needed to develop more site-specfic requirements in order to improve nutrient management practices, especially in environmentally sensitive areas of the LFV.

3.3 The Situation in 1991

The nutrient model was used to determine 1991 zonal nitrogen, phosphorus and potassium balances. Inorganic forms of nitrogen are highly mobile and have a high potential be leached from soils. The zonal balances, presented as kilograms of nitrogen per hectare (kg N/ha), reflect only the cropped area of the agricultural land base available. These values reflect the potential loss of nitrogen from soil systems into surface waters and/or groundwater.

The nitrogen balance for each of the 20 Agricultural Waste Management Zones is shown in Figure 3.1 and summarized in Table 3.1. Zonal nitrogen balance estimates ranged from minus 28 kg N/ha for the West Delta zone to a high of 408 kg N/ha for the South Matsqui zone. Positive balances were estimated for 17 of the 20 zones. Balances exceeded a background soil nitrogen level of 50 kg N/ha in 16 of the zones or in 10 of the zones at the 100 kg N/ha level. The overall nitrogen balance for the Lower Fraser Valley was estimated to be 115 kg N/ha or 6,000 tonnes. The area of the 10 zones where balances exceeded 100 kg N/ha represented 57% of the total Lower Fraser Valley cropped area. Three zones (South Matsqui, West Matsqui and South Langley) actually had balances exceeding 200 kg N/ha and represented 11% of the total cropped area.

The South Matsqui AWMZ included the majority of the Canadian portion of the Abbotsford aquifer recharge area. Agriculture has been identified as the most significant contributor to the unacceptably high levels of nitrate in some areas of that aquifer. Studies of the Matsqui Slough and Sumas River watersheds have identified agriculture as a significant contributor to degraded surface water quality in both watersheds and to degraded groundwater quality in the Matsqui Slough watershed. The boundaries of the Matsqui Slough watershed area are similar to those of the North Matsqui AWMZ , where a zonal nitrogen balance of 152 kg N/ha was estimated. The boundaries of the Sumas River watershed are similar to those of the Abbotsford AWMZ, for which a 135 kg N/ha balance was estimated (Figure 3.1).

Unlike nitrogen, phosphorus and potassium are not as mobile and therefore less likely to leach from soils. Phosphorus and potassium were assessed based on the relative ratio of the amount of nutrient the cropping system could potentially remove to the amount being applied (Figures 3.2 and 3.3). Positive phosphorus balances (where a ratio is greater than one) were estimated for all 20 zones. The net phosphorus application was more than four times the potential crop removal (indicated by a ratio of 4 or greater) in 11 of the zones. A positive potassium balance was estimated for 18 of the 20 zones and the net application was more than three times the potential crop removal in 3 of the zones. The overall balance for the LFV for phosphorus and potassium was estimated to be 85 kg P/ha and 126 kg K/ha respectively.

Phosphorus is the limiting nutrient in most healthy streams and even small amounts of extra phosphorus can stimulate plant growth in streams. The zones with numerous streams and high phosphorus balances are most at risk to phosphorus related water quality problems.

The modeling results suggest that a large percentage of the Lower Fraser Valley agricultural land base is receiving excessive applications of nutrients. Zones with nitrogen balances greater than 200 kg N/ha represented about 6,000 cropped hectares. Another 27,000 cropped hectares were within zones which had a balance between 100 and 200 kg N/ha.

More recent agricultural inventory data indicates that the total amount of manure generated nutrient has increased since 1991 (BCMAFF, 1994; Statistics Canada, 1995(a); Statistics Canada, 1995(b); Statistics Canada, 1996), However, the level of detail of the data and the absence of more current information on on-farm manure management practices does not provide the basis for adjusting the 1991 balances.

Figure 3.1 : Zonal Nitrogen Balances for Large Farms Using 1991 Census Data and Management Practices

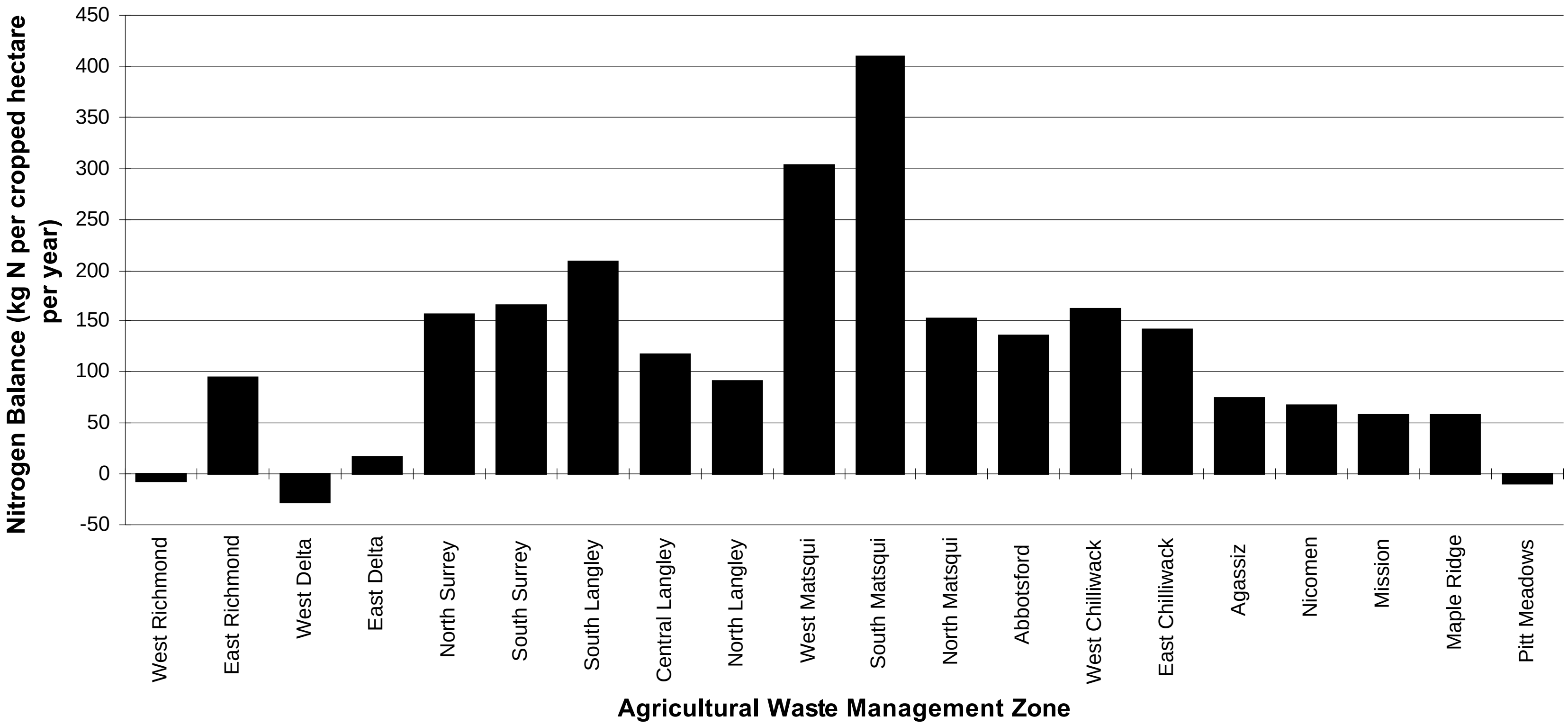


Table 3.1 **Cropped Area and Number of Zones Affected Under 1991 Management Practices for Different Background Soil Nitrogen Levels**

Soil Background Nitrogen	Management Scenario	% cropped area within LFV	Number of AWMZs
Positive Balance	1991 Management	85	17/20
> 50 kg N/ha	1991 Management	78	16/20
> 100 kg N/ha	1991 Management	57	10/20
> 200 kg N/ha	1991 Management	11	3/20

Figure 3.2 : Ratio of Net Phosphorus Application to Potential Crop Removal for Large Farms Using 1991 Census Data and Management Practices

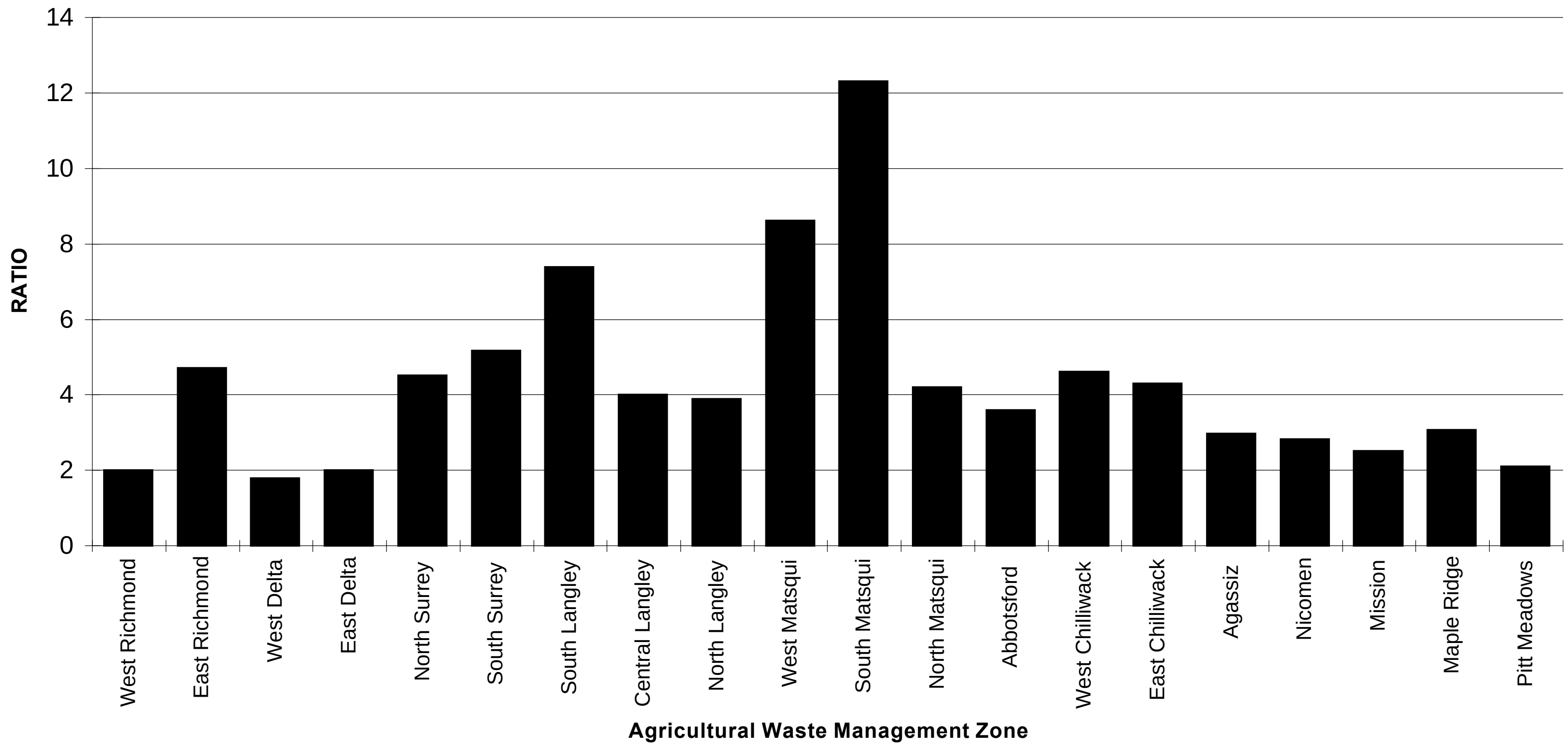
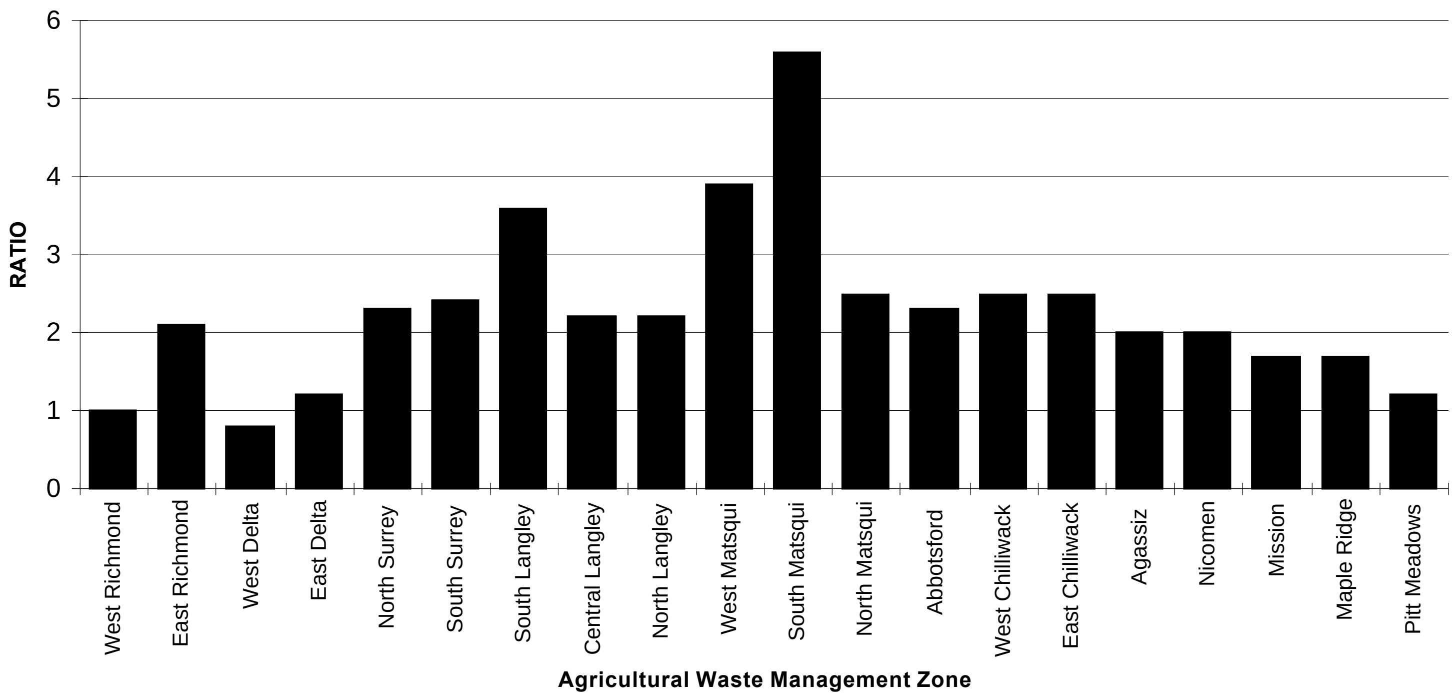


Figure 3.3 : Ratio of Net Potassium Application to Potential Crop Removal for Large Farms Using 1991 Census Data and Management Practices



4.0 IMPROVEMENTS ARE POSSIBLE

Two improved management scenarios were investigated using the nutrient model:

- **Scenario 1: where model inputs were changed to reflect a reduced rate of inorganic fertilizer application (for most crops inorganic fertilizer applications were set at 30% of the potential crop removal) and improved manure handling practices (there were no losses of manure nutrients to either surface water or groundwater prior to land application and there was, with sufficient manure storage capacity provided, no late fall or winter spreading of nutrients), and**
- **Scenario 2: where in addition to Scenario 1, a model input reflecting improved feeding strategies (reducing the amount of nutrients excreted through improved feed utilization efficiencies) was added.**

4.1 Scenario 1 - Nitrogen

Reducing the use of inorganic fertilizers and improving manure handling practices decreased the overall LFV nitrogen balance by an estimated 60%, from 115 kg N/ha to 46 kg N/ha (Figure 4.1).

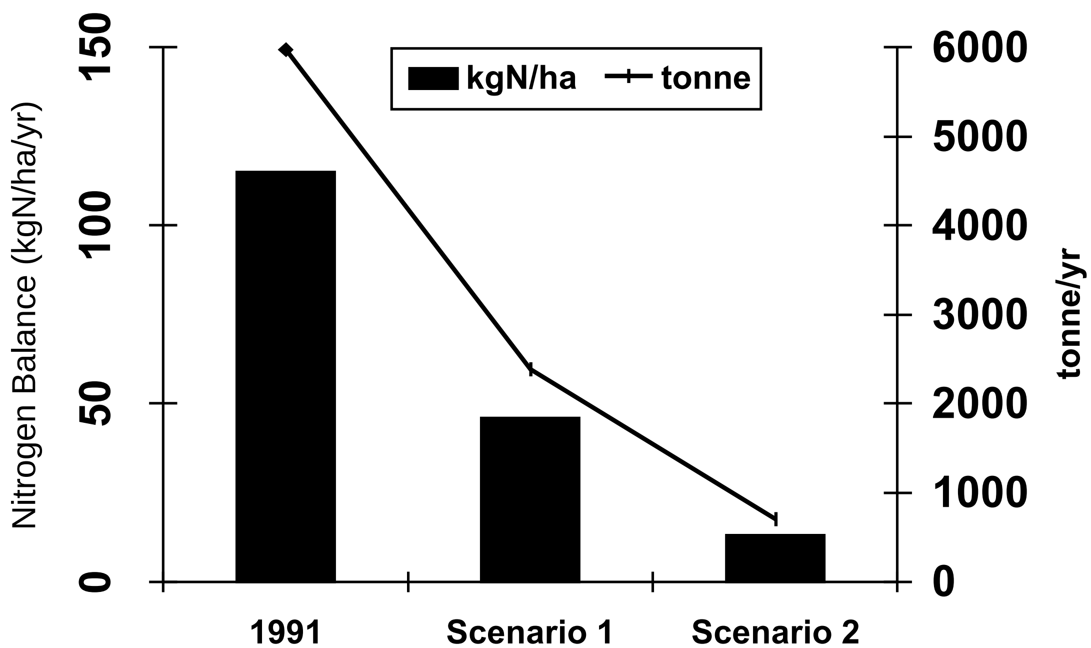
For each background soil nitrogen level considered in Section 3.2 (50 kg N/ha and 100 kg N/ha) the resulting reduction in cropped area and the number of AWMZs affected by the two management scenarios is presented in Table 4.1. With a 100 kg N/ha background level the number of zones exceeding this decreased from 10 zones (57% of the total LFV cropped area) to 5 zones (19% of the cropped area). With a 50 kg N/ha background level the number of zones exceeding this decreased from 16 zones (78% of the cropped area) to 9 zones (44% of the cropped area). Regardless of background level considered, nitrogen balances in both the South Matsqui and West Matsqui zones which together include 7% of the cropped area, remain greater than 200 kg N/ha.

Improving manure handling practices by ensuring that there are minimal losses to surface water or groundwater prior to land application and eliminating late fall and winter manure applications reduced “direct” surface runoff losses of nitrogen by approximately 50%. That nitrogen would be primarily in the form of ammonia. For the overall Lower Fraser Valley, the model estimated that the “total” losses of nitrogen to surface water would be reduced by an estimated 52% and losses to groundwater by an estimated 45%.

4.2 Scenario 2 - Nitrogen

When improved feeding strategies are added to the Scenario 1 nitrogen balance analysis, there could be a further 29% reduction of the 1991 estimate for an overall LFV balance of 14 kg N/ha (Figure 4.1). The number of zones exceeding the 100 kg N/ha background level could be decreased further, from 5 zones to 3 zones representing 11 % of the cropped area (Table 4.1). Under a 50 kg N/ha background level the number of zones could be decreased further, from 9 zones to 5 zones representing 19% of the cropped area. Only the South Matsqui zone, at 310 kg N/ha and representing 4% of the cropped area, exceeded even the highest background level

Figure 4.1 : Reduction in 1991 Lower Fraser Nitrogen Balance Under Improved Management Scenario 1 and Scenario 2



Scenario 1 : Reduced rate of inorganic fertilizer application plus improved manure handling practices

Scenario 2 : Scenario 1 plus improved feeding strategies

Table 4.1 **Cropped Area and Number of Zones Affected Under Improved Management Scenarios for Different Background Soil Nitrogen Levels**

Soil Background Nitrogen	Management Scenario		% cropped area within LFV	Number of AWMZs
Positive Balance	Scenario 1	Improved Fertilization and Manure Handling	64	12
	Scenario 2	Improved Fertilization, Manure Handling and Feeding Strategies	51	11
> 50 kg N/ha	Scenario 1	Improved Fertilization and Manure Handling	44	9
	Scenario 2	Improved Fertilization, Manure Handling and Feeding Strategies	19	5
> 100 kg N/ha	Scenario 1	Improved Fertilization and Manure Handling	19	5
	Scenario 2	Improved Fertilization, Manure Handling and Feeding Strategies	11	3
> 200 kg N/ha	Scenario 1	Improved Fertilization and Manure Handling	7	2
	Scenario 2	Improved Fertilization, Manure Handling and Feeding Strategies	4	1

considered of 200 kg N/ha. With this second scenario, nitrogen losses to surface waters are reduced by 74% compared to the 1991 situation. Losses to groundwater are reduced by 68%. Nitrogen losses to surface runoff remain much the same as they were under Scenario 1 since the major reduction in runoff results from improved manure handling practices.

4.3 Scenario 1 and 2 - Phosphorus and Potassium

The regional phosphorus balance could be reduced by 19% under Scenario 1 (from 85 to 69 kg P/ha) and by 33% (from 85 to 57 kg P/ha) under Scenario 2. The zonal phosphorus balances remain positive in 19 of the 20 zones, with a net application to potential crop removal ratio of greater than one. (Figure 4.2). The ratio is two or greater in 16 of the zones, under both scenarios. This indicates that most of the cropped area would still receive phosphorus at rates of at least twice that of potential crop removal.

For Scenario 1 the overall LFV potassium balance could be reduced by 11%, from 126 kg K/ha to 112 kg K/ha. Under this scenario the ratio of net potassium application to potential crop removal is greater than one (indicating a positive balance) in 19 of the zones (Figure 4.3). The number of zones where the ratio is two or greater, indicating a net application of at least twice the potential crop removal, is reduced from 14 to 12 (Figure 4.3). Feeding strategies (Scenario 2), which would impact the amount of potassium excreted were not investigated in this program, although there are strategies available.

4.4 Summary

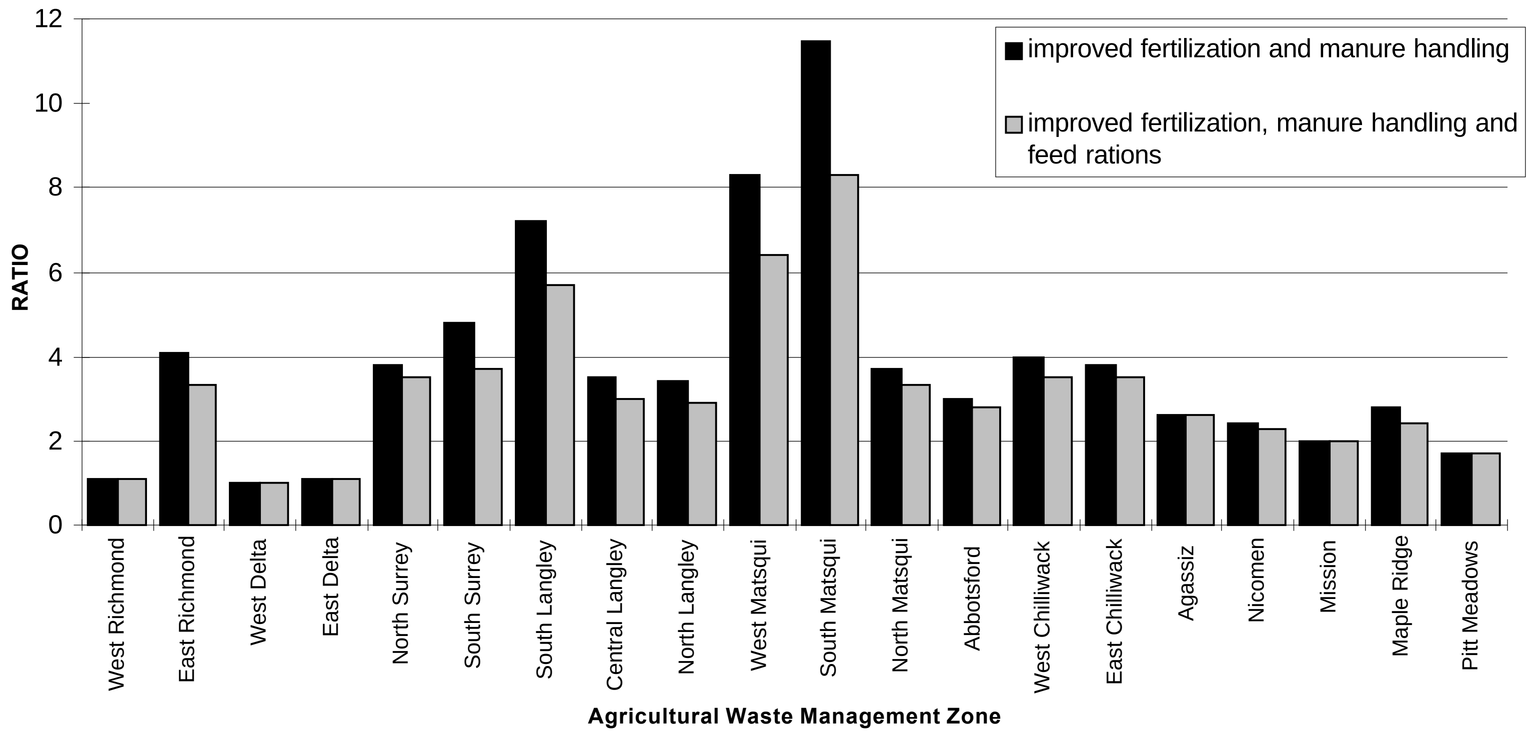
These estimates show that improvements within the farm gate (reduced use of inorganic fertilizers, improved manure handling and improved feeding strategies) plus some off-farm movement (within zones) of manure could significantly reduce nutrient loading to the receiving environment from agriculture. However, the estimates also show that even with these improvements there would remain extensive areas (entire zones) where nutrient balances are excessive. There are several zones where increased manure nutrient production may not be adequately accommodated with on-farm management and within zone manure relocation.

Agricultural nutrient management issues can therefore be considered to fall into two general categories:

- **where the available land base is adequate and on-farm management improvements will solve environmental problems, and**

- **where animal and livestock densities are too high relative to crop removal and acceptable nutrient balances can only be achieved by moving the nutrients elsewhere or by relocating the livestock or poultry.**

Figure 4.2 : Ratio of Net Phosphorus Application to Potential Crop Removal for Large Farms Under Improved Management Scenario 1 and Scenario 2



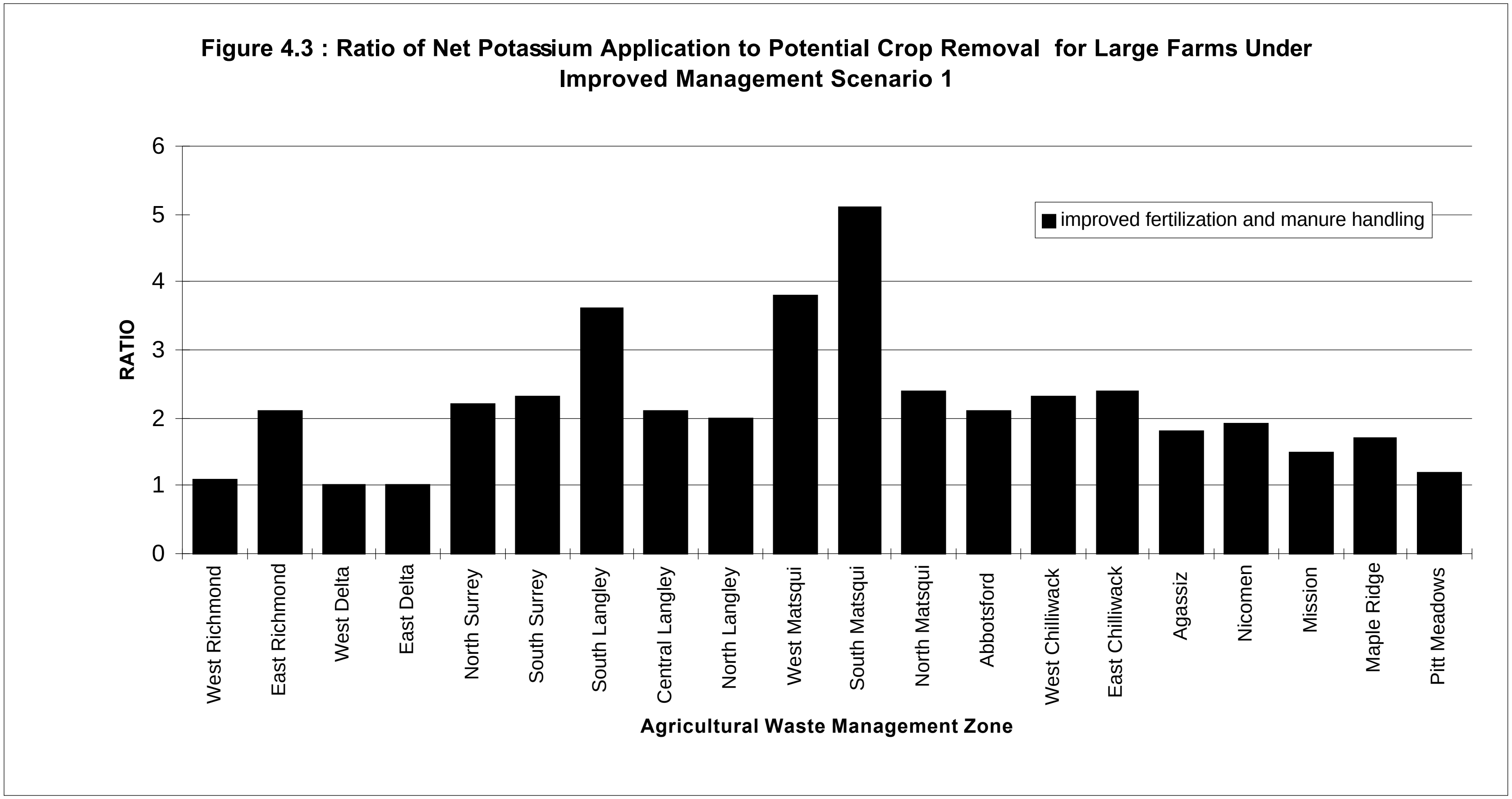


Figure 4.3 : Ratio of Net Potassium Application to Potential Crop Removal for Large Farms Under Improved Management Scenario 1
6
5
4
3
2
1
0
RATIO
improved fertilization and manure handling
West Richmond
East Richmond
West Delta
East Delta
North Surrey
South Surrey
South Langley
Central Langley
North Langley
West Matsqui
South Matsqui
North Matsqui
Abbotsford
West Chilliwack
East Chilliwack
Agassiz
Nicomen
Mission
Maple Ridge
Pitt Meadows
Agricultural Waste Management Zone

5.0 WHAT IS DONE ELSEWHERE

In reviewing what has been done in jurisdictions outside of B.C. (Runka,1995) the two major points which became evident included:

- **BC is not alone in searching for innovative ways to address the problems associated with livestock and poultry manure management and impacts on receiving environments, and**
- **there is no one model used elsewhere that can be considered as a prototype for addressing livestock waste management issues in the Lower Fraser Valley. However, experience from other jurisdictions could help with developing a "made in" the Lower Fraser Valley livestock waste management policy**.

Several other significant points were also highlighted in the review including:

- **in areas of intensive livestock production in Europe, the USA and Canada, waste management and associated environmental considerations are becoming increasingly key public policy issues**,
- **approaches to livestock waste management practices, legislation, regulation and policy are extremely dynamic. Changes result from new research findings, applied experience, industry economics and integration with other environmental and land use planning policy,**
- **governments, agencies and farmers are struggling with intensive livestock waste management issues, but with so many areas of concern and such a diverse and complicated system, the best solutions to these problems remain to be found,**
- **actions taken elsewhere have often been more of an effort to abate the problems while continuing to search for longer term solutions,**
- **any consideration of off-farm central processing of livestock waste must be subjected to a rigorous economic and technical analysis as a result of unfavorable experiences elsewhere, and**
- **education of the producer, government resource manager and the public is given a high priority in several agricultural waste management strategies being used elsewhere.**

Experience with central processing of livestock manure in the Netherlands has shown that the capital costs for the facility were in the order of $84 per tonne of capacity and that the value of the product produced was $21 to $28 per tonne less than operating costs (Wohl, 1996).

6.0 IDENTIFYING WHAT NEEDS TO BE DONE

To focus the discussion on which potential options to include in a Lower Fraser Valley agricultural waste management policy, three major areas that needed to be addressed were identified. They included:

- **stabilizing the nutrient loading to prevent problems from getting worse,**
- **reducing the nutrient loading in areas where this is clearly necessary, and**
- **achieving agronomic and environmental sustainability (an acceptable long term nutrient balance).**

In order to progress towards acceptable solutions the need for educational, technical and regulatory options are necessary. The options could include one or several of the following components:

- **research,**
- **development of guidelines and Best Management Practices,**
- **extension,**
- **development and demonstration of appropriate technology,**
- **policy, legislation, regulation and enforcement, and**
- **evaluation.**

The two types of agricultural waste management issues for which the options were required included:

- **those where the available land base is adequate to effectively utilize the nutrients and on-farm improvements will prevent pollution and achieve an acceptable background nutrient level, and**

- **those where sufficient land is not available and where livestock numbers must be decreased or nutrients (manure) relocated in order to achieve an acceptable background nutrient level.**

An initial list of potential options was developed based on the information identified in jurisdictions other than BC and from individuals with local LFV experience - including that of the Technical Committee. With the initial options list as a starting point, a series of meetings and a workshop (Brisbin and Runka, 1996) were held to discuss and evaluate the options. Input from BCMAFF staff, representatives of conservation farming groups and a workshop held for producers was used to develop the final list. Those options considered to have the best chance of helping to solve the agricultural waste management problems in the Lower Fraser Valley are discussed in the following Chapter.

7.0 AN OUTLINE FOR ACTION

The knowledge gained through the Management of Agricultural Wastes in the Lower Fraser Valley program strongly indicated a need to improve and track nutrient management practices in the LFV. To achieve this, it would be best that a group of stakeholders take on this role and be responsible for guiding the course of action that is required.

7.1 NEEDS DEFINITION

The broader need is to attain environmental and agronomic sustainability in the LFV with respect to nutrient management. Sustainable agri-food systems have been defined as "those that are economically viable, and meet society's need for safe and nutritious food, while conserving or enhancing natural resources and the quality of the environment for future generations" (The Advisory Committee to the Accord on Environmental Sustainability in the Agri-Food Sector, 1993).

The key actions identified in this project are summarized in Table 7.1. The following discussion on environmental protection issues concentrates on the three major nutrients contained in animal manure (nitrogen, phosphorus and potassium). It is anticipated that with proper management of these key nutrients, other manure contaminants (e.g. pathogens) would not likely be an issue.

7.1.1 Groundwater Quality Protection

The principal need for groundwater quality protection is to prevent further increases in nitrate levels in groundwater sources. In areas where nitrate levels exceed the drinking water standard of 10 mgN/l, the nitrogen loading must be reduced so that acceptable groundwater nitrate concentrations are met. Other issues such as pesticide use and management with respect to agriculture and environmental quality were not addressed in this program.

The area most evidently requiring attention, to address groundwater quality concerns, is the Abbotsford aquifer. The deterioration in groundwater quality in this area has received considerable notoriety. This area has been identified as the portion of the LFV which experiences the largest excess application of nitrogen and which didn't respond to the two management scenarios reported herein (Brisbin, 1995b). Agriculture is considered the major contributor to high nitrate levels. A technical action plan aimed at reducing contaminant loading to groundwater from agriculture and other sources has already been prepared (Technical Subcommittee to the Federal/Provincial Groundwater Coordinating Committee, 1995) and needs to be enacted.

The strategy outlined in the technical action plan included:

- **designation of the area over the aquifer as a sensitive water supply area,**
- **development of a "package" of suitable land use practices for the designated area and development of environmental safeguards,**
- **a legislated management system (authorized under the recommended groundwater legislation and developed with input from all stakeholders) to**

Table 7.1 Key Actions Needed to Achieve Protection of Groundwater, Surface Water, Air and Soil Quality

Key Actions	Groundwater Quality Protected	Surface Water Quality Protected	Air Quality Protected	Soil Quality Protected
General	- Nitrate levels do not increase. - Nitrogen loading reduced before nitrate concentration reaches 10 mgN/L. - Abbotsford aquifer Technical Plan adopted and implemented. - Groundwater protection legislation adopted and implemented.	- Compliance with Code of Agricultural Practice and Fisheries Act. - Riparian zones and buffer strips established. - Water quality objectives developed and implemented.	- Issues fully defined. - Monitoring conducted to better understand and improve nutrient model.	- Soil quality maintained for all uses. - Potassium levels reduced In high potassium soils.
BAWMP Process (Table 7.2)	- Nutrients applied at agronomic rates and at appropriate times. - No leachate or runoff form housing or storage structures. - Nutrient surpluses identified and recommended solutions acted on. - Soil and manure nutrient analysis program recommended. - Increased on-farm feed production promoted.	- Nutrients applied at agronomic rates and at appropriate times. - No leachate or runoff form housing or storage structures. - No surface water runoff during manure applications. - Nutrient surpluses identified and recommended solutions acted on. - Riparian area management promoted and guidelines developed.	- Nitrogen volatilization losses minimized.	- Nutrient management plans developed with emphasis on potassium. - Routine soil, manure and crop sample analysis and interpretation promoted. - Benefits of soil organic matter promoted. - Conservation farming techniques promoted to prevent soil erosion.
Manage Excess Nutrients (Table 7.3)	- Excess manure moved to areas where use is sustainable. - Land exchanges (crop rotations between farms) promoted. - Livestock and/or poultry production relocated to areas where it is sustainable.	- Excess manure moved to areas where use is sustainable. - Land exchanges (crop rotations between farms) promoted. - Livestock and/or poultry production relocated to areas where it is sustainable.		- Excess manure moved to areas where use is sustainable. - Land exchanges (crop rotations between farms) promoted. - Livestock and/or poultry production relocated to areas where it is sustainable.
Manage Land Use (Table 7.4)	- Underutilized agricultural land use optimized. - Agricultural land preserved. - Commercial agricultural units preserved. - Watershed based approach used for land use planning. - Land use monitored and reported regularly.	- Underutilized agricultural land use optimized. - Agricultural land preserved. - Commercial agricultural units preserved. - Watershed based approach used for land use planning. - Land use monitored and reported regularly. - Aquatic and terrestrial habitat planning improved.		- Soil quality monitored and reported regularly.
Awareness and Alternatives (Table 7.5)	- Promote “area” conservation groups (area = watershed, recharge area) using a community rather than only a commodity based model. - Promote stewardship.	- Promote “area” conservation groups (area = watershed, recharge area) using a community rather than only a commodity based model. - Promote stewardship.	- Airshed concept promoted.	- Promote conservation farming groups. - Promote stewardship.

openly and fairly enforce the suitable land use practices and environmental safeguards, and

- **a communication plan to educate, and obtain the cooperation of all stakeholders reliant on this water resource.**

The technical action plan also included the following specific recommendations for action with respect to agricultural nutrient management:

- **improved manure and fertilizer nitrogen management over that portion of the aquifer in agricultural production,**
- **identification of alternate uses of poultry manure, and enhanced movement of manure off the aquifer,**
- **initiation and continuation of research and monitoring activities, and**
- **implementation of a wellhead protection plan.**

The recommendations of the technical action plan are ambitious, particularly the recommendation for a legislated land use management system. However, considering that the Abbotsford aquifer recharge area (South Matsqui AWMZ) does have the highest nitrogen balance in the Lower Fraser Valley and that the aquifer is an important international drinking water resource for 100,000 people, ambitious action is required.

There are other areas in the LFV where excess nutrient applications are contributing to groundwater contamination and for which similar actions could be required. For these areas, a plan with a focus on integrated on-farm waste management planning (Section 7.2) could be adequate to resolve most of the problems.

The absence of groundwater protection legislation has been identified as a key obstacle to controlling activities which lead to groundwater contamination. The implementation of groundwater legislation allowing for the regulation of activities which can degrade groundwater resources is needed.

7.1.2 Surface Water Quality Protection

The primary nutrient management concern for the protection of surface water quality relates to controlling "direct" surface runoff sources. This runoff can result in the excessive loading of several contaminants (including ammonia, phosphorus, pathogens, solids, oxygen demanding material, and organic matter). There are also issues with "subsurface drainage" water sources where concerns would primarily be over nitrate and phosphorus loading.

Minimizing the amount of contaminated yard or field runoff can significantly reduce the loading of contaminants into water courses. When runoff containing these contaminants is allowed to flow through the soil profile, the physical filtering and biological activity (crop uptake and transformation) which takes place reduces the concentration of many of the contaminants that would reach subsurface and groundwater sources.

Nitrogen in the ammonia form can be toxic to fish at low concentrations (1.5 mgN/l). This form of nitrogen can easily be introduced into streams through manure contaminated surface runoff. As ammonia moves through the soil it is subject to microbial action and would likely be oxidized to nitrate, a much less toxic form of nitrogen. As nitrate, average concentrations of less than 40 mgN/l may present no toxicity problems to aquatic life. Concentrations less than 10 mgN/l are considered acceptable for drinking water. Nitrate concentrations below 40 mgN/l would contribute to eutrophication of surface waters although phosphorus is more often considered the limiting nutrient in this process.

The primary pathway for phosphorus entering surface water is usually via "direct" surface runoff since most soils have a high capacity to immobilize phosphorus. However, if this immobilization capacity is fully utilized then phosphorus could leach through the soil into subsurface drainage waters and eventually enter surface waters. Little information is available actually quantifying the phosphorus loading from agricultural lands.

There are several documented cases of eutrophication of LFV watercourses. More monitoring would likely further demonstrate the problems associated with NPS pollution and the need to manage it. Integrated watershed based monitoring programs would help to develop a better understanding of some of the interactions that exist between land management practices and environmental quality in different areas of the LFV. Water quality parameters of typical concern to agricultural waste management include ammonia, nitrate, phosphorus, bacteria, solids, oxygen demand, pH, organic matter, dissolved oxygen and chlorophyll-a (as a measure of algae production).

The concern over "direct" surface runoff introducing contaminants to surface water highlights the need to consider management practices in riparian areas, those areas immediately adjacent to watercourses. There are competing demands for lands next to watercourses. In general, setting aside an area required to optimize environmental protection benefits would be viewed by producers and others as a significant reduction in the area available for crop production. However, research shows that surface runoff quality can be greatly improved by providing "relatively" small vegetated buffer strips next to watercourses. Proper management and restoration of these areas can greatly improve water quality and the productivity of the aquatic habitat. There are potential benefits to producers through improved irrigation and livestock water quality and reduced soil erosion.

Addressing the needs of land and stream stewardship together is an appropriate strategy to develop management guidelines for riparian areas. Guidelines should consider the level of improvement provided to both the land base and the water resource under various management practices. The variability in LFV watersheds including the agricultural and urban landscape and the degree of physical alteration of some watercourses highlights the need to plan on a watershed basis.

7.1.3 Air Quality Protection

Ammonia emissions may be the most important air quality concern related to agricultural waste management in the Lower Fraser Valley. Ammonia may be a key component in the formation of small particulate matter. Small particulate matter is a major health and visibility concern (BCMELP, 1994), particularly in the eastern portion of the Lower Fraser Valley. Agriculture is believed to be the most significant source of ammonia to the LFV airshed (Levelton, 1995; Brisbin, 1995b).

Although LFV air quality issues are being addressed by BC Ministry of Environment, Lands and Parks, the Greater Vancouver Regional District and Environment Canada, the dynamics of small particulate formation is not yet well understood. The chemical and physical processes which occur in the air are complex and it is not known if reducing ammonia emissions would result in a reduced amount of small particulates (ammonia may not be the limiting factor in small particulate formation) or if reducing the amount of ammonia would create a different but still serious problem.

Given the available information the general view, at least for agricultural waste management, is not to consider practices where ammonia emissions are increased beyond that of current practices. There should be continued research and demonstration of management practices (several have been developed elsewhere) which reduce the amount of ammonia lost to the atmosphere. It may be that reducing losses of nitrogen as ammonia and having more nitrogen available for land application is attractive and optimizes the use of manure as a nutrient in crop production.

7.1.4 Soil Quality Protection

Within the context of agricultural nutrient management, the over application of potassium to soil is the major concern. The application of excessive amounts of potassium is not uncommon (Schmidt, 1994; Brisbin, 1995b), a situation which leads to high concentrations in forage crops and creates costly dairy herd health problems.

Efforts are required to identify high potassium soils. The development, promotion and implementation of management practices which will reduce the amount of potassium added to these soils and thereby reduce the associated dairy herd health problems is necessary.

7.2 RECOMMENDED KEY ACTION ACTIVITIES

A balanced management approach incorporating education, coordinated planning and enforcement is recommended for the LFV. This approach is consistent with what is supported by other work on NPS pollution. A coordinated planning model, rather than the status quo or a regulatory control model, has been suggested as the best approach to meeting the requirements of a NPS management strategy in B.C. (KPMG,1996).

For each of the key actions, recommended activities have been identified and are summarized under the following groupings: research and guidelines; extension; technology development and demonstration; policy, legislation, regulation and enforcement; and evaluation.

7.2.1 The BAWMP Process

A key recommended action is the development and implementation of Best Agricultural Waste Management Plans (BAWMPs) for all Lower Fraser Valley farms.

These integrated on-farm waste management plans would identify environmental problems on individual farms, evaluate and recommend alternative solutions and encourage the implementation of chosen alternatives. Key actions in support of BAWMPs are summarized in Table 7.2.

A comprehensive BAWMP would address the following issues for individual farms:

- **nutrient handling and utilization plan,**
  - ⇒ application rates (based on the soils and crops of the available land base and using soil, manure and plant tissue sampling programs, to ensure acceptable nutrient balances)
  - ⇒ application timing (to minimize surface runoff and maximize the utilization of manure nutrients)
  - ⇒ application methods
- **manure storage,**
  - ⇒ capacity
  - ⇒ location
  - ⇒ integrity
- **off-farm movement of manure if required,**
  - ⇒ with or without some level of on-farm treatment
- **reduction in manure nutrients on the farm,**
  - ⇒ changes to feed rations and feeding strategies
  - ⇒ greater utilization of home grown feed
- **riparian area management, and**
- **conservation farming techniques.**

There are currently not enough farms in the LFV which have developed and implemented BAWMPs to provide the desired level of environmental protection. If all farms were to develop and implement a comprehensive BAWMP, agricultural nutrient management problems could largely be resolved. The BAWMP process requires encouragement through educational promotion and to some degree through enhanced enforcement of current regulations. There are several technical issues which require further research and further guideline development and potential management techniques which require evaluation and demonstration.

7.2.2 Management of Excess Nutrients

When the land base of an individual farm is not sufficient to effectively utilize the nutrients brought onto the farm (as feed and inorganic fertilizer), then the surplus must be managed in other ways (Table 7.3). In some cases an excess nutrient problem can be solved by reducing the nutrient content of manure through changes in feed rations and feeding strategies. Changing cropping patterns may also be effective so that more nutrients are removed by the crop.

There will be farms which still have excess nutrients even after the adoption of different feeding strategies and cropping patterns. In these situations the solutions may involve either moving the excess nutrients to locations where they can be accommodated by

Table 7.2 Recommended Activities to Support BAWMP Process

Conduct Research (R) & Develop Guidelines (G)	- Nutrient application rates and timing determined for all crop types (R,G). - Earthen manure storage construction facility standards (G). - Soil and drainage water phosphorus levels (R). - Manure application methods (R,G). - Atmospheric nitrogen deposition rates (R). - Runoff quantity and quality modeling for risk assessment (R). - Buffer strip and riparian area management (G). - On-farm manure treatment systems (R,G). - Feed rations and feeding strategies (R,G). - Water quality objectives (R,G). - Cover cropping and inter-cropping (R,G).
Extension	- Promote implementation strategy for BAWMPs. - Develop BAWMP training and accreditation. - Regular seminars involving stakeholders.
Technology Development & Demonstration	- Promote "demonstration " farms.
Policy, Legislation & Regulation	- Develop implementation strategy for BAWMPS for: (i) new and expanding farms. (ii) all farms within areas with an identified need. (iii) all farms over a specified size or animal density.
Enforcement	- Enforcement of Code of Agricultural Practice. - Timing of manure applications. - Manure storage capacity, location and integrity. - Compliance with nutrient management plan. - Random evaluation of development and implementation of BAWMPS. - Granting of building permits dependent upon proof of environmental prevention and protection.
Evaluation	- Evaluate BAWMP implementation using GIS. - Water quality evaluation programs. - Evaluate success of Agricultural Waste Control Regulation. - Evaluate priority watersheds

Table 7.3 Recommended Activities to Support Excess Nutrient Management

Conduct Research (R) & Develop Guidelines (G)	- Reduce nutrients (feed) imported onto farm (R,G). - Identify and develop alternative manure products to market (R). - Identify and develop markets (R). - Identify crop inorganic/organic nutrient requirements (R,G).
Extension	- Promote BAWMP process. - Promote awareness and alternatives. - Encourage use of organic rather than inorganic nutrient sources. - Encourage producers to develop and implement BAWMPs - Educate end user of manure nutrient value. - Provide information in languages other than English. - Encourage non-livestock producers and hobby farmers to use manure wisely.
Technology Development & Demonstration	- Assess new developments in central treatment. - Develop and implement zone and/or regional nutrient accounting system. - Assess development in small scale treatment processes.
Policy, Legislation & Regulation	- Develop and implement groundwater legislation. - Designate protected water supply areas and habitats through Environmentally Sensitive Areas (ESAs) assessments. - Adopt Technical Action Plan for Canadian portion of Abbotsford aquifer. - Assess need to limit further expansion of livestock and/or poultry in ESAs. - Assess need to limit livestock and or poultry densities in areas of LFV.
Enforcement	- Enforcement of Code of Agricultural Practice. - Timing of manure applications. - Manure storage capacity, location and integrity. - Compliance with nutrient management plan. - Random evaluation of development and implementation of BAWMPS. - Granting of building permits dependent upon proof of environmental prevention and protection.
Evaluation	- Evaluate zonal and regional nutrient balances using 1996 Census. - Develop regional data base to track generation and destination of manure. - Continue water quality monitoring. - Evaluate success of Agricultural Waste Control Regulation. - Monitoring areas receiving manure from elsewhere.

the land base or moving some of the livestock or poultry operations to locations where an adequate land base is available to utilize the nutrients through crop production.

There are some situations where an acceptable balance can be achieved by moving manure to nearby farms. There are other cases (South Matsqui AWMZ being the most noteworthy) where excess nutrients are a feature of a large geographically distinct area. More ambitious efforts to move manure to a suitable area are required in these cases. Suitable destinations and markets for this manure are needed. Transportation issues will need to be addressed. Transportation costs will be an issue which may be at least partially off-set by the nutrient value in the manure. There is a need to find or develop suitable equipment for handling manure, for loading at the originating farm, for transport, and for storage and application at the receiving location. Along with the need for a “broker” to develop markets for the excess manure and ensure market continuity, there will be a need for some on-farm treatment to improve marketability and to facilitate handling and transport.

Continued research on technologies for on-farm treatment and development of potential markets is required. More promotion of the use of organic based nutrient sources as an alternative to inorganic nutrients is needed.

7.2.3 Land Use Management

There are several key land use management actions which are required to support improvements to agricultural nutrient management while maintaining agricultural productivity (Table 7.4). The need to preserve the agricultural land base for manure nutrient management has not lessened. However, ensuring a balance exists between nutrient supply and crop demand is a necessity. Preserving large commercially cropped agricultural units to handle livestock and poultry manure production is required as part of any plan to achieve acceptable zonal nutrient balances. Reducing animal production in certain areas to achieve an acceptable balance should also be considered.

Other important land use management actions involve the designation of areas where restrictions to agricultural activities are warranted. Developing compensation mechanisms (e.g. property taxation policies) are needed that off-set the lost opportunity to producers who, rather than farm sensitive areas, leave them in a more natural condition. Most importantly there is a need for encouraging environmental stewardship and taking a more watershed based land use planning approach. All areas of development and activities (urban, parks, forests) within a watershed need to be considered in efforts to develop an integrated land management approach for the LFV.

7.2.4 Awareness and Alternatives

Increasing producer and public awareness of issues and alternatives to current practices is key to fostering the attitude needed to achieve increased environmental sustainability (Table 7.5).

Table 7.4 Recommended Activities to Support Land Use Management

Conduct Research (R) & Develop Guidelines (G)	- Determine optimal potential for underutilized agricultural land base (R,G). - Develop and demonstrate watershed land use planning model (R).
Extension	- Assess self-sufficiency and concept of "ecological footprint" within LFV further.
Technology Development & Demonstration	- Develop and implement nutrient accounting system.
Policy, Legislation & Regulation	- Designate protected water supply areas and habitats through ESAs. - Maintain preservation of agricultural land through ALC. - Adopt Technical Action Plan for Canadian portion of Abbotsford aquifer. - Maintain commercial agricultural units. - Ensure land use planning and management of uplands protect agricultural land. - Provide protection to producers from imports from areas with lower environmental standards. - Evaluate environmental subsidies to producers in competing areas. - Investigate expanding ALC mandate to include environmental issues.
Enforcement	- Assess use of bylaws and granting of building permits dependent upon proof of environmental prevention and protection.
Evaluation	- Evaluate zonal and regional nutrient balances using 1996 Census. - Develop regional data base to track generation and destination of manure. - Support water quality monitoring.

Table 7.5 Recommended Activities to Support Awareness and Alternatives

Conduct Research (R) & Develop Guidelines (G)	- Evaluate protein quality in feed (R). - Develop increased self-sufficiency in livestock feed (better utilization of homegrown feed) (R). - Develop and evaluate different production systems (e.g. more dairy on pasture) (R,G). - Evaluate ground ear corn production with utilization of stalks as low energy, low potassium feed for dry cows (R).
Extension	- Support existing commodity and area conservation groups. - Develop "area" conservation groups based on community model. - Support agency extension efforts. - Promote increased awareness of agriculture by non-farm public. - Support proper training of peer advisors through Agricultural Environmental Protection Council (AEPC). -Promote increased awareness by producers of wildlife and aquatic life habitat needs. - Assess, review and report on current activities of groups and programs with an interest in agricultural nutrient management.
Technology Development & Demonstration	- Promote land sharing (e.g. crop rotations between farms).
Policy, Legislation & Regulation	- Assess new developments in agricultural policy, nationally and internationally.
Enforcement	- Promote increased awareness by producers of regulations.
Evaluation	- Evaluate success of implementation and effectiveness of various programs and initiatives and report to stakeholders.

Many of the needed actions will occur on-farm and it will be producers who implement and manage the changes. In order for producers to properly fulfill their roles as stewards and managers of agricultural lands, their awareness of environmental stewardship issues needs to be increased. Producers are a vital link in the solution making process chain and need to be informed about alternative approaches and other interests.

Continuing extension and technology demonstration programs are important. Government agencies can provide some of this, however the efforts of groups which include producers, such as the sustainable farming groups, are considered a highly effective means for developing increased awareness and cooperation.

7.3 LEADERSHIP AND RESOURCES

The Code of Agricultural Practice in 1992 set the legislative benchmark for change and from which to evaluate progress. Documenting that process and progress is often lacking. Some progress towards meeting the “Code” and achieving environmental sustainability has been made in recent years with the assistance provided through various initiatives focusing on agricultural issues.

Government agencies (BC Ministry of Agriculture, Fisheries and Food, BC Ministry of Environment, Lands and Parks, Agriculture and Agri-Food Canada , Environment Canada and Department of Fisheries and Oceans) and research institutions (UBC’s Sustainable Development Research Institute) have devoted person and financial resources to address complex issues.

The Canada-B.C. Green Plan for Agriculture has provided assistance to:

- **the Sustainable Practices Program which included cost sharing for on-farm waste management improvements,**
- **formation and functioning of Producer Conservation Organizations whose work was directed by producers and included extension, problem definition, applied research and technology development and demonstration,**
- **numerous joint industry and agency applied research projects,**
- **planning, monitoring and evaluation programs, and**
- **public and producer awareness initiatives.**

The Fraser River Action Plan has provided assistance for:

- **environmental quality monitoring programs,**
- **the development of environmental stewardship,**
- **economic and planning studies,**
- **enforcement,**
- **pollution abatement,**
- **habitat enhancement, and**
- **atmospheric data acquisition.**

The Eco-Research Program provided assistance to:

- **foster advanced research and training in environmental studies including NPS pollution and watershed management in the LFV.**

If the current level of effort was maintained there would be continued progress on several fronts. Any progress made to date could potentially be offset with increased and unmonitored intensification in the livestock and poultry industries and especially in the context of the whole LFV.

The Canada-B.C. Green Plan for Agriculture, the Fraser River Action Plan and the Eco-Research program all effectively wind down as of March 1997 to March 1998. Governments are under continual pressure to reduce their agency budgets, affecting resources that can be applied to agricultural issues. It is uncertain whether the positive momentum recently evident to address agricultural environmental issues, will continue in some other form.

In order to continue to make measurable progress towards addressing agricultural waste management issues, new approaches and funding sources will need to be considered. Sources might include “green” charges on agricultural products to support programs, levies on imports from areas where the costs of environmental compliance are not as great and possibly changes in taxation measures to promote practices that incorporate and meet stewardship requirements. It was beyond the scope of this program to estimate the cost of all the on-farm works needed to achieve environmental sustainability in Lower Fraser Valley agriculture. However, this project identified potentially significant reductions in on-farm operating costs (in the order of $12 million for LFV) that could be realized through reductions in inorganic fertilizer use and potentially re-invested in the industry.

The objective of long term environmental sustainability in agriculture can only be achieved over a period of years. There is a need to track that process and especially within key AWMZs. A management framework is required, one which will continue to build upon the progress which has been made to date. Determining what that detailed framework might be was beyond terms and scope of this program. There are several agencies and organizations (Appendix B) which have a mandate or interest in agricultural nutrient management and should have input into the development and implementation of a management framework. All parties need to understand what each others management issues and obstacles are, and then, set to working together to develop long term cooperative arrangements that have win-win solutions.

With such a large and diverse group of interested parties and the need for action on several fronts, coordination is essential. Information must be shared between the different agencies and organizations, which may require establishing a coordinating entity. Advancing and setting priorities for research, development of guidelines and other activities is a role that needs to be embraced by all parties.

There is some degree of coordination of activities at present but a more formal and detailed level of planning, cooperation and coordination is recommended. Leadership in initiating and developing that process could be provided by the provincial government. Producers do not appear to favor local governments as the responsible entity for managing land use related to agriculture.

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APPENDIX A

Management of Agricultural Wastes in the Lower Fraser Valley

List of Reports

Report Number	Title
1	Agricultural Inventory of the Lower Fraser Valley - Data Summary Report (Brisbin, 1994)
2	Application of Inorganic Fertilizers in the Lower Fraser Valley (Brisbin, 1995)
3	Agricultural Nutrient Pathways (Brisbin and Runka, 1995)
4	Agricultural Nutrient Management in the Lower Fraser Valley (Brisbin, 1996)
5	Livestock Waste Management Practices and Legislation Outside British Columbia (Runka, 1995)
6	A Literature Review of the Economics of Manure Management Options (Wohl, 1996)
7	Producer Workshop Proceedings - Agricultural Waste Management in the Lower Fraser Valley (Brisbin and Runka, 1996)
8	Description of Selected Waste Management Problems, Options and Strategy (Brisbin, 1996)

APPENDIX B

Agencies and Organizations with an Interest in Agricultural Nutrient Management in the Lower Fraser Valley

Provincial Government
- BC Ministry of Environment, Lands and Parks
- BC Ministry of Agriculture, Fisheries and Food
- BC Ministry of Health
- BC Agricultural Land Commission

Federal Government
- Department of Environment
- Department of Fisheries and Oceans
- Department of Agriculture and Agri-Food

Local Governments
- Greater Vancouver Regional District
- Fraser Valley Regional District
- Municipal Governments

Producer Groups
- BC Federation of Agriculture
- BC Horticulture Coalition
- BC Cattlemens Association

Universities and Colleges
- University of British Columbia
- University College of the Fraser Valley

Conservation Groups
- Dairy Producers' Conservation Group
- Sustainable Poultry Farming Group
- Hog Producers' Sustainable Farming Group
- Horse Council of BC Environmental Protection Practices Program
- Sumas Prairie Soil Conservation Group
- Matsqui / Langley Soil Conservation Group
- Delta Conservation and Farm Stewardship Project

Industry Groups

Environmental Groups

Public

(this is not intended to be complete list of all groups which may have an interest in agricultural waste management)