AN ASSESSMENT OF ALTERNATIVES FOR THE COLLECTION AND DISPOSAL OF PESTICIDE CONTAINERS IN MANITOBA

by
David Wayne Dessens

A Practicum Submitted
in Partial Fulfillment of the
Requirements for the Degree
Masters of Natural Resources Management

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The University of Manitoba
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A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of Master of Natural Resources Management.

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ABSTRACT

Collection and disposal of empty pesticide containers from agricultural areas presents unique problems to waste managers, because toxic pesticide residues often remain within the containers. Human exposure to these residues creates a potential health risk to rural populations in agricultural areas, and improper disposal of these containers may result in soil and groundwater contamination. Approximately 500,000 pesticide containers are used annually in Manitoba.

Manitoba has established a loose program to collect and dispose of containers, and approximately 150 collection areas have been designated for their voluntary drop-off by farmers and other pesticide users. Unfortunately, many collected containers are burned (producing potentially toxic emissions), some are buried at local landfills or dumps, and only a few are recycled. This collection program also does not account for as many as 250,000 containers used in Manitoba each year.

Residues can be rinsed from containers to such a degree that containers can be treated as solid waste, but containers are often not rinsed before being dropped off at collection areas. Rinsing must therefore be guaranteed through an improved collection process, either by requiring containers to be clean if they are to be accepted, or by rinsing all containers once they are collected.

Collection and subsequent disposal of containers may be accomplished through a variety of alternative programs. Container collection is possible through a modification of the current voluntary program, a deposit-refund system, a subsidy program, or direct regulation. Disposal of collected containers can then be accomplished through burial, incineration, recycling or reuse, although application of these disposal alternatives is limited in some cases. Comparison of various alternatives is possible through consideration of specific criteria used to evaluate each program. These criteria are: environmental effectiveness, economic efficiency, political and administrative feasibility, flexibility, and compatibility with existing institutional frameworks.

A container management program can be administered publicly, privately, or jointly through an integration of public and private sectors. The program can also be centralized or decentralized, depending upon the size and extent of the overall program. This research indicates the need for a joint administration that may be centralized if the program is limited to Manitoba, or decentralized if the program covers several provinces. The best collection alternative appears to be a deposit-refund system, and burial appears to be the most practical current disposal alternative.

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LIST OF ABBREVIATIONS AND ACRONYMS

CEPA - Canadian Environmental Protection Act

CPIC - Crop Protection Institute of Canada

DGHTA - Dangerous Goods Handling and Transportation Act (Manitoba)

EA - Environment Act (Manitoba)

EMS - Environmental Management Service

EPS - Environmental Protection Agency (United States)

FIFRA - Federal Insecticide, Fungicide, Rodenticide Act (United States)

HDPE - High Density Polyethylene

MDA - Manitoba Department of Agriculture

MEWSH - Manitoba Environment and Workplace Safety and Health

MGEA - Manitoba Government Employees Association

PCPA - Pest Control Products Act (Canada)

PFCA - Pesticides and Fertilizers Control Act (Manitoba)

PHA - Public Health Act (Manitoba)

TDGA - Transportation of Dangerous Goods Act (Canada)

WCD - Weed Control District

WHMIS - Workplace Hazardous Materials Information System Act (Manitoba)

WSHA -Workplace Safety and Health Act (Manitoba)

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Chapter I

AN OVERVIEW

1.1 INTRODUCTION

Empty pesticide containers are a serious pollution problem in agricultural areas such as rural Manitoba. The actual containers in which chemical pesticides are packaged are a solid waste, and pesticide residues within unrinsed containers constitute a hazardous material. Containers may still retain traces of the original chemical contents, even when rinsed of residues (Trask, 1985b; Miles et al, 1983). These containers are often discarded in ditches, creeks, rivers, fields, and in unlined rural public landfills (McKinley, 1985; Miles et al, 1983). Such disposal practices create significant litter and pollution problems for which no easy solutions exist.

Eliminating empty pesticide containers from Manitoba's environment initially requires a two-fold program. Containers must first be collected from users, and then disposal of collected containers must be accomplished. Eventually, new products may be produced that eliminate the need for this collection and disposal system. For example, research is currently underway to mass-market dissolveable packages, and some products are already being introduced to the market in limited form using this technology (Crabbe, 1989). Development of these and other packaging innovations may take years to implement on a wide

scale; therefore, a more immediate collection and disposal program for empty pesticide containers is necessary.

Many avenues exist for province-wide collection of conventional pesticide containers from agricultural areas. Perhaps the simplest alternative is a voluntary program, based on the ethics of pesticide users. Other options for more effective collection of containers from farmers and commercial applicators include: a deposit-refund system, a subsidy program, and regulation to mandate proper disposal practices. Each of these alternatives exhibits both positive and negative qualities in areas such as effectiveness, cost, implementation and administration. No one program may be considered "best", although some may appear better than others from specific points of view.

Once containers are collected, they must then be addressed in terms of disposal. Again, many alternatives are available to meet this disposal need. Containers may be buried or burned; however, these disposal techniques may not adequately eliminate pollutants unless proper measures of control are employed (Trask, 1985; Cochran, 1988). Other alternatives include recycling containers and reusing containers to package equivalent chemical products. Each of these alternatives also exhibits both positive and negative qualities, and may be evaluated differently from various points of view.

In Manitoba, the problem of pesticide container collection and disposal has been the focus of at least two studies: the Pesticide Container Disposal Pilot Project Summer 1982 (Environmental Management Services [EMS], 1982) and "Pesticide container disposal in Manitoba"

(Roche et al, n.d.). These studies involved students from the University of Manitoba, Manitoba Environment and Workplace Safety and Health (MEWSH), and the Environmental Protection Service of Environment Canada.

A voluntary collection program for pesticide containers resulted from the EMS study (1982), in which farmers deliver empty containers to specially designated collection areas for later disposal. This program started in 1982 as a pilot project with 23 sites established in 12 rural municipalities in southern-central Manitoba. Nearly 30,000 containers were collected by this project in 1982, representing perhaps 6% of the total number of containers used annually in the Province (EMS, 1982). The program has been greatly expanded since that genesis, with approximately 150 collection areas having been established across the Province to date (Manitoba Department of Agriculture, 1986). This program is now successful to the point of collecting over half of all containers used in Manitoba each year (Plews, pers. comm.). Residues collected from these containers are incinerated at hazardous waste disposal facilities in either Ontario or the United States.

The voluntary collection program appears to have grown more successful over time, as indicated by increases in the percentages of containers used that are collected. However, many problems still exist that indicate the need for improvements in the overall approach to the problem. For example, each municipality is responsible for maintaining its own depots, and little central organization of efforts exists. Complete provincial-wide records are not maintained of the true number of

containers collected; therefore, the accuracy of figures indicating success of the current program is uncertain. Collection areas are not standardized or regulated, and may consist of nothing more than space adjacent to a rural landfill (EMS,1982). Viability of recycling metal containers is marginal, due to high transportation costs and a perceived risk of employee exposure to hazardous materials at recycling firms (Trask, 1985d). Plastic containers present unique problems in that they must be shredded and cannot be recycled at present (Trask, 1985c). Many containers are not properly rinsed of residues before disposal, and many of these unrinsed containers are still finding their way into the environment through improper and illegal disposal. These problems indicate the need for a stronger program to control the collection and disposal of pesticide containers in the Province.

1.2 PROBLEM STATEMENT

Manitoba is in need of a good database of information concerning alternative programs for pesticide container collection and disposal in agricultural areas. Research is needed to collect data from studies and programs that currently exist and to consolidate these data into a single, concise report. Alternative programs may then be compared, contrasted, and considered specifically from the viewpoint of Manitoba's needs and parameters. In this manner, the most appropriate solutions can be fully researched to provide the necessary analytical foundation on which future decisions concerning a pesticide container collection and disposal program may be based.

1.3 OBJECTIVES OF THE STUDY

This research will provide a consolidated review of alternative programs for pesticide container collection and disposal in Manitoba. The implications of implementation and management of these programs will then be analyzed. Specific objectives are:

1. to assess the current status of the pesticide container problem in Manitoba;
2. to review legislation and regulations which may affect Manitoba's policy development;
3. to review research conducted on pesticide container management possibilities;
4. to examine programs currently implemented elsewhere in North America and in selected countries in other parts of the world;
5. to investigate administrative and operational requirements, and to suggest allocation of responsibilities for various components of selected programs;
6. to determine industries' response to the most viable alternatives for Manitoba; and
7. to provide a summary analysis of the most acceptable alternatives for future consideration.

1.4 METHODS

This study was based on existing literature, research and experience involving pesticide container collection and disposal. Some data were available in environmental and scientific journals, and other data were taken from proceedings of various farm chemical conventions in the United States. Some data were not available in a published form, and were sought from experts in the field and in appropriate government offices. More general data were reviewed from texts detailing options

for pollution control in general. These data were used to document a review of related literature, which is presented as Chapter II of this report.

Upon completion of the literature review, more detailed inquiry was made of specific programs which have been tested and/or implemented in other areas. Some alternatives have not been applied to pesticide container collection and disposal and in such cases, general theories of pollution control were considered. Each alternative was considered in the context of Manitoba's needs and parameters to determine if that alternative offers a viable solution for this Province. A series of interviews followed this step to determine acceptance or rejection of various alternatives by representatives of pesticide manufacturers and distributors. The most acceptable alternatives were then analyzed in terms of cost, environmental effectiveness, economic efficiency, political and administrative feasibility, flexibility, and compatibility with existing institutional frameworks. A summary of results is provided at the end of each section discussing various components of an overall container management program.

1.5 SCOPE OF THE PROJECT

This research project provides a discussion and summary of alternatives for the collection and disposal of pesticide containers in agricultural Manitoba. The most viable alternatives are presented for consideration, and final selection of a specific program is left for provincial policy-makers utilizing data provided by this report. The

main objective of this study is to provide a complete assessment of the best alternatives available to Manitoba.

This paper represents a pilot study into alternatives available to the Province, and further specific research in selected areas may be desired. Complete cost-benefit and risk-benefit analyses for each alternative will be quite useful in developing an appropriate program for the Province, and these analyses may constitute major research projects in themselves. Further research may also be desired to analyze the effects of national ethics and law enforcement on programs implemented in other parts of the world. Such a study may identify biases in comparisons of programs from countries where pollution and litter are viewed differently than in North America. Finally, research may be required to analyze the chemical content of residues mixed from the broad range of pesticides that are currently used. This analysis may provide insight into better and/or more cost-effective disposal options for residues, for dilute rinsates from rinsing the containers, and for the actual containers as well. This analysis may also lead to a cost-effective method of checking containers to ensure that they have been rinsed before being accepted for disposal or for recycling.

This project is intended to consolidate existing data concerning pesticide container collection and disposal for the benefit of policy-makers in Manitoba. Achieving the stated objectives enables the Province to address the need for management of this potential source of contamination in Manitoba's environment.

Chapter II

PESTICIDE CONTAINERS IN THE ENVIRONMENT

2.1 THE PESTICIDE CONTAINER PROBLEM IN GENERAL

Pesticides are widely used in agricultural areas throughout North America and around the world, and this use is generating growing concerns of the effects of pesticides and pesticide residues on the overall environment. An uncontrolled source of pesticide residue contamination is from improperly or inadequately discarded pesticide containers in ditches, creeks, rivers, fields, and unlined rural public landfills (McKinley, 1985; Miles et al, 1983). Such disposal techniques produce soil and water contamination throughout the immediate and surrounding areas of the disposal sites, and contribute to a rural litter problem that threatens the health of any person exposed to these containers (Ohm, 1984; Gehlbach and Williams, 1975; Stojanovic et al, 1972).

Pesticide container collection and disposal provides a unique challenge to administrators, manufacturers, distributors, and users of pesticides. Problems arise due to the somewhat heterogeneous factors involving these containers which preclude any simple solution. Many products fall under the general term 'pesticide', which Kahn (1980) describes as "any substance or mixture of substances intended for preventing, destroying or repelling any insect, nematode, fungus, weed or

any other form of terrestrial or aquatic plant or animal or microbiological life, and for use as a plant regulator, defoliant or desiccant" (p.9). Pesticides include herbicides, insecticides, fungicides, rodenticides and numerous other products designed to control general and specific predators of farmers' crops (see Table 2.1).

TABLE 2.1

Types of Pesticides and Target Organisms

Acaricides - mites, ticks	Fungicides - plant pathogens	Ovicides - eggs
Algicides - algae	Germicides - germs	Pediculicides - lice
Attractants - animals	Growth Regulators - plants	Pheromones - interrupt mating
Avicides - birds	Herbicides - weeds	Pisicides - fish
Bactericides - bacteria	Hormones - disrupt life cycles	Repellents - animals
Dessicants - water removal	Insecticides - insects	Rodenticides - rats, mice
Defoliants - leaf removal	Miticides - mites	Sanitizers - microorganisms
Disinfectants - microorganisms	Molluscicides - molluscus	Sterilants - microorganisms
Fumigants - insects, rodents	Nematicides - nematodes	Wood Preservatives - mold, fungi, insects

Source: Harein and Cink, 1988.

Pesticides are sold in both dry and liquid forms, and are packaged according to physical requirements and manufacturers' preferences (see Table 2.2). Dry chemicals are usually packaged in paper or plastic bags which, following use of the pesticide, are often burned or buried

TABLE 2.2

Pesticide Formulations

Emulsifiable Concentrates	Soluble Powders
High Concentrate Liquids	Wettable Powders
Low Concentrate Liquids	Granules
Ready to Use Liquids	Dusts
Solutions	Baits
Flowables	Volatile Solids
Aerosols	Pellets
Pressurized Gasses	Tablets
Amine Salts	Volatile Esters

Source: Harein and Cink, 1988.

in sanitary landfills (Vitsthum et al, 1982; Lande, 1976). Liquid pesticides are usually sold in plastic or metal containers that range in size from 1 litre (L) to 208 L (45 gallons imp.), but the volume of most containers is 23 L or less. Metal containers are often the 23 L size, and plastic containers usually hold 1 to 10 L of chemicals (Applied Polymer Research Canada Ltd., 1988; United Grain Growers, 1988). Plastic containers are lighter in weight and are easier to handle, and have become very popular with pesticide users. This market demand has prompted many manufacturers and formulators to shift the majority of agrochemical product packaging to plastics (Krahn, pers. comm.; Walkof, pers. comm.; Waterer, pers. comm.). A representative of one manufacturer in the United States estimates that 80% of agricultural chemical containers are plastic (Pesticide & Toxic Chemical News, 1988). Another study reports that industry officials estimate plastics to comprise 70% of containers used today (APR Applied Polymer Research Canada Ltd., 1988). As well, Alberta Environment projects that 90% of containers in that Province will be plastic by 1990 (McKinley, 1985).

Plastic pesticide containers are made almost exclusively of high density polyethylene (HDPE), some with a fluorination treatment and some with a nylon coextrusion (APR Applied Polymer Research, Ltd., 1988). These containers may range in weight from 0.12 kg to 1.33 kg, depending upon the size of the container and treatment such as fluorination (APR Applied Polymer Research, Ltd., 1988). Metal containers are significantly heavier, as they are made from 22 to 24 gauge steel (Lee, pers. comm.). The weights of various sizes of containers are listed in Table 2.3 below. Approximately 80% of plastic containers are the 10 L size, with the remaining 20% being a combination of 500 gram, 1 L, 5 L and 23 L containers. The total amount of plastic used to package agrochemicals in western Canada is in excess of 1,135 tonnes (2,500,000 pounds) annually.

TABLE 2.3

Typical Masses of Various Types of Containers

Type	Size (L)		Mass (kg)
plastic	.5		0.12
plastic	2		0.08
plastic	4		0.16
plastic	10	(untreated)	0.37
plastic	10	(treated)	0.42
plastic	20		1.33
steel	20		2.37
steel	200		29.51

Source: Adapted from APR Applied Polymer Research, 1988, p.22.

Pesticide containers by themselves pose a rather significant solid waste problem in the environment, and if residues of pesticide concentrate remain in the empty containers, they should also be considered hazardous waste (Berg, 1985; Goulding, 1971). It is recommended that pesticide users rinse emptied containers to remove residues so that the containers may be treated as solid waste (Harein and Cink, 1988; Manitoba Department of Agriculture, 1986; FAO, 1983; Parasram et al, 1980; Lande, 1976). The recommended rinsing procedure is not always followed by pesticide users, however, possibly because the time and effort required to properly rinse emptied containers is considerable. Farmers with large single crops requiring a large number of containers of pesticides are less likely to rinse containers thoroughly than mixed farmers with smaller crops that require fewer containers of chemicals (Dessens and MacPherson, 1989). One study in Manitoba found that approximately 50% of containers returned to collection areas were not rinsed. Between 50 and 250 mL of residue remained in the unrinsed metal containers and 50 to 150 mL of residue remained in the unrinsed plastic containers (the difference may be attributed to a better design of plastic containers which allows for more complete draining) (EMS, 1982). Other studies have also found that an average of 1 to 5% of the original contents remain in unrinsed empty containers (Trask, 1985e; Miles et al, 1983; Braun et al, 1983; Moore, 1973).

Proper rinsing of containers removes enough hazardous residue that rinsed containers may be treated as solid waste, thus alleviating the most serious component of collection and disposal problems (Miles et al, 1983). The triple-rinse is the most common recommendation for

cleaning containers in the field, and is quite effective in removing most residues. The procedure is rather simple and involves the following steps:

1. Empty the container into the spray tank and allow it to drain in a vertical position for 30 seconds.

2. Add rinse water or other diluent so the container is about 1/10 to 1/4 full (depending on recommendations).

3. Rinse the container thoroughly (agitate, roll, etc.), pour the rinsate into the spray tank, and drain again for 30 seconds.

4. Repeat the procedure twice more.

5. Puncture, break, or otherwise render unusable the rinsed container (Maine regulation 22 M.R.S.A. (1471-Q); Harein and Cink, 1988; Manitoba Department of Agriculture, 1986).

The total procedure takes about 5 minutes and should remove as much as 99% or more of the pesticide in most cases (Manitoba Department of Agriculture, 1986; Braun et al, 1983; Miles et al, 1983). This level of effectiveness depends upon the viscosity, solubility, concentration of the original pesticide formulation, and shape of the container (Peck, 1985; Braun et al, 1983; Wolfe et al, 1961). Rinsing containers fewer than 3 times is not as effective as the triple-rinse procedure; however, significant amounts of residues are still removed. Trask (1985b) found that the quantity of residues left within containers also depend upon how well the container is drained and rinsed (see Table 2.4).

An optional rinsing method is to use one of a variety of pressure rinsing devices to remove residues from containers. Such devices, which can be attached directly to the pump on the water storage tank, are designed to puncture containers from the bottom and rinse residual pesticides into the spray tank. Several pressurized jets of water are

TABLE 2.4

Effectiveness of Rinsing and Draining Containers

Stage	Quantity of Pesticide Formulation (g) left in X amount of residual rinsate after draining		
	X = 30 mL	60 mL	90 mL
After Draining	14.2	28.3	42.49
After 1st Rinse	0.22	0.85	1.91
After 2nd Rinse	0.004	0.025	0.085
After 3rd Rinse	0.00005	0.0007	0.0036

(based on rinsing a 19 L metal container which formerly contained a 0.48 kg per litre formulation with solvent equivalent to 10% of the capacity of the container [1.9 L])

Source: Adapted from Trask, 1985b.

directed by the rinser to cleanse the top, sides and bottom on the inside of each container. Rinsing by this method has been shown to be as effective as triple-rinsing containers, and takes as little as 30 seconds per container to perform (Manitoba Department of Agriculture, 1986; Anderson, 1986; Miles et al, 1983). Miles et al (1983) also found that a 30 second pressure rinse uses 9 to 11 L of water. Pressure rinsing is faster and at least as efficient as triple-rinsing (triple-rinsing a 23 L container uses up to 17.5 L of water if the container is filled 1/4 full 3 times). Pressure rinsing is also effective in rendering the container useless by puncturing it in the rinsing process.

Unrinsed pesticide containers pollute the environment through soil and groundwater contamination, and threaten the health of humans and other animals directly exposed to toxic residues. Stojanovic et al

(1983) have shown that concentrated pesticides in soil may cause shifts in microbial populations, temporarily favoring a group or groups of microorganisms which may overpopulate the soil. This artificially induced shift of microbial inhabitation creates a condition of partial soil sterility. Groundwater contamination from improperly discarded containers is also a problem, and has been documented in several areas of North America. Much of this pollution comes from hazardous waste sites, landfills and dumps (Ohm, 1984). During a 1979 clean-up effort in Alberta, nearly 1000 pesticide containers were recovered from 18 small landfills and open dump sites south of Lethbridge. Six of these sites were classified as high risk areas for water pollution from residues, and four other sites were classified as environmental hazards (Reid Crowther & Partners Ltd., 1980). Such improperly buried containers also produced enough leachate to threaten contamination of a local aquifer in Florida (Gehlbach and Williams, 1975).

Direct exposure to unrinsed pesticide containers creates a human health risk that is much more immediate than soil and groundwater contamination. Chemical pesticide compounds can cause sickness or death if inhaled or ingested, and some compounds such as organophosphates may be toxic when absorbed directly through the skin (Parasram et al, 1980). A lethal dose of some highly concentrated pesticides may be as little as a few drops or milligrams (Lawson, 1976). Unfortunately, such minute quantities remaining in containers are somewhat common. For example, discarded containers in Ontario were found to retain quantities of residue that would certainly be lethal if containers were mishandled (Miles et al, 1983). As well, more than 500 cases of pesti-

cide poisoning were reported in the early 1970s to the North Carolina Pesticides Program, with 35 of these cases becoming fatalities. A few such cases involved children playing around discarded containers and youths cleaning an area where pesticides had been spilled (Gehlbach and Williams, 1975).

2.2 THE PESTICIDE CONTAINER PROBLEM IN MANITOBA

2.2.1 Estimating the Magnitude of the Current Problem

The number of pesticide containers used annually in Manitoba is generally estimated to be about 500,000 (Roche et al, n.d.; Manitoba Environmental Management Services, 1982; Plews, pers. comm.). No provincial records are kept concerning the actual number of containers used annually, so this estimate may be high or low, depending upon many factors affecting crop growth (Plews, pers. comm.). As many as 62,500 L of residual pesticide formulation require disposal each year, based on the 500,000 figure with an average of 125 mL of residue in each container, as determined by the Pesticide Disposal Pilot Project (EMS, 1982). This study also found that only about 20% of collected containers were plastic in 1982 but use of plastics was expected to rise as manufacturers moved away from metal. In 1987, 57% of containers collected by Weed Control Districts (WCD) were plastic, according to the Manitoba Department of Agriculture's (MDA) 1987 summary of the Manitoba Agriculture Container Disposal Survey.

While the number of containers used in the Province each year has not been specifically recorded, loose verification of the 500,000 fig-

ure is possible through consideration of other data. For example, Manitoba Environment estimates that at least 55% and perhaps as many as 70% of all containers used in the Province are voluntarily delivered to collection areas (Plews, pers. comm.). As many as 300,000 containers were collected in 1987 by the current voluntary program (see 'Manitoba' under the section, "Existing Programs for Container Collection and Disposal"); therefore, the total number of containers used in Manitoba in 1987 may have been as low as 429,000 (300,000 / 0.70) or as high as 545,000 (300,000 / 0.55) in that year.

This estimated range is consistent with data provided by a representative of Interprovincial Cooperative Ltd., a company that packages and distributes pesticides for the prairie provinces of Canada. This company distributed approximately 16,400 m^3 of pesticides in 1988, of which 90% was packaged in containers ranging from 7 L to 10 L in size. Interprovincial Cooperative distributes approximately 55% of all pesticides used in Manitoba, Saskatchewan and Alberta (Lee, pers. comm.). According to Statistics Canada (1987), the area of land dusted or sprayed in Manitoba equals approximately 16.6% of the total land dusted or sprayed in the prairie provinces; therefore, the number of plastic containers used in Manitoba (according to these figures) was:

$$(16{,}400\ m^3)\ (0.90)\ (0.166)\ (10^3\ L / 8.5\ L) / 0.55$$

$$= 524{,}112$$

The calculation of $(10^3\ L / 8.5\ L)$ is used to convert 1 m^3 into 8.5 L units, which represent the approximate average size of plastic containers (midpoint of 7-10 L range). The number of metal 23 L containers used, according to these figures, is:

$$(16{,}400\ m^3)\ (0.10)\ (0.166)\ (10^3\ L / 23\ L) / 0.55 = 21{,}531$$

The calculation of $(10^3$ L / 23 L) is used to convert 1 m^3 into 23 L units).

$$524,100 + 21,500 = 545,600$$

so approximately 546,000 containers were used in Manitoba in 1988, according to these data.

These figures are both consistent with the 500,000 estimate as previously discussed. If approximately 300,000 containers are being collected in voluntary collection areas, then approximately 200,000 to 250,000 containers are not being collected; however, determination of the number of containers left in the environment should not end with these simple calculations. As previously stated, 57% of containers collected by the Weed Control Districts were plastic. Most of these containers were burned and others were buried in municipal landfills (MDA 1987 Survey). Plastic containers may have been burned on farm properties as well, so that many of the containers left in the environment may have actually been destroyed. This burning may have released toxic emissions (including toxic combustion products) into the atmosphere, thereby resulting less in disposal of pollution than in dispersal of pollution across the province.

The range of sizes of containers also presents problems in calculating the number of containers left in the environment. Many plastic jugs containing such toxic chemicals as Furadan (carbofuran), Roundup (glyphosate), and Lontrel (clopyralid) are sold in container sizes of 4 L or less (United Grain Growers, 1988; Shaffeek, 1988). These containers may be easily thrown out with household garbage and subsequent-

ly buried in local landfills or dumps. The quantity of these smaller containers sold in Manitoba is not known, and none of the Weed Control Districts made reference to container sizes in their annual reports. These containers pose environmental problems if they are not rinsed, and, as with containers burned on the farm, they are not always discarded in the most visible and most potentially harmful areas such as ditches, river banks, and other public areas.

2.2.2 Future Estimates: A Need for Improvement

The rough estimates provided in this section indicate that a container disposal problem does presently exist in Manitoba, although a significant number of containers used each year are collected through the current voluntary program. A loose verification of the magnitude of the problem is possible by comparing various data, and this comparison indicates that an increased rate of collection is both possible and necessary. Further review of the problem and of potential solutions is required.

The inaccuracy of the estimates creates several difficulties which suggest a need for an improved monitoring system. Accurate estimation of the percentage of containers used that are subsequently collected is not possible, because the initial number of containers used is only loosely approximated. Without this accurate estimation, the effect of changes in the current collection program cannot be statistically measured. The final destruction, disposal or dispersal of at least 30% of all containers used annually in Manitoba is not known; therefore,

accounting for the final destination of perhaps 200,000 or more containers per year is not possible. The disposal of these containers dictates the amount of improvement needed to the current program. These data are absolutely necessary to justify changes to the existing program, if the value of such changes is to be measured in any way. An improved monitoring system is essential for logical selection, development and operation of a future collection and disposal program for empty containers in Manitoba.

2.3 EXISTING LEGISLATION AND REGULATIONS

Federal and provincial legislation and accompanying regulations address both pesticides and containers under many circumstances; however, in most cases, these topics are addressed separately. Many of these laws, either individually or in combination, may affect the operation of each component of a program to manage pesticide containers. Legal interpretation of these laws is beyond the scope of this report, and no such attempt is made; however, the remaining text in this section represents a partial list of legislation and regulations that may be of interest to provincial policy-makers (see Appendix A for a more detailed review of these enactments).

For the purposes of this discussion,

CEPA = Canadian Environmental Protection Act (Canada)
TDGA = Transportation of Dangerous Goods Act (Canada)
PCPA = Pest Control Products Act (Canada)
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PHA = Public Health Act (Manitoba)
PFCA = Pesticides and Fertilizers Control Act (Manitoba)

Many sub-components of a pesticide container program can be identified under a general strategy to address these containers. These sub-components include packaging, education, use, collection, storage and disposal. Many of the Acts and regulations listed in Appendix A appear to address these sub-components of an overall program. Section 5(k) of PCPA grants the Governor in Council the power to make regulations regarding packaging and labelling of pesticides. Sections 27 and 46 of regulations under this Act detail the actual labelling and packaging requirements.

Education may also play an important role in developing a successful program. Section 2(3) under EA enables the Minister of the Environment to produce and distribute educational materials for the public involving environmental issues. The Minister may also develop public education courses utilizing those materials. Worker education is required under WSHA for workers using, storing or handling controlled products, or for working in areas where fumes or other fugitive emissions are released from such products. These regulations (MR 52/88 and MR 53/88 under WSHA) appear to cover farm employees as well as anyone involved in collecting, storing or disposing of containers retaining pesticide residues.

Licenced users of pesticides must meet certain requirements under EA and PFCA regarding rinsing and disposal of containers. Triple-rinsing or pressure-rinsing, as well as disposal of containers in designated collection areas is required of pesticide users working under a provincial permit, as required by MR 94/88 R (under EA). These disposal

practices, in addition to certain other disposal requirements under PHA, are also required under MR 216/87 (PFCA), perhaps for all pesticide users. Section 8(2) of this regulation appears to exempt farmers from requirements of obtaining an application permit, unless excessive off-farm application of pesticides is practiced. In cases of unlicenced farmers, rinsing and collection area use requirements are unclear.

Collection of pollutants can be regulated by the Lieutenant Governor in Council, as specified in Section 41(1) of EA. Such collection of specified dangerous materials generally requires a manifest and record of transportation for these products in quantities greater than 5 kg (for solid materials) or 5 L (for liquid materials), under MR 139/88 (DGHTA). These specified materials are listed in regulations under TDGA, which are also adopted as regulations under DGHTA. A manifest might therefore be required under MR 139/88 for any person transporting unrinsed containers (as in a public or commercial waste collection program) retaining residues greater than specified amounts. Such collection personnel may also require proper education and training as specified in MR 52/88 and MR 53/88 under WSHA.

Storage of pollutants and wastes is addressed by several Manitoba regulations, and may be regulated by the Lieutenant Governor in Council under Section 41(k,m) of EA. Provincial registration and reporting is required of any person storing or providing storage facilities for hazardous wastes generated by other persons, as specified in MR 175/85 (under DGHTA). This regulation may apply to collection depots if con-

tainers are not properly rinsed prior to storage. Workers employed to operate and maintain these depots may also require education and training under MR 52/88 and MR 53/88 (WSHA). If containers are stored on private property (such as on the farm), they must be stored in "a sanitary and orderly manner and in a suitable location", according to Section 2(1c) of MR 321/88 R (PHA).

Disposal of solid wastes and hazardous materials is addressed by a number of federal and provincial Acts and regulations. Section 9(2) of PCPA requires a person applying to register a new product or ingredient to supply the Minister with information regarding suitable methods for disposal of the product and its empty package. Section 41(1 1,p,v) of EA grant the Lieutenant Governor in Council the power to regulate disposal of pollutants and packages, and to prohibit littering. Section 8 of PFCA also specifically grants the Lieutenant Governor in Council the power to regulate the disposal of pesticide containers. Disposing of litter on land, water or ice is prohibited in MR 92/88 R (EA), unless deposited in a designated area or left during an emergency. Section 2(1) of MR 326/88 R (under PHA) also prohibits disposal of wastes in or on the banks of any water body or course, as public health may be compromised. Section 8 of MR 98/88 R (EA) specifies where disposal grounds may be located, and Section 10 of this regulation prohibits or limits open burning at such grounds. Section 7 of MR 216/87 R (PFCA) specifies that disposal of containers must be carried out in compliance with regulations under EA and PHA, and MR 52/88 and MR 53/88 (WSHA) require worker education for persons involved in disposing of any wastes containing controlled substances (such as pesticides).

Pesticide containers may be addressed by these and other Acts and regulations; however, interpretation of these laws regarding any specific application may require the services of a legal professional. Application of several regulations listed in this section and in Appendix A may also depend upon the legal classification of pesticide residues. If these residues are classified as flammable liquids or toxic materials (Class 3 or 6 under TDGA), containers retaining such residues may be covered by hazardous waste legislation. If residues are not classified as flammable or toxic, or if containers have been properly rinsed, container disposal must still meet solid waste disposal requirements, and in some cases requirements under the Environment Act and PFCA.

Numerous gaps occur in current legislation that may require attention before an improved container management program can be developed. Unrinsed containers must be identified as either hazardous or solid wastes so that disposal requirements can be identified and followed. If unrinsed containers are identified as hazardous wastes, collection areas may require licensing under MR 175/85. A more precise description of a clean container is also needed to specify the maximum amount of residue allowed in the container for it to be considered "decontaminated". Regulations should specify whether or not decontaminated containers may be buried in public landfills and, if so, what requirements must be met by such landfills to accept decontaminated containers (i.e. Class I landfills only, or any public disposal ground). Exemptions of farmers from pesticide application license requirements and apparent exemption from rinsing and disposal requirements should also be

reviewed, as meeting these requirements provides a basis for better container management. Addressing these ambiguities within the current regulatory structure may provide a stronger foundation for improved container management in Manitoba.

2.4 EXISTING PROGRAMS FOR CONTAINER COLLECTION AND DISPOSAL

A variety of approaches have been taken in other areas to collect and dispose of pesticide containers, and to manage residues. Most of these approaches use some variation of voluntary collection, and disposal options usually incorporate burial or incineration. Metal containers are sometimes recycled, and the viability of recycling plastic containers is currently being researched; however, no active plastic pesticide container recycling program was found through this study.

The programs established in other areas that were reviewed are those in selected countries in Europe, in selected states of the United States, and in the prairie provinces of Canada. The State of Maine in the U.S. is the only program found that employs an economic incentive for container rinsing and collection, by using a deposit-refund system. Other states in the U.S. rely upon voluntary efforts of farmers for container rinsing and collection. Countries in Europe also tend to depend upon voluntary programs, although regulation is used in some limited applications. The prairie provinces of Canada depend upon a program which is entirely voluntary as well. Each program reviewed in these areas will be discussed in terms of operation and effectiveness.

2.4.1 European Countries

Many countries of the European continent are actively pursuing solutions to problems of hazardous waste disposal in general; however, few data are available regarding specific waste streams such as empty pesticide containers. Many countries have initiated programs to collect, transport and dispose of industrial wastes. Several of these countries have developed subordinate programs to collect and dispose of household hazardous wastes as well. Disposal of toxic chemical containers and waste oil containers are covered by some legislative actions, although many of these laws or policies do not specifically apply to agricultural activity. For this reason, the following discussion is limited to more general practices of several European countries in disposing of hazardous wastes. Costs of disposal are assumed to be the responsibility of governments, rather than industries or individuals.

Many European countries differ significantly in size and in population density from Manitoba, and social attitudes toward litter and waste disposal may differ as well. Such variations may account for a degree of success of certain programs in collecting wastes; therefore, these differences must be considered when comparing practices of European countries to those of Canada and Manitoba.

On 20 March 1978, the Action Programme of the European Community for Protection of the Environment (as part of the Commission of the European Community) adopted the Directive on Toxic and Dangerous Wastes. This Directive was designed to be incorporated into the national laws of member states; however, in the process of consulting with various

governments, many highly specific rules were dropped. The Directive was therefore reduced to a general framework under which toxic and dangerous wastes should be handled. A medium-term program was developed by the commission which identifies 'priority tasks' and 'other problems'. Under 'other problems', one specific waste stream identified is packaging and conditioning, relating to selection, criteria and regulations for containers, decontamination, and disposal of used containers (Risch, 1983). This framework provides a basic guideline for types of wastes that should be addressed by hazardous waste programs developed in individual nations.

The Directive on Toxic and Dangerous Wastes (78/319/EEC) distinguishes consumers of small quantities of pesticides (such as households and home gardeners) from consumers of relatively high quantities of pesticides (such as agriculture, horticulture, forestry, and government road maintenance programs). The recommendation to small users for disposal of containers is to include such materials in regular household refuse. Consumers of high quantities of pesticides are recommended to rinse and puncture empty containers, and to store these containers in an enclosed, covered area until disposal is possible. Disposal of metal and glass containers should be by delivery to a local refuse-disposal plant, and paper and plastic containers should be burned in rural areas where toxic emissions will cause no damage (FAO, 1983). A few countries have expanded upon this directive, and general programs developed by these nations will be discussed briefly.

2.4.1.1 Denmark

The Kingdom of Denmark has developed perhaps the most advanced system in the world for collection of hazardous waste materials. Collection stations have been developed in every major community in the nation, for a total of more than 300 collection stations established nationwide. Mobile collection stations are used in addition to the established permanent sites (Piasecki and Messinger, 1987). Collected wastes are then transported to a central collection facility, where the wastes can be prepared for treatment or incineration at the Danish treatment plant at Kommunekemi. As of 1983, 21 central collection facilities had been established in cities across the country (Toffner-Clausen, 1983).

Denmark is less than 1/10 the size of Manitoba, covering 43,070 square kilometers (4,307,000 hectares) within its borders. The 1987 population of this small country was approximately 4,932,000, with 5.3% of the people being directly employed in agriculture. Permanent crop production required only 3,000 hectares in 1986, but 214,000 hectares were used for permanent pastureland in that same year (FAO, 1988).

In 1972, the Danish government adopted Act no. 178, entitled "Disposal of Waste Oil and Chemical Wastes". General administration of this Act falls under the federal Ministry of the Environment, but more specific responsibilities are delegated to individual municipal governments. These municipal councils are responsible for establishing local collection and receiving arrangements for oil and chemical wastes. These arrangements include local collection stations in each municipal-

ity, and central collection stations covering perhaps several municipalities. Most activities regarding the collection of these wastes, issuance of instructions, spillage cleanup, and notification of chemical wastes fall under the jurisdiction of these municipal councils. Empty containers that have been contaminated by toxic chemicals are covered by the Notification of Chemical Wastes (Toffner-Clausen, 1983).

The collection facilities are available to all residents of the country and, although use of such facilities are not required by law, most people use the system because of its convenience. Use of collection facilities is free of charge to private citizens, and costs of operation are instead divided between the federal government, local governments, and industry (Piasecki and Messinger, 1987). Farms and industries are expected to transport wastes to a central collection facility for shipment to Kommunekemi (Toffner-Clausen, 1983). Empty pesticide containers are assumed to be collected through the established national collection program, and treated or destroyed at the final destination.

2.4.1.2 The Netherlands

The Netherlands is slightly smaller than Denmark, with a total area of 3,729,000 hectares (37,290 square kilometers). Of this total area, 3,392,000 hectares are land, populated in 1987 by an estimated 14,661,000 people. Still, 29,000 hectares of land are devoted to permanent crops and a further 1,108,000 hectares are devoted to permanent pastureland (FAO, 1988). The country is densely populated and highly

industrialized, and is dependent upon both surface and subsurface water sources for potable water (Goudsmit et al, 1983).

Most land in the Netherlands is low-lying, so few areas are suitable for disposal of wastes by landfilling. Instead, waste reduction is heavily emphasized, and recycling, reuse and recovery of materials from wastes is maximized. Disposal of hazardous materials by burial is also prohibited by this country's Chemical Waste Act, even if the hazardous substance is enclosed in a container. Waste generators must deliver wastes to any person licensed by the Minister of Health & Environmental Protection to dispose of such wastes (Goudsmit et al, 1983). Industrial wastes are covered by this Act, but coverage of empty pesticide containers is not clear.

2.4.1.3 Norway

Norway is a country with a relatively large land mass and small population, in comparison to Denmark or the Netherlands. Norway encompasses a total area of 32,422,000 hectares (324,220 square kilometers) with a land area of 30,786,000 hectares. This country, which would cover almost 60% of Manitoba, has a population of nearly 4,200,000. Agriculture provides employment for 6.1% of the people, although only 99,000 hectares are devoted to permanent pastures and no land is devoted to permanent crops (FAO, 1988).

Norway is not a highly industrialized country, and it has a large land area with a rather small population. For these reasons, centralized treatment of hazardous waste has not been pursued because such a

facility would be too expensive (Piasecki and Messinger, 1987; Waage, 1983). Instead, hazardous waste disposal is accomplished through agreements with the cement industry, which incinerates wastes in cement kilns of various companies nationwide. The Norwegian cement companies provide this service as a profit-oriented business (Waage, 1983).

The program to use cement kilns was first proposed by the Norwegian cement industry and was then investigated by a government steering committee, which included members of industry, the State Pollution Control Authority and the Ministry of the Environment. The committee was divided into 4 working groups to study collection and transportation, techniques and processes, economic issues, and regulation and control. The result of the committee's research was preparation of the Nationwide Plan for Hazardous Waste Handling. One specific hazardous material listed under this plan is wastes containing pesticides (Waage, 1983).

The nationwide plan was recommended for implementation by the steering group, including usage of existing processes in Norwegian industry for hazardous waste treatment. The plan also suggested a nationwide network of collection sites, a coordinated transportation scheme, and a central collection site where wastes could be prepared for subsequent transport to the final treatment facility (Waage, 1983). Perhaps as a result of this recommendation, municipalities are now required to provide local collection facilities for small amounts of hazardous wastes; however, the federal government is still contemplating the need for a large central collection facility (Piasecki and Messinger, 1987).

2.4.1.4 Other European Countries

Other countries of the European continent have placed less emphasis on collection of household toxic wastes than on industrial waste processing. As such, most nations do not have a developed collection system promoted for use by the general public. Most European countries will accept household toxic wastes at collection centres, but do not encourage this practice. These countries instead rely on solid waste incineration with the belief that this program provides the best control for low concentrations of toxic materials found in household hazardous waste (Piasecki and Messinger, 1987).

This section has focused on nations emphasizing proper collection and disposal of household hazardous wastes, because development of such programs indicates keen interest in preventing all types of environmental contamination from toxic materials. Some of these programs list empty chemical containers as toxic wastes, and include such refuse in the category of materials to be collected for controlled disposal. Empty pesticide containers have not been labelled as household hazardous wastes, but neither have they been classified as industrial toxic wastes. These gaps in data indicate that more research is needed on the European strategies for controlling empty pesticide containers, and on the social attitudes of countries developing such programs. With this combination of data, a better comprehension of the European response to controlling this waste stream will be possible.

2.4.2 United States

Empty pesticide containers are the focus of much concern in the United States, and several states have individually attempted to develop policies or programs for collection and disposal of this waste stream. The only federal involvement at this point regards the rinsing of empty containers prior to disposal. Containers which have not been rinsed by the triple-rinse or pressure-rinse procedure are regulated as hazardous waste under the Resource Conservation and Recovery Act (Cochran, 1988). Specific disposal of rinsed containers is left to the discretion of individual states. Several programs have been developed and applied in various states, and several of these programs are discussed in this section. Costs for these programs are generally covered by state governments.

2.4.2.1 Maine

A deposit-refund system for pesticide containers has been established in the State of Maine, and the program appears to be quite successful; however, the exact percentage of containers which are collected has not been calculated. The State has noted a reduction of illegally discarded containers, and is satisfied with the results of the current program (Jennings, pers. comm.). The Maine program is limited to chemicals restricted under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), and the agriculture industry is much smaller than in Manitoba. Due to these limitations, only about 8000 containers were collected in 1987 (Jennings, pers. comm.). Still, this

program serves as an excellent model for development of a similar program in Manitoba (Maine regulation 22 MRSA/1471 Q is reproduced in Appendix B).

Under Maine regulation 22 MRSA/1471 Q, each container sold at the retail level must have a label affixed that identifies the buyer and the seller of the chemical. This label can later be used to trace illegally discarded containers and even collected containers that were not properly rinsed after final use. A $5.00 deposit is collected for each container under 114 L, and $10.00 is collected for larger containers. The value of the deposit is essentially held by the label, because the label must be intact for return of the deposit (Denney, 1985). Incentive is thus provided for the purchaser to protect, rather than deface, the label.

Containers are collected and deposits refunded during a two-week period after the growing season closes. State environment employees are stationed at 19 designated collection depots to accept containers, checking each container for label identification (to prevent return of containers sold outside of Maine) and for proper rinsing (Batteese, n.d.). This check is usually visual, although chemical field tests are occasionally performed on random containers (Jennings, pers. comm.). The pesticide user also fills out an affidavit stating that the container has been properly rinsed. Acceptable containers are crushed at the site, and the affidavit is stamped to show that the containers were accepted. The pesticide user then returns the stamped affidavit to the retail dealer for a refund of the deposit (Maine, 22 MRSA/1471 Q).

This affidavit step eliminates problems of collection employees holding large sums of money for payment of refunds, and the signed statement provides legal recourse by collection officials against specific pesticide users if containers are later found not to be rinsed (Jennings, pers. comm.).

Containers are treated as solid waste once collected, because almost all containers are rinsed of residues. Only 4% of returned containers were not rinsed in 1985, and in 1987 this amount was reduced to 1% of all containers returned to collection depots. If containers are not rinsed, the whole load is rejected by collection personnel and the owner must rerinse all containers before they will be accepted. The method for disposal of rinsate from this rerinsing is not known, but the rinsate is not collected by the State. Rinsed, collected containers are buried in community landfills at eight of the collection sites, and others are transported by local pesticide dealers to a commercial landfill in the center of the state. Maine is eventually expected to establish several regional landfills, and state officials feel that triple-rinsed pesticide containers will be one of the safest wastes to be deposited in these sites (Batteese, n.d.).

While the Maine program is perceived by state officials to be quite successful, the exact percentage of containers used annually that are subsequently collected has not been calculated. One reason for not calculating this figure may be that all containers purchased in one year are not necessarily used that year. Some are stored for use in the next season. Also, only restricted chemical containers require

deposits and less than 10,000 such containers are sold each year. Minor noncompliance might therefore be perceived as less significant in Maine than might be perceived in areas such as Manitoba, where the number of containers used annually is much higher. A high level of compliance in Maine is indicated by a reduction in illegally discarded containers, by the high percentage of rinsed containers that are returned, and by the acceptance of the program by the farm community.

2.4.2.2 Minnesota

The State of Minnesota considered implementation of a deposit-refund system; however, such a program was not supported by a report of the Minnesota Department of Agriculture (1988) to the Minnesota Government. As stated in the report, "A pesticide container deposit and return program should not be implemented due to the projected difficulty and expense involved with the volume of containers and in consideration of the viability of other options" (p.35). The actual costs of the program were not calculated, but were assumed to be massive due to administrative and operative costs. Additionally, complete data were not available to the authors of the report to make such detailed calculations (Rick Hansen, pers. comm.).

The actual number of containers used annually in Minnesota, while undoubtedly high, is not precisely known; however, other data concerning the use of pesticides in the state were determined through a 1987 pesticide container disposal survey issued to farmers, commercial applicators and pesticide dealers. The most popular products were sold

in plastic containers ranging in size from under 4 L to 19 L. Metal containers are also used widely in Minnesota, but are more popular with commercial applicators than with farmers. More than 80% of those surveyed considered container disposal important or most important in relation to other environmental issues. Still, very few farmers, users and dealers indicated problems in pesticide container disposal, and all three groups overwhelmingly (85-88%) opposed additional training to manage pesticides and empty containers. Approximately 80% of farmers and other users were willing to pay a deposit on containers if this deposit would later be refunded. Only 60% of dealers were in favor of collecting such a deposit on pesticide containers (Minnesota Department of Agriculture, 1988).

Farmers in Minnesota are allowed to burn empty pesticide containers, and this method of disposal has steadily increased from 36% (of all containers disposed of) in 1981 to 65% in 1987. Commercial applicators cannot legally burn containers, although 21% of these users reported burning containers as a method of disposal used. The majority of containers were otherwise taken to a landfill after being triple-rinsed. Still others were buried on private property, returned to dealers, stored on site, recycled, used for other purposes, or disposed of through regular garbage collection (Minnesota Department of Agriculture, 1988). Many options for disposal are available to all groups, which may account for the low incidence of reported problems relating to container disposal.

One objective of the Minnesota Department of Agriculture 1988 report was to develop a pilot deposit-refund program for consideration by the Minnesota legislature. This program was developed (see Appendix C), but was discouraged for reasons previously mentioned. It was decided to increase the educational program which will support a voluntary collection program in the future. The first stage of this program will focus on educating farmers and other users to properly rinse containers by triple or pressure-rinsing procedures. As part of this stage, an educational packet has been developed and sent to interested parties around the state. The second stage of the program will involve public demonstrations of proper rinsing techniques, crushing of metal containers and shredding plastic containers. The third stage of the program will concentrate on developing a pilot collection project for development throughout the state. This pilot collection system should be in place in 1990 (Rick Hansen, pers. comm.). In addition to developing this voluntary program, the recommendation was also made that a special work group be convened by the Minnesota Department of Agriculture to further evaluate the pesticide container disposal issue and to develop recommendations to manage pesticide container disposal (Minnesota Department of Agriculture, 1988). The state has thereby elected to maintain a voluntary effort while exploring the problem in much greater depth.

2.4.2.3 Illinois

Since 1975, The Illinois Farm Bureau Young Farmer Committees have collected steel 19 L pesticide containers and have subsequently taken

these containers to metal scrap dealers for recycling. The program was started after numerous complaints concerning illegal dumping and rinsing of containers were made to the Illinois EPA. As the government considered taking corrective actions, the Young Farmer Committees introduced the voluntary collection and disposal program to resolve the problem without government intervention. The program was financed in part through revenues generated by the recycling effort, and further funding was donated by the state's Department of Energy and Natural Resources to purchase a double-cylinder can crusher (Ohm, 1984).

The strength of the Illinois program lies in the labor and management provided by the Farm Bureau Young Farmer Committees. These groups advertise dates, times, and temporary storage sites where farmers may deposit triple-rinsed containers for disposal. On specified days, Young Farmer Committee members crush cans to reduce the volume of containers and dispose of the crushed containers in one effort (Mergen, 1983). The voluntary program operated at its peak in 1978-81, when approximately 1.5 million 19 L steel cans were used annually in Illinois. The program operated in as many as 26 counties across the state, and succeeded in disposing of approximately 10% of containers used each year. Since 1981, the number of steel containers has steadily declined to as low as 300,000 in 1983, as pesticides are being packaged more often in plastic containers or sold in bulk to farmers utilizing truck-mounted 950 L chemical tanks (Ohm, 1984). The program activity has also declined each year, and is no longer the main option for container disposal in the state (Taylor, pers. comm.).

Disposal of plastic containers is mainly accomplished with low-temperature incineration. Plastic containers may be burned in the same field where chemicals are applied, and must be burned at least 305 m away from any building, according to Jim Mergen of the Illinois Farm Bureau. Farmers are also urged not to breathe fumes from burning plastics, as emissions may be toxic. This method of disposal is recognized for its convenience, but the fumes from burning plastics and residues create an additional environmental concern (Ohm, 1984).

Bulk sales have reduced the problems of pesticide container collection and disposal in Illinois, but this option has created a new set of problems as well. These problems relate to more storage and transportation of the chemicals, according to A.G. Taylor of the Illinois EPA. The hazard produced by a spill is greatly increased because the quantity of chemical spilled is much larger. Bulk tanks may hold as many as 19,000 L of pesticides, and the toppling of such a tank produces a very dangerous toxic spill. As well, the 950 L tanks mounted on pickup trucks are not always mounted securely, and these containers sometimes tip over in sharp turns (Ohm, 1984).

2.4.2.4 Oregon

A voluntary collection and disposal program has been established in Oregon by the Oregon Agricultural Chemical Association. This program emphasizes education of farmers regarding immediate and future problems caused by improper container disposal, and stresses the value of properly rinsing containers prior to disposal. Containers are collected

once a year at approximately a dozen sites across the state, metals are sent to a scrap recycler for reforming the metal into steel rebar, and plastics are cut in half and picked up for burning or recycling if possible. One plastic recycler in the area has expressed interest in using the pesticide containers, but no details are available concerning how plastics will be decontaminated or how the recycled plastic will be used (Mark Hansen, pers. comm.).

Rinsing containers is considered to be a key objective of the Oregon program, and significant effort is taken to ensure that containers are cleaned. Farmers are taught proper rinsing techniques as part of a 1.5 day course required for obtaining a licence to use chemicals restricted under FIFRA. The licence must be renewed every 5 years, so all farmers applying restricted chemicals are updated periodically on proper use and disposal methods for containers. When farmers deliver empty containers to the collection site, they must sign a form stating that the containers are rinsed when deposited. If the containers are later found not to be rinsed, the noncomplying farmer may be held responsible for any cleanup required of the residue contamination. This requirement is designed to parallel the Conservation Environmental Response Compensation and Liability Act (Superfund) for addressing environmental contamination (Mark Hansen, pers. comm.).

The Oregon program has been in effect for about 5 years, and has succeeded in collecting 20,000 containers last year alone. No figures are available to determine what percentage of total containers used this collected amount represents. Transportation costs are generally

covered by the scrap value of the metal, and trucking costs can be covered by this revenue for transportation up to 161 km (depending upon the value of the scrap). Further transportation and all labor for collection and treatment is voluntary, so that no funding is required from the state.

2.4.2.5 Iowa

No organized program for collection and disposal of containers has yet been established in Iowa, although legislation has been introduced to address the issue. One bill currently under consideration proposes collection of a $1.00 U.S. charge per nonreturnable container to help pay for the disposal costs of each container. Another bill under consideration by the Iowa government proposes that requirements be made of manufacturers to reduce the problem. The level of support to be received by either of these bills is questionable (Eckermann, pers. comm.).

Agricultural crop production in Iowa is estimated to generate as many as 188,000 metal containers and 2,611,000 plastic containers each year. The large quantity of plastic containers represents a major shift within the past five years from single 19 L metal pails to two 10 L plastic jugs packaged as one unit. Bulk chemical sales have also accounted for the reduction of metal containers used, and approximately 24% of agricultural herbicides used in the state are presently sold in bulk quantities (more than 208 L). Most insecticides (84%) are sold in paper bags (Cochran, 1988).

Disposal of pesticide containers in Iowa is presently accomplished through burial or burning. Containers which are properly rinsed may be treated as solid waste to be deposited in ordinary landfills, or may be burned in the field by the chemical applicator (Cochran, 1988). Regulations under the Iowa Administrative Code (Chapter 567-23.2 [455B]) also allow agricultural producers to burn up to one day's accumulation or 23 kg of plastics, whichever is less. The burning site must be at least 402 m from any inhabited building, livestock area, wildlife area or water source. Containers to be burned must also be triple-rinsed.

The Iowa Department of Agriculture contends that the most practical approach to resolving problems with pesticide containers is to educate agricultural chemical users and dealers. The educational program proposed for the state suggests dissemination of information to the public through a variety of methods. These methods include classroom instruction, brochures, demonstrations, trade and professional journals, television, video cassettes and radio. These educational techniques can be employed through sources such as pesticide applicator training programs, landfill operator training programs, pesticide dealers and manufacturers, professional and trade associations and journals, pesticide advertisements, public interest groups, demonstration projects, and governmental agency cooperative programs. Further education can be pursued through cooperative extension 4-H programs and Future Farmers of America (FFA) programs. The focus of the suggested education is on proper disposal practices, of which container rinsing is considered the primary concern for resolving the problems of pesticide container disposal (Cochran, 1988).

2.4.2.6 Wisconsin

The State of Wisconsin has not developed any specific program for collecting or disposing of pesticide containers, and most are currently burned, buried or landfilled. Empty containers are a problem in the state, although bulk sales have reduced the magnitude of the problem in the past several years (Morrison, pers. comm.).

Chapter Ag 29 of Wisconsin Agriculture, Trade & Consumer Protection states that:

> "No person may dispose of or hold pesticides or their containers, including empty containers, for disposal in a manner which is inconsistent with label directions or which may contaminate the waters of the state or create a hazard to persons, property, fish or wildlife. Pesticide containers, other than containers recycled for scrap or returned to the pesticide manufacturer for re-use, shall not be re-used for any purpose" (Ag 29.15 [5]).

In a survey conducted by the Wisconsin Department of Agriculture, Trade & Consumer Protection, 37% of farmers responding to questions regarding container disposal burned containers, 37% took containers to a landfill, 11% said the local co-op handled containers, and 9% buried containers somewhere other than at a landfill. Only 3% used containers for other purposes and only 2% took containers back to the store (Wisconsin Agricultural Statistics Service, 1986).

Containers buried in landfills may only be accepted by landfills approved by the state. The approval program, which requires public landfills to be lined with an impermeable layer of material and be engineered to prevent leachate contamination of groundwater, has been in place for the past 15-20 years. Presently, almost all landfills are approved to accept rinsed containers, and all unapproved landfills must

be closed by 1995. This requirement should significantly relegate the potential hazard of groundwater contamination from residues left in buried containers (Morrison, pers. comm.).

2.4.2.7 Other States

Most other states do not have an organized collection and disposal program in place, and many rely on burning or landfilling for container disposal. South Dakota approves landfills for acceptance of wastes such as containers, but those landfills are not required to accept containers (Bachman, pers. comm.). North Dakota is studying the problem, and is developing a pilot voluntary collection program for container dropoff. Landfills must again be approved by the state, but burial or burning on the farm is still acceptable. Bulk sales have also reduced the quantity of containers requiring disposal, although spillage of bulk chemicals has created a new set of problems in North Dakota similar to those problems in Illinois (Peterson, pers. comm.). California simply requires users to follow label instructions on the container for disposal (Formoli, pers. comm.). Indiana also suggests following label instructions for disposal, although open burning of plastics is prohibited in that state (Scott, pers. comm.).

Research is being funded by the U.S. Environmental Protection Agency to study options for collection and disposal; however, this project is only in the introductory stage. The main thrust of this research is to focus on waste minimization through new types of containers, modified pesticide formulations, and similar strategies. The study is being

conducted in a county of Mississippi where as many as one million containers are used each year. Metals are being recycled by a local scrap dealer, and efforts are underway to secure a recycler for plastics. Decontaminating containers is a major concern; however, cross contamination is not a major issue in using recycled plastics to form new pesticide containers if original containers are separated into use categories (herbicides, insecticides, etc.). No plastic recycler to recycle plastic pesticide containers has yet been selected at the writing of this paper (Gilding, pers. comm.).

2.4.3 Canada

Disposal of pesticide containers by farmers is not specifically regulated by any Canadian legislation, although residues in unrinsed containers may technically require special treatment (see section "Existing Legislation and Regulations" and Appendix A). Pesticide container management has been contemplated in several provinces across the nation, and active programs for collection and disposal of containers have been established in Alberta, Saskatchewan and Manitoba. Each of these collection programs is based on voluntary compliance, and disposal is left either to the province or to the municipality.

2.4.3.1 Alberta

The exact number of containers used annually in Alberta is not known; however, the approximate number of containers can be calculated from other available data. These data include the total weight of

packaging material used for containers, and the amount of land dusted or sprayed for weeds or brush. The weight of packaging materials for agrochemicals used annually in Alberta is estimated to be approximately 340 tonnes (t), which represents 50% more material than the estimated 227 t used each year in Manitoba (APR Applied Polymer Research Ltd., 1988). If 500,000 containers are used annually in Manitoba, then approximately 750,000 containers are used annually in Alberta. Statistics Canada (1987) reports spraying or dusting of approximately 6.1 million hectares of land in 1986, which represents 69% more land than was treated in Manitoba (approximately 3.6 million hectares). According to this comparison, approximately 850,000 containers are used annually in Alberta. The total number of containers of all sizes used in Alberta may thus be estimated at 750,000 to 850,000 each year.

Alberta has established a voluntary provincial collection program which includes a total of 336 collection areas. These areas consist of 110 provincially funded permanent collection depots and another 226 temporary collection areas which were constructed by municipalities without provincial aid. Permanent site locations were initially evaluated by Alberta Environment for acceptance or rejection, with the main criteria used for selection being strategic location and soil permeability. If soil was not satisfactory (such as a bed of clay), construction of an impermeable foundation was required. The costs of the permanent collection depots varied greatly, according to size, construction needs and site preparation requirements; however, the total costs of constructing the permanent depots were not available at the date of this report (Pledger, pers. comm.). See Appendix D for design

specifications of the permanent depots. Approximately 60 to 70% of used containers are believed to be recovered through the existing collection program, which is funded entirely by the Province (APR Applied Polymer Research Ltd., 1988).

Provincial policy prevents burial of containers in public landfills in Alberta, and lack of other disposal options has created a large stockpile of used containers. Approximately 30% of containers used in Alberta are metal, and some of these cans are recycled after having been drained and crushed. Plastic containers are drained and shredded, and are presently being stored until an acceptable disposal program can be established. An estimated 1,135 t of material is currently in storage, and this quantity is growing each year. The collection program has therefore been temporarily discontinued until disposal becomes viable, although farmers are continuing to use the collection depots, which are becoming overcrowded and unusable (APR Applied Polymer Research Ltd., 1988).

2.4.3.2 Saskatchewan

The Province of Saskatchewan contains the largest agricultural area in Canada, with over 17.5 million hectares in crop production. Farmers in this province reported dusting or spraying nearly 10.5 million hectares of land for weeds or brush in 1986, which represents over 190% more land than was treated equivalently in Manitoba (Statistics Canada, 1987). Approximately one million containers of pesticides are sold annually in Saskatchewan, which has created concern for proper contain-

er disposal and prompted the development of a pesticide container disposal program (Saskatchewan Environment, n.d.).

The Pesticide Container Disposal Program of Saskatchewan was initiated in 1983 by Saskatchewan Environment and Public Safety, and is currently operated as a joint venture between the Province and participating municipalities (Crop Protection Institute of Canada, 1988; Saskatchewan Environment, n.d.). Municipalities are responsible for land rental of collection depots, fencing and maintenance of the depots. Containers are deposited voluntarily by farmers and other agrochemical users, and the Province requests that these users triple-rinse containers prior to delivery. The provincial government then hires an independent contractor to drain containers and collect residues, crush metal containers and shred plastic containers (Ferris, pers. comm.). The Province is also responsible for approving the locations of collection depots, which is usually based on proximity to establishments and permeability of soil (Hallsworth, pers. comm.).

More than 700,000 containers were crushed or shredded in 1987 alone, although the program has averaged collection of about 650,000 containers per year for the first 5 years of operation. These figures indicate a collection rate of 65 to 70% of containers sold each year. Residues are stored at a central facility near Regina until they can be shipped to Sarnia, Ontario (Tricil, Limited) for disposal at the expense of the Saskatchewan government. Metal containers were shipped to a Manitoba scrap dealer (General Scrap & Car Shredders Ltd.) for recycling from 1983-86, and were shipped to a recycler in Saskatchewan

in 1987 (Crop Protection Institute of Canada, 1988). In the past year, metal containers were shipped to a metal recycler in North Dakota, although the unrinsed condition of these containers created some public concern over the method of transportation. Plastic containers are presently being shredded at the collection depots, and are then being shipped to a recycler in Hong Kong (Demoskoff, pers. comm.). Prior to finding this recycler, shredded plastics were held for several years at a storage area near Regina (Crop Protection Institute of Canada, 1988). Saskatchewan Waste Management legislation prohibits burial of pesticide containers in this province (Ferris, pers. comm.). This prohibition significantly limits disposal alternatives for collected containers.

The Saskatchewan program has been rather successful in collecting containers, as more than 3.25 million containers were collected, crushed or shredded from 1983 to 1987. Disposal, however, is not adequately addressed because disposal options for contaminated plastics are extremely limited. The provincial prohibition against burying even rinsed containers in approved landfills means that shredded plastics will be stored until recycling becomes viable, or until these materials are shipped to a hazardous waste facility for incineration at an extreme cost. The program averages collection in excess of 650,000 containers annually, and an average of over 17,500 L of residue are collected each year as well. The current annual cost to the Province averages $351,847 per year, which equates to a cost of $0.54 per container (Crop Protection Institute of Canada, 1988). This expenditure covers the cost of contractor services as well as residue disposal (Ferris, pers. comm.). No cost figures are available for collection depot construction or maintenance.

2.4.3.3 Manitoba

The only program established in Manitoba to collect pesticide containers for disposal is an entirely voluntary operation. Municipalities individually set up container collection areas where farmers, commercial applicators and weed control officers are asked to deposit emptied rinsed containers. Many such areas have been established at or near municipal landfills and are little more than designated areas surrounded by snow fences (Environmental Management Services, 1982). Over 150 collection areas have been established across the Province entirely at the expense of municipal governments (see Figure 2.1). These areas, however, are not regulated or registered by Manitoba Environment and Workplace Safety and Health (MEWSH) (Plews, pers. comm.). This lack of regulation may stem from the need for unrinsed pesticide containers to be specifically identified as hazardous or toxic waste by provincial legislation.

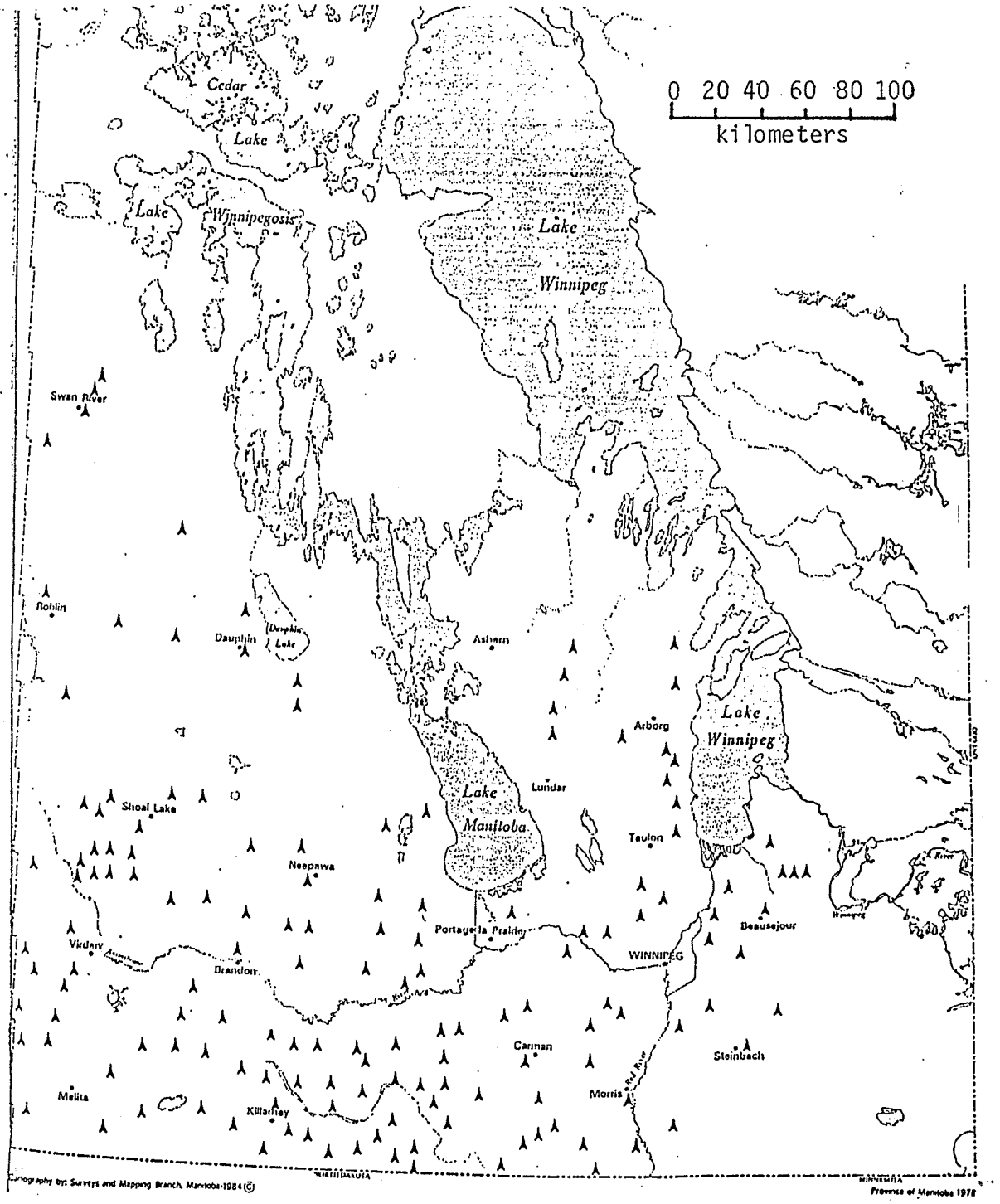
Once containers are collected in the voluntary collection areas, MEWSH and the municipalities divide the responsibilities of clearing the areas and disposing of collected residues. The municipalities are responsible for draining and crushing containers, storing residues in 208 L drums, and disposing of emptied containers. These containers are sometimes buried in landfills, although metal containers are often recycled as scrap and plastics are burned in open trenchs (WCD 1987 Annual Reports). MEWSH then takes responsibility for collecting and disposing of collected residues. As many as 226,598 containers were collected from 113 disposal sites in 1987, according to the Manitoba

Agriculture Container Disposal Survey (1987 Summary). Based on this rate, as many as 300,000 containers requiring draining, crushing and disposal may have been collected from all 150 sites across the Province in that year.

Excluding administrative costs, the Province of Manitoba spends approximately $35,000 per year to collect and dispose of residues. This cost essentially breaks down to $5,000 spent to hire a truck and two employees for two weeks to collect residues from collection areas around the Province, and about $30,000 per year (depending upon quantity of residues collected) to pay for incineration of residues. Disposal is subcontracted to incineration facilities either in Ontario or in the United States, which costs between $250 and $350 per 208 L drum of residue waste that is incinerated (Plews, pers. comm.).

In addition to these costs, each municipality must pay for maintaining collection areas, for purchasing or renting a can crusher and maintaining that equipment, and for physically crushing and draining containers once collected. Crushing alone costs $0.04 to $0.087 per can, according to reports from four Weed Control Districts in their 1987 Annual Reports. Total annual costs to municipalities for can crushing labor may range from about $12,000 to $26,100 based on collection of 300,000 containers each year. General labor for provincial employees pays approximately $10.00 per hour plus benefits, according to rates set by the Manitoba Government Employees Master Agreement. If site and equipment maintenance requires an additional 40 hours of labor per site per year, the total annual cost of maintenance to all municipalities

Figure 2.1: Pesticide Container Disposal Compounds in Manitoba



Source: Manitoba Department of Agriculture.
Guide to Chemical Weed Control, p. 6.

combined may total as much as $60,000 or more ($10.00 X 150 sites X 40 hours). Total annual costs of the program may therefore range from $107,000 (35,000 + 12,000 + 60,000) to over $121,100 (35,000 + 26,100 + 60,000). This range of estimated total costs of the current program still does not include the initial purchase or annual rental of the can crushing equipment.

Of the containers collected by Weed Control Districts across Manitoba, 71% were thought to have been triple-rinsed by the user before deposit in collection areas (MDA 1987 Survey). No tests were actually conducted on the containers, so rinsing was determined by visual inspection only or by residues being extracted from the containers. Residues that dried inside the empty containers, as well as containers which had been inadequately rinsed, may have therefore been included in the approximation of rinsed containers (Todd, pers. comm.).

The current provincial collection and disposal program has been rather successful as an initial attempt to control disposal of empty containers; however, the opportunity exists for substantial improvement to the program. One unfortunate result of the collection of plastic containers may be the concentration of emissions from burning these materials, even though burning is no longer a recommended disposal method by MEWSH (Plews, pers. comm.). As well, lack of rinsing of some containers has discouraged many recyclers from accepting the metal pails. Smaller containers may never be collected and properly destroyed unless strong incentives are provided to inspire proper collection; otherwise, these small containers simply exacerbate the household hazardous waste problem.

2.4.3.4 Comparison of Prairie Provinces

The percentage of used containers recovered in each of the prairie provinces is roughly equivalent among all three provinces, and this percentage is quite high when compared to similar voluntary programs in the United States. The costs of the Alberta program are not known; however, the operation resembles that of the Saskatchewan program. Operation costs per container should therefore be close to the cost per container for crushing, shredding and removal from compounds in Saskatchewan. Residue incineration is likely less expensive, as this disposal is now accomplished at the Alberta Special Waste Management facility at Swan Hills, Alberta. The average cost per container may therefore be nearer $0.50 for container compaction and removal, and for residue disposal. At this amount, the Alberta program costs between $240,000 and $280,000 per year.

The success of the prairie province programs can be measured by the percentage of containers collected and by cost per container. This success must also be measured in terms of environmental effectiveness. Alberta has developed an excellent infrastructure for container collection; however, the lack of disposal alternatives has created major problems which threaten the effectiveness of container collection in the future. Containers are collected and stored in an environmentally safe manner, which greatly reduces the hazards created by empty containers. Saskatchewan has not developed the formal infrastructure; instead, this province has committed to a system where containers are compacted and removed to an area where environmental contamination can

be avoided. Manitoba has neither the infrastructure of Alberta nor the centralized collection of Saskatchewan, and environmental contamination is still risked in the Manitoba program even after containers are collected. The Manitoba operation is the least expensive, and it is also the least environmentally effective. See Tables 2.5 and 2.6 for a summarized comparison of the prairie province disposal programs.

2.4.3.5 Other Canadian Provinces

Of all other Canadian provinces, only New Brunswick has made any real attempt to address problems posed by pesticide containers. No formal collection program has been established in this province; however, an effort is made to educate users about proper rinsing and disposal techniques. This education is accomplished through public education programs, grower meetings and through pesticide dealers. As well, illegal dump sites are being cleaned up across New Brunswick and "no-dumping" signs that encourage proper disposal are being posted at these sites. Rinsed containers are accepted at most landfills across the Province. An estimated 26,000 containers (14,000 plastic and 12,000 metal) are used annually in New Brunswick agriculture, and approximately 150 person-hours are spent annually to address problems caused by these containers. Industrial use and forestry pesticide containers are handled more on a case-by-case basis by the provincial Environment Department, and are not included in the above figures (Sexsmith, pers. comm.).

TABLE 2.5

Container Management Programs of the Prairie Provinces

Province	Allocation of Responsibilities	# Collection Depots/Areas	# Ctrs Collected Annually ('000)	# Ctrs Used Annually ('000)	%
Alberta	Province: * Funding of permanent depots * Approval of depot locations * Disposal of residues Municipalities: * Construction and operation of temporary depots * Maintenance of all depots	336	480-560	750	60 to 70
Saskatchewan	Province: * Approval of depot locations * Container compaction * Residue collection and disposal Municipalities: * Depot construction and maintenance	273	650 (see note 1)	1,000	65 to 70
Manitoba	Province: * Some container compaction * Residue collection and disposal (see note 2) Municipalities: * Construction and maintenance of collection areas * some container compaction	150	300	430-545	55 to 70

Notes:
1. Five year average
2. Often performed by local weed control officer under MDA

TABLE 2.6

Container Disposal Programs of the Prairie Provinces

Province	Container Disposal	Total Annual Program Costs ('000)	Total Costs Per Container (Collect & Dispose)
Alberta	* All containers drained * metal crushed and either recycled or stored * Plastic shredded and stored (see note 1)	$240-280 (see notes 2,3)	$0.50
Saskatchewan	* All containers drained * Metal crushed and recycled * Plastic shredded and stored (see note 1)	$351 (see notes 3,4)	$0.54
Manitoba	* All containers drained * Metal crushed and either recycled or buried * Plastic burned or buried (not shredded)	$107-121 (see notes 3,5)	$0.36 - 0.40

Notes:
1. Container burial is not allowed in these provinces.
2. Based on $0.50 per container cost.
3. This estimated cost does not include depot construction or maintenance.
4. Five year average.
5. Does not include cost of can-crushing equipment.

2.5 EXISTING SOURCES OF FUNDING

Operation of a container management program requires funding for many components of the overall strategy. From the operational perspective, money is needed to pay for container collection and equipment maintenance costs, residue collection and disposal, preparation of containers for disposal, transportation of containers to disposal areas (if necessary), and final disposal of containers. Administratively, funds are required to pay for managerial staff salaries, overhead costs including office space and equipment, promotional material and educational expenses. Operational costs expressed in Table 2.6 represent only a portion of the overall costs of collecting and disposing of empty containers because depot (or collection area) construction and maintenance is not included in these figures.

Existing programs in Canada are managed and operated by provincial and/or municipal governments, so funding of these programs is provided through general provincial tax revenues. The Province of Alberta recently considered cutting this expense from the provincial budget and forcing industry to pay total costs of the program. To avoid this regulatory approach, the Crop Protection Institute of Canada (CPIC) proposed collecting a $1.00 surcharge on all containers sold in the prairie provinces to help cover container management costs (Krahn, pers. comm.). All three provinces have approved this proposal, and the surcharge is being collected as of November, 1988 (Dickson, pers. comm.).

The CPIC surcharge is initially paid by the manufacturer or distributor, but is ultimately paid by the pesticide user. The charge is collected from the packager of pesticides, and this cost is added to the retail price of the product. Once the surcharge is collected from the user through the retail sale, the packagers are reimbursed for their original payment (Dickson, pers. comm.). Produce prices are often set by national or even international markets, so the farmers are unable to raise the price of their produce and thereby pass the cost to the general consumer.

Collection and disbursement of the surcharge will be administered by CPIC, and funds will be distributed to the governments of each of the prairie provinces. The quantity of funds paid to each province will be based on how many containers are sold in that province (Dickson, pers. comm.). This surcharge may therefore provide not only funds, but also a means by which the number of containers sold annually in each province can be more accurately counted. CPIC is willing to take this action in recognition of container management problems, but does not wish to be involved in establishing or operating a container management program. CPIC believes that these responsibilities lie with the provincial governments (King, pers. comm.). Provincial governments, however, believe that container management should be the responsibility of the pesticide and agricultural industries. This difference of opinions has created an impasse which hinders development of an improved container management program.

2.6 SUMMARY

This chapter has reviewed many of the problems associated with empty pesticide containers and has shown that management of this waste stream is both possible and necessary. A solid waste problem is created by the sheer bulk of materials used to package agricultural pesticides, and if pesticide residues contaminate this refuse, the total bulk of material may need to be handled as hazardous waste. Rinsing residues from empty containers notably abates this hazardous component and simplifies the overall problem.

Pesticide container management has been attempted in several European countries, in several states of the Unites States and in each of the prairie provinces of Canada. The European communities appear determined to control all forms of hazardous waste, including industrial, agricultural and household, and this determination provides a level of social support necessary to successfully collect these wastes. Programs in the United States and in Canada indicate good potential for development of a fully integrated collection and disposal program; however, no large scale program of this nature has yet been successfully implemented. This ultimate management program will require both an appropriate collection and disposal infrastructure, and a centralized management structure to administer the program over time. Table 2.6 summarizes the existing programs within these various jurisdictions.

Manitoba's container management program has many strengths, and it also suffers a number of weaknesses. The program operation has been quite inexpensive compared to similar programs in other provinces,

while the rate of collection of used containers is roughly equivalent to the rates of these other provincial programs. The collection areas, however, are not built to be environmentally safe, and disposal of plastic containers by burning only disperses the pollution across a wider area. The current program is not fully organized, and little monitoring of efforts and results has been attempted, even though these data are necessary to tailor a program to fit Manitoba's needs. The CPIC surcharge may provide a means to count the number of containers sold each year; however, additional data are needed to determine what is happening to uncollected containers. These and other problems indicate that while the current program has achieved a certain level of success, modifications are needed if empty containers are to be properly managed in the Province of Manitoba.

TABLE 2.7

Summary of All Existing Programs Studied

JURISDICTION	COLLECTION				DISPOSAL								
	Voluntary	Regulatory	Deposit-Refund	None	Recycle (Metal)	Bury in Landfill	Bury - Elsewhere	Low-Temperature Incineration	High-Temperature Incineration	Chemical/Other Treatment	Follow Label Instructions	Store/Other	Unknown
Denmark	X	X							X	X			
Netherlands		X											X
Norway	X								X				
Maine			X			X							
Minnesota	X				X	X	X	X					
Illinois	X				X			X					
Oregon	X				X	X							
Iowa				X		X		X					
Wisconsin				X		X	X	X					
S. Dakota				X		X							
N. Dakota				X		X	X	X					
California		X									X		
Indiana				X							X		
Alberta	X				X							X	
Saskatchewan	X				X							X	
Manitoba	X				X	X	X	X					
New Brunswick				X		X							

Chapter III

ALTERNATIVES FOR COLLECTION AND DISPOSAL OF CONTAINERS

3.1 OPERATIONAL NEEDS

A fully integrated management program for agricultural pesticide containers requires a system to collect containers from pesticide users, decontaminate collected containers, collect and dispose of residues from this decontamination, and dispose of the collected containers. Collection without disposal tends only to shift the burden of the container problem from farmers and society to the organization responsible for collecting the containers; however, the problem remains unsolved.

Collection is a major component of the overall program. This function must be performed adequately to remove containers and residues from the environment and to prepare the containers and residues for disposal. If clean containers can be compacted and treated as solid waste, the number of alternatives for disposal can be maximized while the costs for disposal are minimized. The acceptability of various disposal alternatives may therefore be dependent upon the effectiveness of the collection system.

As discussed in Chapter II, many containers are not properly rinsed prior to being destroyed, discarded or delivered to designated collec-

tion areas. These unrinsed containers add a toxic component to the overall waste stream, thus limiting disposal alternatives to those incorporating facilities that handle hazardous materials. Conversely, rinsed containers might be considered as solid waste or perhaps as "delisted" or non-hazardous waste, which provides several additional alternative methods for container disposal. The collection system must therefore provide some guarantee that containers are rinsed either by the users or by collection personnel, so that no question remains that containers are clean. These containers can then be crushed or shredded and handled accordingly.

A collection system may be composed of local collection areas, regional storage facilities, and/or a provincial storage facility where containers can be held prior to disposal. Container preparation and residue collection can be performed at any of these facilities. If regional or provincial facilities are used, a transportation infrastructure may also become necessary to ship containers from smaller collection areas to these larger storage facilities. These facilities might also require registration as hazardous waste facilities, and transported containers may require a manifest identifying them as hazardous material. The collection system may therefore be rather complex; however, it will facilitate easier disposal by fully preparing the collected containers.

Once containers have been drained and rinsed to an acceptable level of decontamination (which should be specified by provincial regulation), they may then be handled by more traditional solid waste dispos-

al facilities. Residues and rinsate from container rinsing must still be treated as hazardous material, however, requiring the services of special disposal facilities. Such services are currently available in Sarnia, Ontario (Tricil, Limited) and in several areas of the United States. Disposal of materials through these facilities is quite expensive, which further highlights the need for containers to be properly rinsed in the field by pesticide users.

3.2 EVALUATING OPERATIONAL ALTERNATIVES

Several alternative methods exist to collect containers, and these methods will be discussed in the following section. The alternatives that will be considered for collecting containers are as follows:

1. A modified voluntary program,
2. a deposit-refund system,
3. a subsidized collection program, and
4. direct regulation.

Disposing of collected containers is the necessary complement to a good collection program, because only with adequate disposal can the problem be ultimately resolved. The following alternatives for container disposal are available to Manitoba:

1. burial,
2. incineration,
3. recycling, and
4. reuse.

Each of these alternatives has both positive and negative aspects, or externalities, which can be categorized into specific predetermined groups. These groups can then be used to develop criteria by which each alternative may be judged. A brief discussion of externalities and related criteria is therefore necessary before the implications of various alternatives can be fully explored.

3.2.1 The Effects of Externalities

Pollution is a by-product of the production or consumption of goods by various groups and/or individuals of society. This by-product is referred to as an external diseconomy, or a negative externality associated with activity involving the aforementioned goods (Randall, 1987; Aranson, 1981). An externality exists whenever the welfare of one individual is affected by an activity under the control of some other individual (Randall, 1987). Aranson (1981) distinguishes an externality from the good itself by defining the externality as "the external utility people have for the good" (p.80), which refers to extraneous effects of a good (any product or service) additional to the intended effects of that good. This external utility may be either positive or negative.

Externalities represent market failures because they produce benefits or costs for which proper compensation is neither paid nor received. Pollution thus represents a market failure because polluters discard wastes without paying costs to society for environmental degradation. The polluters' expressed costs of production are inappropri-

ately low so that benefits (profits) are too high (Randall, 1987). Reduction of a negative externality such as pollution can result in a more efficient distribution of income (costs and benefits) which improves the welfare of society in general; therefore, pollution abatement acquires a positive social value (assuming a competitive marketplace). The positive value or benefit of pollution abatement can then be compared to costs incurred by establishing the program, and if benefits outweigh costs, social welfare is improved. This comparison is known as a social cost-benefit analysis.

3.2.2 Establishment of Criteria

Assigning a definite monetary value to social costs and benefits is not always possible, as numerous methods of evaluation exist which may yield different outcomes. For this reason, programs involving areas such as environmental policy are often measured by success in addressing specific types of externalities. These types of externalities identify areas of interest which can be used as criteria to judge the success of proposed actions being considered as solutions to existing problems.

Specific criteria are commonly used to evaluate environmental policy tools which deal with externalities such as pollution. These criteria are: environmental effectiveness, economic efficiency, political and administrative feasibility, flexibility, and compatibility with existing institutional frameworks (Majone, 1976). For the purposes of this paper, these criteria shall be defined as follows:

1. environmental effectiveness: This criterion measures the physical effectiveness of a program in removing pollution from the environment, while realizing the effective re-employment of all resources involved. In the case of pesticide containers, the most effective program will collect all containers after they are used, ensure cleanliness of these containers and proper disposal of any toxic residues, and encourage future use of scrap materials derived from the containers.

2. economic efficiency: This criterion measures the cost-effectiveness of a program for its environmental effectiveness. Cost per container collected is one measure of the economic efficiency of various programs; however, true economic efficiency should consider not only monetary costs but also costs to society for unabated pollution, and effectiveness of internalizing externalities (where the pollute prevents wastes from adversely affecting others).

3. political feasibility: This criterion describes the level of acceptance of each program by pesticide users, manufacturers, distributors and the public in general.

4. administrative feasibility: This criterion considers the effort and complexity of actually implementing and maintaining a program.

5. flexibility: This criterion describes the adaptability of a program to a changing environment and to future problems as the types and quantities of containers change over time.

6. compatibility with existing institutional frameworks: This criterion considers how each program fits into existing policy, legislation, and existing infrastructural developments such as transportation routes and disposal (or recycling) facilities.

Each of these criteria is important and should be carefully considered; however, certain criteria will be of higher value to different individual interest groups, in the context of each of those groups' specific interests. For example, environmental effectiveness may be more important to environmental lobby groups, regardless of economic efficiency or political feasibility. Flexibility and compatibility (at least with existing legislation) may be of most importance to industry representatives. Political and administrative feasibility and economic

efficiency may carry a heavier weight from the viewpoint of the provincial government. These differing opinions are the result of very different viewpoints from which each alternative is considered. An alternative which appears best from one person's point of view may not meet the most important criteria from the viewpoint of another. For this reason, no one alternative is necessarily better than the others from every perspective.

3.3 ALTERNATIVES FOR COLLECTING CONTAINERS

Pesticide containers can be collected by four methods: a voluntary program, a deposit-refund system, a subsidized program, and a regulatory program. Each of these alternatives is discussed in this section, and operational costs are estimated for each program where possible. Employment wages and salaries are based on the Manitoba Government Employees Master Agreement 1987-1990, as negotiated between the Manitoba Government Employees Association (MGEA) and the Manitoba Government. One should note that employees under a non-governmental administration may be hired at wages different from those specified. MGEA rates are used as a guideline for consistency among various program costs. All estimated costs are based on 1989 constant dollar values.

3.3.1 A Modified Voluntary Program

A voluntary program for collecting empty pesticide containers is based on moral suasion which is a strong recommendation, although not an order, to comply with suggested guidelines. Moral suasion is a

noneconomic alternative to achieve pollution abatement because it derives from moral beliefs and not from economic incentives for compliance. Voluntary compliance may play a valuable complementary role in any pollution abatement program, and may provide a strong and perhaps useful impetus for developing a future program. This tactic is also an effective tool when enforcement of other methods is impossible and/or funds are not available to establish economic alternative programs. Enforcement needs and administrative costs are minimized under a purely voluntary program; however, this alternative provides no guarantee for effectiveness or permanence of the program. Moral suasion is sometimes used as a diversionary tactic by interested parties lobbying against implementation of more stringent programs. This tactic can be successful if the problem or negative externality is reduced voluntarily to the point where capital and administrative costs of establishing a permanent program exceed the additional benefits that may be achieved through further abatement (Baumol and Oates, 1979).

Voluntary collection has proven to be somewhat successful for gathering containers in the Canadian prairie provinces; however, these containers are often not rinsed, making their disposal extremely difficult. As well, plastic containers are often mixed with metal containers and with a variety of other refuse that may be deposited in collection areas, greatly increasing the effort needed to clear the areas of stored containers (EMS, 1982). A system is therefore needed to separate, drain, rinse, and shred or crush containers using as little effort as possible. Special equipment will require development to perform these activities efficiently, and preferably within a single unit.

Assuming development of this equipment, the current voluntary program in Manitoba appears to offer significant promise of negating the need for a more stringent program. Improvements are necessary to make this promise a reality because, as shown in Chapter II, 130,000 to 245,000 containers are being improperly discarded in Manitoba's environment each year. Although some of these containers are burned on farms or deposited in local dumps with household waste, these methods of disposal are not acceptable from environmental and health perspectives. Such practices tend only to disperse pollution; however, larger problems are created as these pollutants accumulate over time. Of more immediate concern are the uncounted containers discarded in ditches, along river banks, and in other public areas. Users must be persuaded to abandon these practices in the interest of reducing risk of exposing the public to these containers.

Perhaps the best tool for improving the current voluntary program is increased public education. Pesticide users must become more aware of environmental degradation caused by improper disposal of containers and of the benefits of properly rinsing containers in the field. This education could be accomplished by promoting proper disposal techniques through press releases and public media advertisements, and through field demonstrations of rinsing containers. Public notices of collection area locations should be prominently displayed at all retail pesticide dealer outlets, and similar public announcements in local newspapers and on radio stations should also be pursued. Use of these marketing techniques was reported by only one Weed Control District in its 1987 Annual Report, and while others undoubtedly use these tech-

niques to some minor extent, the potential for increased public awareness campaigns certainly exists.

Convenience is also a key factor in developing a successful container collection program, and research is needed to determine where new collection areas might be required. Users of the existing voluntary program should be studied to learn how far farmers are willing to travel to use collection areas, and what other factors contribute to users' acceptance of the program. Collection area locations across the Province could then be revised according to these data.

Local collection areas should be cleared of containers each year, if the program is to accomplish operational and environmental success. This annual clearance could be accomplished much more efficiently if containers were separated and stacked: additional educational effort should be employed to inform users of these needs. Collection areas should also be divided into specific sections for plastic containers and metal containers. Containers could then be rinsed and prepared for disposal more quickly, and residue collection could be reduced because containers would not fill with rain water. Prepared containers could be removed to regional collection facilities or to acceptable disposal facilities, unless on-site disposal is allowed (as in a Class I landfill). Disposal alternatives will be discussed in the next section of this chapter.

The financial requirements for operating this program (excluding disposal of residues and rinsates) would be approximately $247,000 to $253,000 per year (see Table 3.1), and as much as 80% of containers

used annually might be potentially collected. This estimated budget is based on a 10 year average, and it should be noted that start-up costs may be higher because of capital investment needs and "fine-tuning" of the operation. Each collection area is assumed to require approximately two days for clearance. Costs not specified include: disposal of cardboard boxes (in which plastic jugs are often delivered), and work crew transportation costs to and from each collection area. These costs are covered by the "contingencies" category. Program costs also assume that collection areas would not require special construction to prevent groundwater protection, as specified in Appendix D.

Disposal of collected residues and rinsates would significantly increase the total annual program cost, because these additional expenses may total over $485,000 per year, assuming a cost of $350 per 208 L drum of hazardous material. These costs might be reduced if users rinse containers in the field and stack containers in collection areas so that rainwater does not accumulate in open containers.

The costs in Table 3.1 assume development and use of special equipment to rinse, shred and/or crush containers, and to deposit the resulting material in a trailor or vehicle for transportation. No such machine currently exists on which to base estimated costs, and the assumption is made that four such machines could be designed and produced for a total cost of $400,000. Each machine would essentially consist of a series of pressure rinsers on a conveyor, on which containers would be placed. A short rinse would be conducted with rinsate being automatically collected, and containers would be moved into a

TABLE 3.1

Annual Operational Costs of Modified Voluntary Collection

Local collection area modification and maintenance	$58,100 - 62,300	(a)
Regional collection depot construction	13,000	(b)
Capital equipment design and production	38,900	(c)
labor (two crews of three persons each)		
Crew Chiefs (Operator 2)	21,600	(d)
General labor	37,200 - 39,900	(e)
Training	1,800	(f)
Transportation of cleaned and compacted containers to regional depots	52,700	(g)
Public education and promotion	**	(h)
Contingencies (10%)	22,400 - 23,000	
Subtotal	246,700 - 253,200	
Residue disposal	105,000	(i)
Rinsate disposal	336,700	(j)
Contingencies	44,200	
Total	732,600 - 739,100	

Notes:

(a) 40 hours labor per year for 150 collection areas at a rate of $9.69 - 10.38 per hour (based on MGEA union pay scale agreement) (does not include Worker's Compensation or other benefits)

(b) four regional depots costing $25,000 each (see Appendix D for specifications) amortized over 10 years at a real interest rate of 5%. (This cost would be eliminated if containers are shipped directly to disposal facilities).

(c) Three mobile units each costing approximately $100,000 amortized over 10 years at a real interest rate of 5%

(d) Three crew chiefs (operator 2 level) at $11.26 per hour, 40 hours per week for 16 weeks (does not include Worker's Compensation or other benefits)

(e) Six laborers (two per crew) at $9.69 - 10.38 per hour, 40 hours per week for 16 weeks (does not include Worker's Compensation or other benefits)

(f) $200 each for nine persons

(g) $0.29 per kg (0.13 per pound) for trucking and labor costs, based on each regional facility servicing an area with an 80 km (50 mile) radius (APR Applied Polymer Research, Ltd., 1988)

(h) Included under administrative costs in Chapter IV

(i) 62,500 L equals 300 (208 L) drums at $350 disposal cost per drum

(j) From rinsing 400,000 containers with 500 mL water (possibly more if later de-watered) yields 962 drums (208 L each) at $350 disposal cost per drum

slow-speed shredder. Shredded material would then be blown into the disposal vehicle for transportation. A parallel conveyor would rinse metal containers and crush rather than shred them. These crushed containers would be stacked (perhaps manually) in a waiting vehicle.

Once containers are rinsed, crushed or shredded, and loaded into a vehicle for transportation, the crew would move directly to the next site to begin preparing containers for disposal, leaving loaded prepared containers behind. A separate person or two-person crew would travel among collection areas and transport the loaded containers to a regional collection depot or disposal facility. Cost studies by APR Applied Polymer Research (1988) determined that transportation would cost approximately $0.29 per kg to truck materials within an 80 km area. This cost would include equipment, fuel and labor.

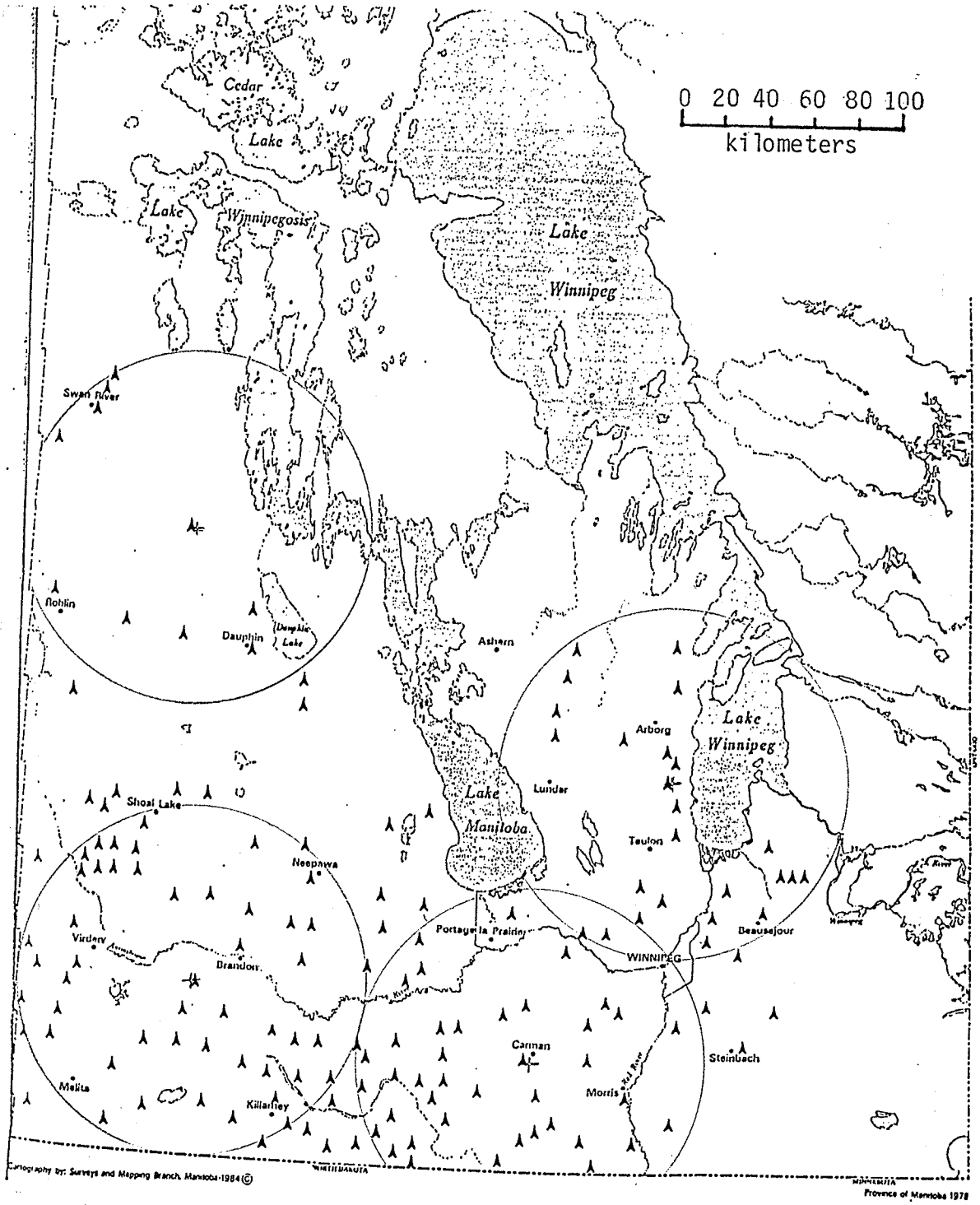
The costs defined in Table 3.1 also assume that existing collection areas would be slightly modified to define areas for plastic containers and metal containers, and no major changes would be made. Four regional collection depots could be constructed so that they are within 80 km of most existing local collection areas (see Figure 3.1). Cleaned and compacted containers could be transported to these regional depots for later disposal. These regional collection depots might be a necessary component of the collection infrastructure, because containers could be double-checked for rinsing, separated and bundled (if necessary) for recycling or disposal, and shipped en-masse to acceptable disposal facilities. Alternatively, containers could be shipped directly to

disposal facilities if these facilities are spaced adequately throughout the Province.

The environmental effectiveness of this alternative would certainly be an improvement over the current program, although a collection rate of 80% fails to collect as many as 100,000 or more containers each year. The local collection areas would not be environmentally secure either, and environmental contamination at collection areas would still be possible. The cost of collection alone would be $732,600 to $739,100 if residue and rinsate disposal is properly accomplished at a hazardous waste disposal facility. If 400,000 containers are collected, this program would cost $1.83 to $1.85 per container with 100,000 or more containers not being collected. Polluters would internalize some costs by absorbing expenses to deliver containers to collection areas, but society would be forced to pay for ensuring that containers are rinsed of toxic residues. This cost does not include administrative or container disposal costs, although monetary costs of disposal may in some cases be insignificant (see next section, "Alternatives for Disposal").

The high cost of the modified voluntary program might compromise its political feasibility, and continued use of existing collection areas might generate public opposition if the environment is not protected. These collection areas might therefore require eventual re-design or relocation, necessitating research and public approval. The program would be quite feasible administratively, however, as it would be based mainly on asking pesticide users to rinse and dispose of containers

Figure 3.1: Areas Covered by Proposed Regional Collection Facilities



Note: The radius of each circle equals 80 km

responsibly. The program would also be very flexible and could easily be adapted to address new containers or even unrelated wastes (such as household hazardous wastes). Finally, a modified voluntary program would simply be an expansion of the existing program, making it highly compatible with the existing infrastructure. Comparison of this program with other programs based on stated criteria will be made at the end of this section.

3.3.2 A Deposit-Refund System

A deposit-refund system employs the same principles as an emissions fee charged to polluters, combined with a subsidy for pollution abatement (Bohm, 1981). The deposit would act as a penalty to pesticide users if containers are improperly discarded, and the penalty would be negated by refunds for proper return of the containers to designated disposal areas. Establishment of an emissions fee provides incentive for pollution abatement up to the point where the marginal cost of abating additional pollution equals the fee for discharging that emission. Beyond that point, the polluter is economically better off by paying the fee and discharging the pollution (Randall, 1987). In the case of a deposit on pesticide containers, the deposit (fee) must be made high enough to offset the time and transportation costs of returning the containers to the collection areas.

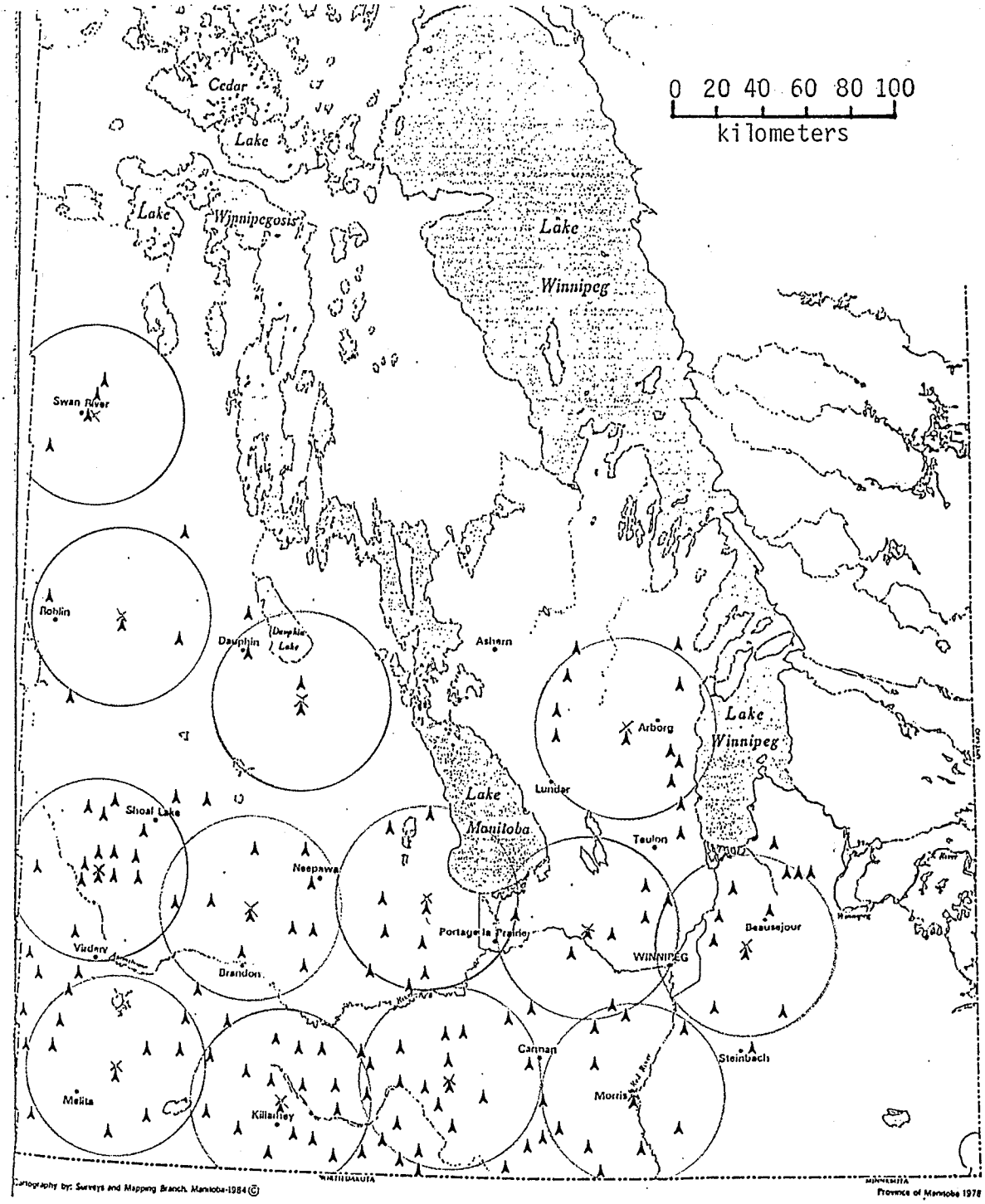
A deposit-refund system similar to Maine's program could be established in Manitoba. Such a program would offer financial incentive for pesticide users to rinse containers and return them to collection are-

as, negating the need for residue and rinsate collection and disposal. The initial deposit could be collected at retail distributors and these deposits could then be collected by the program's administration. Each container would require an identification sticker to show that a deposit is paid when the container is purchased, and only the marked containers would be eligible for the refund.

Collection of deposits would require significant recording, as would payment of refunds for returned containers. With the keeping of these records, accurate determination of the percentage of containers used annually that are subsequently collected would be possible. Data entry would require employment of three persons to input these data and to compare containers sold with those later collected. These employees would work at the administrative level; however, because they are specifically needed for the deposit-refund system, they are included in operational costs of this program.

Collection of the containers could be accomplished with 13 temporary regional collection facilities serving regions with approximate radii of 40 km (see Figure 3.2). Collection through temporary regional facilities is suggested in lieu of collection by pesticide dealers because dealers are not organized or trained to handle empty containers. Regional facilities should not be required to meet hazardous waste facility requirements because containers would be rinsed and therefore non-hazardous. As well, containers would not be stored at these sites for more than one month, so permanent facilities would not be required.

Figure 3.2: Proposed Locations for Deposit-Refund Collection Areas



Note: The radius of each circle equals 40 km

Collection areas would be staffed by locally hired people to check and accept (or reject) containers, and to issue refund vouchers for accepted containers. Two employees of the collection program would be on site at these collection facilities for 224 hours each year (2 weeks, 7 days per week, 8 hours per day). This arrangement would necessitate hiring three employees for each facility to work rotational shifts totalling approximately 37 hours each per week for 2 weeks. In addition to these collection crews, three crews of four persons each would be hired to crush and shred containers with mobile equipment. These crews would travel between collection areas within each of three designated regions in the Province to compact containers and haul them to appropriate disposal facilities.

The containers should only be accepted at collection areas if rinsed, which would provide the incentive for users to rinse residues from the containers. A variety of methods could be used to check for container rinsing. The simplest method would be to visually check containers for residues and for cleanliness. This type of check may provide a guarantee that some type of rinse has been made, although the extent of that rinsing may not be apparent. Spot rinsing of containers could also be used to check for milkiness or discoloration of rinsate. This type of check may identify containers with wet or dried residues still within them, but might actually identify the presence of carrier agents (diluents) rather than actual pesticide formulations. Such a presence, however, still indicates whether or not the containers are clean.

Another method to check for rinsing would be to conduct chemical field tests for remaining chemicals; however, the following requirements would have to be met:

1. an acceptable range of test results would have to be established,
2. the test would have to be capable of checking for a wide range of formulations,
3. accurate field test equipment would have to be purchased, and
4. collection personnel would have to be trained to use this equipment.

A variety of existing tests exist that might be appropriate for field testing of containers. For example, a simple color test might be used to test for vapors of pesticide formulations, organic solvents, or adjuvants present in headspace gas within the containers. Alternatively, containers could be punctured to check for liquid, and this liquid could be checked for milkiness or discoloration. These examples represent only a partial list of available field test technologies, and other existing tests might also be considered for checking residues in containers. Field tests would provide the most accurate results; however, research and/or development is needed to establish an inexpensive and uncomplicated test for various pesticide residues.

The actual operation of the collection program would be rather simple. Upon return of containers to the collection areas, collection workers would visually check containers and lightly rinse sample containers from each load delivered to check for rinsing. If containers are accepted, users would receive vouchers for deposit reimbursements that could be cashed by the original dealers. Dealers would then sub-

mit receipts to the program administration for reimbursement from the provincial fund. Deposits collected on unreturned containers would be retained by the administration and used to subsidize costs of the overall program.

The environmental effectiveness of this program would be maximized, as almost all containers should be collected under the deposit-refund system. Calculations in this portion assume a collection rate of 90-95%, which should not be unreasonable. This figure assumes that approximately 25,000 to 50,000 containers may not be collected, which would generate $125,000 to $250,000 annual revenue if a deposit of $5.00 per container is charged. An even higher rate of return may be achieved with higher deposits so that nearly 100% compliance could eventually be achieved.

An environmental drawback to this program is that some labelled containers would not be properly rinsed and delivered to collection facilities. These containers might eventually be collected for the deposit return by untrained personnel, which implies an additional risk to the public that must be minimized. This problem should be addressed by an educational campaign.

The deposit-refund system would be very efficient economically, because minimal (if any) residue and rinsate disposal would be required to be done by the collection organization. Permanent collection facilities would not be required, and costs of residue disposal as well as delivery of containers to collection areas would be absorbed by pesticide users. The total program should cost between $202,000 and

$208,000 per year, and might collect as many as 95% of containers used annually (see Table 3.2). At this rate, this program would cost $0.43 to $0.44 per container collected.

The political feasibility of the deposit-refund program may not be as high as the voluntary program, because administrative costs of pesticide dealers would rise with the additional record-keeping requirements while users would be forced to pay significant deposits if very many containers are purchased; therefore, pesticide dealers and some users might be expected to oppose this program (Krahn, pers. comm). The siting of temporary collection areas might also create public opposition, because these collection areas could be perceived as handling materials hazardous to local communities. Siting these collection areas might therefore require research, public participation, and perhaps financial or other incentives to persuade local communities to allow establishment of temporary facilities. This program would be administratively cumbersome, as accounting for deposit collection and reimbursement would be difficult. Concern was expressed about this alternative by a major distributor and retailer of pesticide products (Manitoba Pool Elevators), because many agrochemicals are purchased with credit. If accounts are not paid, the dealers would lose the deposit in addition to the money owed for the pesticide. Administration of this program would place responsibility and possible risk on distributors (Doerksen, pers. comm.).

The flexibility of the program would be adequate, because all types of containers can be handled by a deposit-refund system. Some addi-

TABLE 3.2

Annual Operational Costs of A Deposit-Refund System

Temporary collection facilities	$13,000	(a)
Mobile shredders	19,400	(b)
Mobile crushers	3,900	(c)
Collection personnel	28,000 - 30,000	(d)
Crushing and shredding crews		
Crew chiefs (Operator 2)	5,400	(e)
General labor	14,000 - 15,000	(f)
Training: all personnel	5,000	(g)
Transportation of crushed and shredded materials to disposal areas	26,000	(h)
Rinsate disposal	4,600	(i)
Public education and promotion	**	(j)
Contingencies (10%)	11,900 - 12,200	
Subtotal	131,200 - 134,500	
Cost of identification stickers	7,500	
Cost of data entry	57,100 - 59,000	(k)
Contingencies (10%)	6,500 - 6,700	
Total	202,300 - 207,700	

(a) 13 facilities at $1,000 each for land rental, temporary fencing, etc.

(b) Three mobile shredders costing $50,000 each, amortized over 10 years at a real interest rate of 5%.

(c) Three double-cylinder can crushers costing $10,000 each, amortized over 10 years at a real interest rate of 5%.

(d) 13 crews of three persons each, at $9.69-10.38 per hour, 37 hours per week for two weeks (does not include Worker's Compensation or other benefits)

(e) Three crew chiefs (Operator 2 level) at $11.26 per hour, 40 hours per week for four weeks (does not include Worker's Compensation or other benefits)

(f) Nine laborers (three per crew) at $9.69-10.38 per hour, 40 hours per week for four weeks (does not include Worker's Compensation or other benefits)

(g) $200 each for 25 persons

(h) $500 per load for four loads from each of the 13 collection areas (labor is not included in this figure because the work will be performed by existing crews, whose labor costs are already covered)

(i) Based on one 208 L drum being generated at each of the 13 collection areas from test rinsing of sample containers, at a disposal cost of $350 per drum

(j) Included under administrative costs in Chapter 4

(k) Three persons (Word Processor 1) at $19,026-19,560 per year (does not include Worker's Compensation or other benefits)

tional regulation would be necessary to provide legal support for the program, so the existing infrastructure would need some modification. As well, the existing infrastructure of collection areas would need to be completely revised.

3.3.3 A Subsidy Program

A subsidy program actually pays the polluter not to pollute by compensating him/her for the cost of pollution abatement. In theory, the economic incentive for such a program is similar to that of an emissions fee. The would-be polluter will abate pollution discharge up to the point where the marginal cost of pollution abatement (additional cost for abating one more unit of pollution) equals the extra subsidy received for that abatement. Beyond that point, the polluter will ignore the subsidy as it will not cover the incurred abatement costs.

Container collection could be directly subsidized by paying people to bring containers to collection areas, which would achieve the same result as the deposit-refund system. Alternatively, collection could be indirectly subsidized by developing an annual collection program that operates similarly to urban household waste collection. Each of these subsidy alternatives has drawbacks that are difficult to overcome.

Subsidy Payment: Paying a direct subsidy without collecting an initial deposit would require a collection infrastructure similar to that of a deposit-refund system. The cost of this program might therefore be approximately $131,000 to $135,000 (as calculated for container col-

lection in Table 3.2) plus the cost of the subsidy payments. If 80-90% of all containers are collected at a subsidized rate of $1.00 each, this cost would be as much as $450,000 for containers used each year, if 90% of containers are collected. Old containers might also be returned, which would raise the cost even further. This program might therefore cost at least $584,000 to $587,000 each year ($134,000 + 450,000 and 137,000 + 450,000), and would probably not accomplish the same collection rate as the deposit-refund system.

This alternative might provide undue incentive to untrained people to collect containers and return them for the subsidy payments, reducing the program's environmental acceptability because these people could be unknowingly exposed to toxic materials. The percentage of total containers collected should not be expected to be as high as a deposit-refund collection, unless equivalent payment ($5.00 per container) is offered for each container (as suggested under the deposit-refund system as the deposit amount to be collected that would later be refunded). Participation could be increased by raising the subsidy payment for containers, but the program cost would rise significantly with any such increase ($450,000 for each additional dollar paid). At $1.00 per container, 90% collection would cost approximately $1.30 per container collected, which is higher than the deposit-refund system, but lower than the modified voluntary program. Costs would be absorbed primarily by society, with little internalization of externalities by polluters.

Politically, this alternative might be very controversial. Farmers and dealers might approve of the idea, but the non-farming public would not be so accepting. Administratively, this program would be less difficult than the deposit-refund system because less accounting would be required, but administration would be more organized and therefore more complex than the voluntary program. Flexibility and compatibility should be similar to that of the deposit-refund system.

Subsidized Pick-Up: A subsidized pick-up program for collecting pesticide containers would provide more of a convenience to farmers than financial reward. Containers could be collected from each farm by each municipality or Weed Control District, much as household solid waste is collected in urban areas. Farmers would be asked to place rinsed containers in designated places along public roads during specific weeks during (or after) the growing season. Collection trucks would then drive these routes and pick up all containers placed along the road. Through this program, the farmer would expend little effort in disposing of containers, saving the time, trouble and transportation costs of taking containers to a collection area. Only farmers with very few containers might feel that the effort of taking the containers to the road is not worth the time. Even these farmers could accumulate containers over a period of years and eventually place containers out for removal.

Estimating the cost of a subsidized collection program is extremely difficult, and is somewhat beyond the scope of this paper. Such an estimate first requires knowledge of distance to be travelled in each

municipality to collect containers. The number and sizes of containers are also needed to estimate the total weight of the load to be transported by trucks. Finally, the cost per t-km is needed to estimate an incrementally increasing load as trucks move from one collection point to the next. Significant study would be needed of transportation routes, equipment needed, labor required and quantity of containers to be collected. The assumption is made that this program would be more expensive than the modified voluntary program to operate, because capital investment and transportation costs would be quite large. This program would also provide no guarantee that containers would be rinsed prior to collection, because even unrinsed containers placed in specified areas would have to be picked up to prevent container accumulation at these areas. Container draining and rinsing, and residue and rinsate disposal would therefore be required components of this program, as would be necessary under the modified voluntary program.

The environmental effectiveness of the subsidized pick up program would be greater than the voluntary program because the workload and travel cost to users would be minimized. The subsidized pick-up program might not be as effective as the deposit-refund program, however, because no financial incentive would be offered to "bribe" marginal users to comply with the program. The political feasibility would also be questionable as this program strongly indicates that the user has the right to pollute; otherwise, the polluter would be required to abide by some more firmly established policy or regulation, and would be required to pay for container collection. Still, taxpayers in agricultural communities might be in favor of this program, which could partially offset the objections of non-farm taxpayers.

Administratively, a subsidized pick-up program would be somewhat cumbersome. Collection routes would need to be established, and equipment would need to be purchased or borrowed from municipal waste collection programs (requiring incremental depreciation for each piece of equipment for collection usage). Collection personnel would also have to be trained to handle potentially hazardous material. The program would be quite flexible as new types of containers could be placed with existing types of containers. Flexibility might be too great, however, because no disincentive would exist to prevent dumping of other refuse along with containers. Such practice could quickly create a serious litter problem along collection routes. The subsidy program would also not be compatible with the existing infrastructure if new transportation routes and collection methods are required. For these reasons, this program does not compare favorably with other alternatives for container collection.

3.3.4 The Regulatory Approach

Punitive regulation involves the setting of a standard or a limit beyond which pollution is not allowed. Such regulatory standards are common in controlling industrial pollution (i.e., maximum allowable concentration or quantity of emissions per day, etc.) but are less common in controlling waste from a diversified group of polluters. A properly enforced standard is completely effective for controlling pollution beyond an established limit; however, zero abatement occurs for wastes below that limit. Regarding pesticide containers, specific containers (such as those which are not rinsed, or those which previously

contained a restricted chemical) would need to be listed as being regulated by the standard. No incentive would exist for proper disposal of containers not listed by the regulation.

The environmental effectiveness and economic efficiency of a punitive regulatory approach would be directly tied, because adequate enforcement is required to ensure compliance with the regulation. A program that is environmentally effective would be extremely expensive (due to extraordinary enforcement needs) and economically inefficient. An economically efficient program would not be able to support a large enforcement staff financially. Such a program would invite little compliance and would be environmentally ineffective. A very feasible result of a regulatory program might also be low environmental effectiveness and low economic efficiency, if almost but not quite enough enforcement personnel are used. In this sense, a purely regulatory approach would be the least successful of all alternatives being considered.

The political and administrative feasibility of this program would also be low, because much effort would be required to place a control over an industry that resists new regulation. The program would also be rather inflexible, because the regulation would need to be amended each time a new product enteres the market. Finally, a punitive regulatory program would require a new regulation and a new enforcement branch (or additional duties to an existing enforcement staff) to enforce that regulation, making this program incompatible with any existing institutional framework.

Perhaps the only proper application of a regulatory approach would be to support other alternatives, such as the deposit-refund system. Regulation is needed to establish that containers must be rinsed, and an acceptable degree of cleanliness should also be specified. The deposit-refund system would also require regulatory modification to mandate collection of deposits, and guidelines should be established for construction of collection areas or depots. In these and other ways, regulation may be used to develop other collection programs. On its own, the regulatory program appears to be the least acceptable of the four alternatives being considered.

3.3.5 Summary of Collection Alternatives

Five alternatives for container collection have been considered, of which three exhibit some potential. These three programs are the modified voluntary program, the deposit-refund system, and the direct subsidy payment. The direct subsidy would be more expensive than the deposit-refund system while collecting a lower percentage of containers; however, it would be administratively easier to accomplish. The subsidized payment program would be less expensive than the modified voluntary collection program and might collect a higher percentage of containers, but the voluntary program might be more politically and administratively feasible. More data is needed to fully evaluate a subsidized pick-up service or direct regulation, but on the surface, neither of these programs appears acceptable when compared to other options. Each of the other alternatives exhibits some qualities that may appear attractive to some interested parties. Table 3.3 summarizes the comparison of collection alternatives.

TABLE 3.3

Summary Comparison of Collection Alternatives

	Modified Voluntary Program	Deposit-Refund System	Subsidy Payment	Subsidized Pick-Up	Direct Regulation
Total Collection Cost ('000)	$733-739	$202-208	$584-587	?	?
Potential Rate of Collection	80%	95%	90%	75-85%	?
Cost/Container Collected	$1.83 to 1.85	$0.43 to 0.44	$1.30	?	?
Criteria *					
Environmental Effectiveness	3	4-5	3-4	2-4	?
Economic Efficiency	2	5	2-3	1-2	?
Political Feasibility	3	2-3	2-3	3	2-3
Administrative Feasibility	5	2	3-4	1	2
Flexibility	5	5	5	3	1
Compatibility	4	1-2	1-2	2	1

* Notes:
(1) Ranked on a scale of 1 to 5 (1 = poor, 5 = excellent).
(2) Rankings are given to compare programs according to each criterion individually. Columns should not be summed because various interest groups may weigh each criterion differently, according to specific perceptions of importance.
(3) Criteria are defined on page 69.

3.4 ALTERNATIVES FOR DISPOSAL

Solid waste materials from pesticide containers can be eliminated by four methods: burial, incineration, recycling and reuse. Each of these options is briefly discussed in this section; however, the technical feasibility of some of these alternatives does not yet exist, and costs for these developing processes are not fully established. Economic efficiency may therefore be estimated; however, actual costs will not be discussed in every case. This discussion assumes that all containers have been adequately cleaned to be acceptable to the collection program.

3.4.1 Burial

To date, a simple and common alternative to dispose of containers has been to bury them in the field or at a municipal dump. This disposal option has long been recommended on label instructions for most agricultural chemicals, in addition to the recommendation that containers be properly rinsed prior to disposal. Burial was very popular when containers were mostly metal and could be easily crushed and buried in the field with heavy farm machinery; however, many areas in the United States now insist that containers be buried only in landfills that are specially designed to prevent leaching of materials into groundwater (Taylor, pers. comm.; Morrison, pers. comm.; Bachman, pers. comm.; Eckermann, pers. comm.). Burial is not allowed in Alberta or in Saskatchewan (Pledger, pers. comm.; Hallsworth, pers. comm.).

Burying unrinsed containers may create leaching problems, and even burying rinsed containers adds significantly to the physical bulk of wastes deposited in dumps. This problem is especially true where containers have not been crushed or shredded prior to disposal, even though specially designed landfills have been known to cost as much as $173,000 to $210,000 U.S. per hectare in some areas of the Eastern United States. Coupling the bulk of this waste stream with the possibility of hazardous material contamination has led many landfill operators to reject containers for burial (Trask, 1985e). To complicate matters, many rural waste disposal grounds in Manitoba are not specifically designed to protect groundwater from leachate contamination.

Environmentally, burial is an acceptable short-term option only if containers have been thoroughly rinsed and crushed. These containers should ideally be buried in an environmentally secure landfill (such as a Class I landfill in Manitoba), because even properly rinsed containers are not completely free of pesticide residues. From this perspective, burial may not be environmentally acceptable in Manitoba unless containers are properly rinsed and deposited in these specially designed landfills. Even then, this alternative should only be considered as a temporary solution until a process can be developed to destroy or reuse these waste materials, because burying such a large quantity of material wastes the land resource needed for landfill sites, and fails to recover a potentially large source of plastic material.

Economically, this option is inexpensive if the cost of landfill space is not considered. Wastes can be deposited in the Brady Road landfill in Winnipeg at only $9.25 per tonne. At this rate, burial of 227 t of packaging material would cost only $2,100. This figure is low for use of a Class 1 landfill, and may increase in the future to better reflect operational costs. Politically and administratively, burial also creates little resistance, because costs and efforts are minimized. Environmentally conscious groups may eventually oppose this practice if they perceive a risk of groundwater contamination.

Burying containers in secure landfills addresses the final criteria quite well. This disposal alternative can be adapted to dispose of virtually any types of containers, as long as the containers are clean. This option is also compatible with existing facilities, if containers are transported to Class I landfills. New regulation may be required to ensure development and use of such facilities, and considerable financing would be needed to design and develop any new disposal grounds.

Based on these criteria, burial presents numerous problems and is difficult to justify unless a guarantee is provided that containers are rinsed. Containers must also be shredded, crushed or otherwise compacted before being buried in landfills designed to protect groundwater from leachate contamination. If these requirements are met, burying containers in landfills may be an attractive short-term solution for container disposal.

3.4.2 Incineration

While burial was and often is recommended as a proper method of container disposal, burning plastic containers has also been recommended in the past and is the most common disposal practice in Manitoba today. Many plastic containers are burned in farmers' fields, and containers that are collected at voluntary collection areas are frequently burned as well. As plastics comprise perhaps 90% of the total containers used, this practice may eliminate the great majority of containers used each year.

Burning containers is currently being discouraged by MEWSH, MDA, CPIC, and by all of the manufacturers and distributors contacted for this study. This practice is discouraged because harmful emissions may be produced during low temperature combustion of plastics and residues. Potential does exist that a small number of containers are made from nitrogen-containing polymers, sulfur-containing polymers, or plastics containing chlorine (such as polyvinyl chloride and polysulfone). Containers made of such materials may, depending on the temperature of combustion, yield emissions of plastic monomers and by-products such as dioxins and furans, and other gaseous products such as hydrogen cyanide, cyanogen, nitriles, ammonia, sulfur dioxide, or hydrogen chloride when combusted. Complete combustion of high density polyethylene (HDPE) forms only carbon dioxide and water, as this plastic is composed only of carbon and hydrogen and perhaps oxygen (Cochran, 1988).

Even if burning HDPE containers does not yield hazardous emissions, many other emissions are produced from low temperature incineration of

residual chemicals in containers. Research has shown that at least four hazardous gasses (chlorine, hydrogen chloride, hydrogen sulfide, and nitric acid) are produced by burning some rather common pesticides and pesticide combinations (including Atrazine, Zineb + 2,4-D, Malathion + 2,4-D, and Dieldrin + Diuron) at 900° C (length of incineration was not specified) (Kennedy et al, 1972). For these reasons, only high temperature incineration in a furnace designed to capture toxic emissions provides even a remotely acceptable environmental control of dangerous emissions from burning containers.

Many hazardous materials are burned in special high-heat incinerators, and residues collected under the current voluntary program are destroyed in this manner. No such incineration facility exists in Manitoba, and no such facility is planned for the near future. These residue materials would have to be sent to facilities in Ontario or in the United States for incineration at a high cost. Some of these facilities accept liquid wastes only, leaving only a few choices for acceptable incineration of containers. High-temperature incineration at a properly designed facility does destroy or capture most harmful emissions, which indicates that this alternative is environmentally acceptable.

Environmental effectiveness and economic efficiency suffer an inversely proportional relationship for the incineration alternative. The most environmentally acceptable incineration is also the most expensive for each unit of waste destroyed (and thus least efficient), and the least environmentally acceptable method is also the most effi-

cient. High-heat incineration is politically and administratively difficult, because of the high cost and lack of choices for acceptable facilities. Low-heat incineration is administratively easy but environmentally dangerous. It is also politically unwise because those aware of the risks inherent in this practice, environmentalists, and other members of the general public may oppose this practice. Incineration cannot be adapted to metal container disposal, which limits the applicability of this alternative to rinsed plastics. Proper incineration requires development of a high-heat incineration facility, which makes this option incompatible with the existing provincial infrastructure. Based on these criteria, incineration appears to be a poor choice for pesticide container disposal in Manitoba's near future.

3.4.3 Recycling

On February 23, 1989 the Environment Ministers of Alberta, Saskatchewan and Manitoba announced plans to appoint study groups to find better avenues for recycling wastes. Manitoba's particular area of research is focused on pesticide containers, according to former Environment Minister Ed Connery. As stated by the Minister, "before we move a lot of product out of the waste stream into other piles, we want to make sure we have a market for it" (Winnipeg Free Press, 1989). This statement by the Minister defines a major problem facing pesticide container recycling.

Scrap recyclers in Manitoba, as in many parts of North America, are very reluctant to accept metal pesticide containers, because the poten-

tial hazardous component of this waste stream is believed to put scrap yard employees at risk. Metal containers are recycleable, and any residues within the containers are destroyed by the high heat required to melt the metal. If containers are not rinsed, however, scrap yard employees may risk exposure to a hazardous material when handling the containers prior to incineration. This potential exposure may constitute a violation of the Manitoba Workplace Safety and Health Act (specifically, MR 52/88 [respecting Workplace Hazardous Materials Information System] and MR 53/88 [respecting Workplace Health Hazard]), which increases liability risks for the employer.

Scrap metal in Manitoba is worth only $38 to $55 per tonne, according to two of the only three scrap dealers in the Province who would accept such containers (17 of the 19 dealers listed in the provincial Yellow Pages were contacted, and all but 3 refused to accept containers). The third dealer was not willing to pay for the containers, but offered to pick them up province-wide if they were rinsed and crushed. The scrap value of the metal therefore appears to just cover transportation costs to recyclers at best, and may require supplemental funding in some cases.

Plastic container recycling presents an even more perplexing problem, as the plastic actually absorbs a small portion of the pesticides (Trask, 1985c). These chemicals cannot subsequently be rinsed from the plastic or otherwise removed; thus, even the recycled plastic is not useful for most products (plastics are recycled at a much lower temperature than metals, so that residues are not destroyed). The only use

for these materials might be for sewer pipe, fence posts, highway hazard marker cones, and similar products. Even if contaminated plastics were used for these types of products, they would still have to be clearly marked as contaminated so that consumers would not mis-use these products improperly. Currently, no recycler in Canada accepts pesticide container plastics for these purposes.

Another potential application for recycled plastics is to reform them into new pesticide containers. This option requires containers to be separated in some cases (to prevent cross-contaminations) and to be shipped to container manufacturers. No data has been collected to determine how many times containers can be recycled before the cumulative contamination renders the recycled plastic unusable, and research is also needed to determine the actual probability of cross-contamination from previously absorbed formulations. At present, no manufacturers or packagers have expressed any interest in recycling pesticide containers.

Recycling metal containers is possible in Manitoba and is being practiced at present; however, long-term continuation of this alternative requires a collection system that guarantees proper rinsing. If such a system is used, the recycling option is an environmentally sound alternative. Economically, this alternative is relatively efficient, because the value of the scrap offsets a portion of transportation costs, if not all transportation costs. Politically and administratively, the option is also quite acceptable, because recycling is a popular activity at present and can be arranged through a private con-

tractor. This alternative addresses only metal containers, and cannot presently be adapted to recycle other pesticide container materials. The existing industrial infrastructure will only handle metal containers, and a new technological process may be required for recycling plastic containers if chemical contamination is to be minimized.

3.4.4 Reuse

A final alternative for disposing of conventional containers is to reuse them to package similar products in the future, so that used containers are no longer considered waste. This option is actually being employed in the United States in limited markets, and has reduced the container disposal requirements in some areas to an almost manageable proportion. Pesticides are sold in containers known as 'mini-bulk' tanks, which are 380-570 L truck-mounted, sealed containers. Applicators use the chemical from the tank without breaking the seal, so the manufacturer or distributor can be certain that no cross-contamination occurs when the tank is refilled. At the same time, large pesticide users are able to purchase larger quantities of chemicals without being burdened with container disposal.

Mini-bulk containers are becoming popular among large users in the United States; however, the application of this solution is quite restrictive. United States regulation requires that bulk sales consist of 208 L or more (Morrison, pers. comm.; Eckermann, pers. comm.). Smaller users are excluded in this distributional process, as many farmers (especially mixed-crop and small-scale farmers) may need much

less than 208 L of a given pesticide per year. No Canadian equivalent regulation exists specifying minimum quantity sales. As well, a distributional network is not in place to provide or refill smaller sealed containers (containers must be sealed in order to guarantee that no unknown substance was ever stored in the container). Such a network would require retail dealers to maintain large storage tanks of numerous chemicals and to be knowledgeable of refilling techniques. Many dealers in the United States are commercial applicators and, as such, maintain large storage tanks of pesticides. Most dealers in Manitoba are not commercial applicators; instead, they range from farm machinery dealerships to grain storage terminals to small independent retail stores. Manitoba has approximately 900 such dealers across the Province (Kolach, pers. comm.).

Reusing containers eliminates the waste stream of discarded containers entirely, and is therefore very effective environmentally. This alternative requires increased transportation of large quantities of pesticides to retail dealers, which increases the risk of a large toxic spill if an accident occurs. Such an environmental consequence must always be considered, as probability dictates that an accident will likely occur at some point in time. The expanded use of refillable containers would require significant investment by distributors and/or dealers in Manitoba. Normal packaging costs would be eliminated, however, so this alternative might become economically efficient over time.

Politically, this option would be very acceptable as the entire container collection and disposal problem would be eliminated. Administratively, significant monitoring would be required to ensure public safety from spills during transportation and refilling. This alternative would address only the needs of large users of the most common pesticides, unless smaller refillable containers are developed and distributed across the Province. Finally, this option is currently incompatible with the existing distributional infrastructure in Manitoba, as many dealers are not in a position to offer refilling as a service. Significant changes would be required in pesticide distribution and sales for reuse to become a viable process in Manitoba.

3.4.5 Summary of Disposal Alternatives

Five general alternatives are available for disposing of containers, although application of one of these alternatives (recycling) is limited to metal containers. Recycling must therefore be separated in terms of effectiveness for disposing of plastic and of metal. The rating of plastic recycling is based on research exploring development of this technology, and is hypothetical at present. Table 3.4 summarizes the comparison of disposal alternatives, assuming containers are rinsed prior to disposal.

TABLE 3.4

Summary Comparison of Disposal Alternatives

	Bury	Low Temp Burn	High Temp Burn	Metal Recycle	Plastic Recycle	Reuse
Environmental Effectiveness	3	1-2	4	5	3-5	3-4
Cost per Container	5	5	1	4	?	3
Political Feasibility	4	2	3	5	5	5
Administrative Feasibility	5	5	2	4	2	3
Flexibility	5	2	2	2	2	2
Compatibility	3-5	2	1	4-5	1	2

Notes:

(1) Ranked on a scale of 1 to 5 (1 = poor, 5 = excellent).

(2) Rankings assume that all containers have been rinsed.

(3) Rankings are given to compare programs according to each criterion individually. Columns should not be summed because various interest groups may weigh each criterion differently, according to specific perceptions of importance.

(4) Criteria may be defined as follows:

a. environmental effectiveness: measures the physical effectiveness of a program in removing pollution from the environment while realizing the effective re-employment of all resources involved

b. economic efficiency: measures the cost-effectiveness of a program for its environmental effectiveness (cost per container, used in this table, does not actually measure total economic efficiency because social costs and benefits, and externality internalization are not included)

c. political feasibility: describes the level of acceptance of each program by all interested parties

d. administrative feasibility: considers the effort and complexity of actually implementing and maintaining a program

e. flexibility: describes the adaptability of a program to a changing environment and to future problems as the types and quantity of containers change over time

f. compatibility with existing institutional frameworks: considers how each program fits into existing policy, legislation, and existing infrastructural development

3.5 ALTERNATIVES FOR THE FUTURE

Problems involving pesticide container management revolve around the form in which the chemicals are sold and the method by which they are packaged. Plastic containers have become very popular within the past 5 years because the containers are lighter in weight and easier to handle (Waterer, pers. comm.; Walkof, pers. comm.). Much capital has been invested in packaging pesticides in plastics, and this material will continue to be used, at least in the short term (Krahn, pers. comm.; Burgoyne, pers. comm.).

Several chemical manufacturers are pursuing long-term solutions to eliminate packaging problems or to reduce their magnitude, and these efforts are already beginning to change the market. A major thrust of these companies is to dry formulate as many chemicals as possible, so that products may be sold in packages made from polyvinyl alcohol that dissolves in water (Crabbe, 1989). This packaging innovation eliminates the container disposal problem altogether, although several problems also result from this resolution. The chemicals are sold in predetermined amounts, which may prevent users from preparing the exact amount of pesticide mix that they desire. The packages cannot be accidentally wetted, or the package will dissolve and spill the contents. As well, not all products can be converted to dry formulations, so this technology is limited in application (Beechey, pers. comm.; Walkof, pers. comm.; Waterer, pers. comm.). This new type of package should eventually reduce the container disposal problem to a much more manageable volume.

Some manufacturers also concentrate chemicals so that fewer and/or smaller containers are used (Beechey, pers. comm.; Waterer, pers. comm.). Many chemicals are currently sold in a very dilute form, and this practice has only exacerbated the problems involving containers. Other formulations are already quite concentrated, and cannot be concentrated further (Beechey, pers. comm.; Walkoff, pers. comm.).

The current problems involving pesticide container collection and disposal appear to be somewhat temporary, and these problems may become much easier to manage as packaging techniques are changed. Unfortunately, container disposal poses many public health and environmental problems today, and more immediate solutions for the Province, such as the alternatives discussed throughout this chapter, are needed.

Chapter IV

ALTERNATIVE ADMINISTRATIVE STRUCTURES

4.1 A NEED FOR ADMINISTRATION

Collection and disposal of pesticide containers requires planning and coordination to maximize the efficiency and effectiveness of the operation. An executive management staff is therefore needed to meet these administrative requirements. The duties of this administration should include: operational planning, equipment purchasing, hiring and training personnel, monitoring and recording collection and disposal activities, public education, and promotion of the program. The administration should also be responsible for coordinating efforts between the program operation and pesticide dealers, users and manufacturers, government, and any other interested parties.

Several alternatives exist for developing the administration of a pesticide container program. The program can be administered publicly, privately, or jointly (public-private integration), and can be either centrally or regionally organized. Each of these alternatives exhibits advantages and disadvantages that will be discussed in this chapter. Following this discussion, administrative costs will be estimated according to projected requirements of this component of the overall organization.

4.2 BUSINESS STRUCTURE

Numerous arguments can be presented for administering a pesticide container program either publicly or privately. A primary determinant of the ultimate administrative orientation is the source of authority and responsibility for program operation. A publicly administered program would be planned and operated by some branch or component of government, while a privately administered program would be planned and operated by a non-governmental body or organization. A third alternative is to integrate public and private efforts to produce a type of joint venture between public and private sectors.

4.2.1 Public Administration

Public administration can be defined as an arrangement where program operations and administration would be subject to approval by any board, commission or department of government (Cooke, 1988). The program would be operated directly by government employees, assuming that no conflict of interest arises regarding regulation and administration. Funding might be provided from tax revenues of either the existing provincial tax or of a specific tax levied at some level (such as manufacturing, wholesale or retail sales) on the pesticides or their containers. Pesticides are not currently taxed, so legislative action would be required to establish a provincial tax on these products.

Public administration would offer several advantages that should be considered. First, pollution from improper disposal of pesticide containers affects all of Manitoba by contaminating its environment. As

the government is responsible for environmental management and protection of natural resources, administration of this program by the government could be regarded as being logical and consistent with other programs. Current efforts of various departments could be coordinated and focussed (as long as no conflict of interest is created regarding regulatory responsibility), and a new administration could be formed at least in part by existing staff.

Another advantage of public administration would be that funding could be collected through the existing taxation infrastructure, even if a new tax is established on pesticide products. This tax could be collected uniformly on all products, or it could be exempted on specific products such as those in dissolving packages. Exempting environmentally safe packages would allow lower prices to be charged for these products, perhaps influencing the market to increase demand for formulations packaged in these desired materials.

A number of disadvantages are also presented by administering the program publicly. A conflict of interest might be difficult to avoid because under the current program, both environmental regulatory enforcement and container collection are performed by MEWSH. The current program administration would therefore require complete restructuring, with additional person-hours or person-years assigned for any new staff. If a tax would need to be established to generate funds for the program, legislative action would be required that would need to be approved through the bureaucratic process, even if all parties should agree that a program is required. The decision-making process might

also be difficult under public administration. Some research has shown that public sector decision-making is difficult because it is more regulated, more documented, slower, and less responsive to clients than decision-making by other organizations. This same research has shown that public organizations tend to pay less attention to cost control and to customer service (Joyce, 1985). On the other hand, decisions made through the democratic process may receive a high level of public acceptance because the people would "own" the decision.

4.2.2 Private Administration

Private administration can be defined as an arrangement where program operations and administration would be determined by a privately-run organization. Private organizations would include associations representing manufacturers, dealers, farmers or other pesticide users. A private organization created specifically for managing a pesticide container program could also be considered private. Funding for private administration might be available from both public and private sources. Funds could be provided by the government or from special taxes, as discussed under "Public Administration". Support from the pesticide industry would be private, as would be funds generated from the CPIC $1.00 surcharge on containers. Private funding might also be generated from revenues raised by dues of private associations or from voluntary contributions from the general public. Any combination of these sources of funds could be used to administer a private program.

Private administration would offer a number of advantages that could be valuable to a developing program. First, government would be separated from an issue that might raise significant opposition from farming organizations and other groups that use pesticide products, and public funding would be minimized. Another advantage would be that the approval process for proposed actions or program revisions would be streamlined because fewer departments or executives would need be consulted to make and act on every decision. Bureaucracy might therefore be reduced, and managerial decision-making could be accomplished quickly and definitively.

A privately administered program might also be more attentive to program efficiency and effectiveness than a publicly administered program. Private organizations have been shown in some cases to be more market oriented and more focussed on satisfying the public than on satisfying a Minister or Department Head (Joyce, 1985). Also, private organizations often appear to be more interested in cutting costs and maintaining efficiency, possibly because private organizations compete in an open market where other organizations are competing for market share (Bozeman, 1987; Joyce, 1985). This theory might apply to a container management program because a privately administered program would have to compete in the market for funds to operate the program.

A number of disadvantages might also be associated with private administration. A primary concern would be that funds generated for program operation might not flow consistently. Funds derived from pesticide sales (such as the CPIC surcharge) would be directly tied to the

quantity of products sold annually; however, pesticide sales may vary greatly with weather patterns (for example, very dry or very rainy seasons), which would affect the amount of funds produced. Money derived from contributions is also not always predictable, and this lack of reliability might jeopardize program operation in the future.

Private administration would risk developing a conflict of interest, if forces seeking to satisfy a market suddenly undertook an activity that might be unpopular with that market. For example, farmers might be unhappy with being forced to pay additional money for pesticide products, and this dissatisfaction might affect (or be perceived to affect) buying habits. This potential conflict of interest could produce a public perception that problems are not being adequately addressed, creating a potentially volatile socio-political situation. Pure private administration, like pure public administration, exhibits significant weaknesses in addition to its advantages.

4.2.3 Public/Private Integrated Administration

A public/private integrated administration would be a joint venture between the public and private sectors. Funds could be generated from public and/or private sources, and administration would be based on a cooperative effort of interested parties. This type of administration might be best exemplified by an independent organization controlled by a Board of Directors, where members of the Board would represent various interest groups.

The advantages of an integrated administration would be numerous. All interested parties represented by the Board would be able to participate in the decision-making process, and would be thereby guaranteed a voice in establishing policies and objectives. Political pressures would also be reduced, because no one interest group could be credited or blamed for program activities. Instead, the interests of the government, the pesticide industry, and the user market would all be considered and addressed by the Board.

The actual administration of this type of program would also represent an integration of public and private organizations. Executive management would require approval of major decisions by the Board, and would have to report progress to the Board as well. In this sense, the organization would represent a public administration reporting to a Department Head or a Minister. The Board would in itself be a single entity, however, and only major decisions might require Board approval. The decision-making process would be moderately efficient, and would therefore be similar to private sector administration. Also, government allocation of person-years for management and operational staff would not be required because these personnel would not be directly employed by the government, which would again liken the integrated administration to a private administration. These advantages would parallel many of the advantages of both public and private administrations, and would resolve some of the disadvantages of these other administrations as well. Public/private integration therefore becomes a valuable third alternative.

As with other programs, certain disadvantages could be associated with a public/private integrated administration. Public and private sectors might pursue very different and perhaps conflicting goals. On many issues, all parties might not be satisfied and lengthy debates could result. Establishing the initial type of program to be developed might be quite difficult and tedious, and if this situation occured, development of the overall program might be prolonged. Funding sources might also become the focus of lengthy debate, because each sector might perceive funding as being mainly the responsibility of the other sector. As with private administration, a consistent flow of funds could be difficult to establish. Private sector funding might vary, and public sector funding would be required to vary accordingly to produce an even flow.

4.2.4 Summary of Potential Business Structures

Three types of administrations can be considered for overseeing a container management program: public, private, and public/private integration. As with operational alternatives, each of these options presents valuable advantages and dangerous disadvantages. The definition of administrative orientation is based upon the source of authority and upon the allocation of responsibilities for managing and operating the program. Any of these administrations may be appropriate for operating a program derived from operational alternatives presented in Chapter III, although certain restrictions might apply. For example, continued collection of a container surcharge to pay program costs might be inappropriate for a deposit-refund system, because all costs

would be shouldered by pesticide users. In such a case, funding should be obtained from the government or from the pesticide industry to spread costs among all interested parties that would also receive benefits from the program. With the exception of the establishment of a Board of Directors for the integrated administration, staffing requirements would be equal. The Board of Directors for integrated administration should be considered as a voluntary body requiring only minor funding for travel expenses and per diem payments. These expenditures should not be significant and should be covered by the contingencies category (under Staff) in Table 4.1 (in the section, "Administrative Costs"). Administrative costs of the three alternatives (estimated at the end of this chapter) are therefore assumed to be approximately equal.

4.3 ORGANIZATIONAL STRUCTURE

The organizational structure of a container management program may greatly affect the performance of the operation. The program's administration can be organized in either a centralized or decentralized structure, which affects the decision-making process. According to Daft (1983), "Centralization refers to the hierarchical level that has authority to make a decision. When decisions are delegated to lower organizational levels, the organization is decentralized. When decision-making authority is kept at the top level, it is centralized. Organizational decisions include the authority to make purchases, set goals, choose suppliers, set prices, and decide market territories" (p.15). Arguments can be made for and against each option, depending

upon the extent and complexity of administration and operation. A container management program can be developed to address problems in a single province, or a program can be developed to manage problems multi-provincially. Determining the program's scope could dictate the organizational structure required.

A centralized organization is controlled by a central administration that makes all decisions concerning business and operational functions of the organization. The central administration is therefore responsible for marketing, finance, accounting and general management in addition to operations of the program throughout its entire market. A centralized structure may be appropriate for a small organization and/or an organization operating in a small or relatively uncomplicated market. In these situations, uniform operation throughout the organization is justified. The centralized structure may therefore be appropriate for a container management program that operates in a single province, because the types of pesticide use, regulatory infrastructure, and media channels are all fairly homogeneous across each province.

Michel Crozier (1964) presents a major argument against centralization (and therefore in favor of decentralization) in that "formal authority to set policies, plans, rules and regulations is vested at the top, while the knowledge and information and thus power to get things done is located at the bottom. The organization, in other words, contains a mismatch between formal authority and informal power." Decentralization vests a greater authority in regional managers

who are more familiar with local market conditions and needs, and have the ability to address these conditions and needs quickly and efficiently.

A decentralized organization maintains an executive administration to coordinate general activities of the program; however, much of the operational authority is delegated to regional administrators. The executive administration might retain control of marketing (including market research, program promotion and public education), finances, accounting and other business functions, while decisions concerning hiring operational staff, timing operational activities and other related operational details would be left to regional managers.

A decentralized structure might be appropriate for a complex organization and/or an organization operating in a large, complex market. In these situations, operational requirements might vary considerably in different regions, and individual decisions would have to be made according to these specific requirements. The decentralized structure might therefore be appropriate for a container management program that operated across several provinces because regulatory infrastructures, available media, existing facilities, farming activity and pesticide use is quite different in each province.

A centralized or decentralized administration could be organized under any of the three business structures presented earlier and might enhance the overall program if properly employed. The key factor for selecting centralization or decentralization is market complexity, and this may be determined by the scope of the operation of this program.

If the program addresses container management in a single province, a central administration may be adequate to plan and coordinate activities. If the program addresses container management in several provinces, a central administration would still be required for each province; however, these administrations would become regional offices and would report to a central overall administration for general direction. In this manner, a diversity of market needs could be met effectively and efficiently by the appropriate organizational structure.

4.4 ADMINISTRATIVE COSTS

The administration for a pesticide container management program requires a staff that includes a director, an assistant director, and a secretary. The staff would plan and coordinate operational activities of the program, and would monitor program costs and successes or failures.

Planning, coordinating and monitoring the program should be divided between the Director and Assistant Director, while office management and filing would be left to the secretary. The Director's duties should include: conducting market research to determine current public knowledge and attitudes, planning operational activities, coordinating efforts and communication between the program and interested parties, overseeing budget expenditures, organizing public education and promoting the program. The Assistant Director's duties should include helping to implement planned activities of the Director, gathering and analyzing data concerning container use and collection, hiring and

training field personnel, and providing feedback to the Director about program operation. Both the Director and Assistant Director should also conduct field inspections of program operations. The secretary's duties should include typing, telephone duty, office management, and maintenance of office and operational records.

The administrative budget also requires inclusion of office overhead and marketing costs. Office overhead includes office space rental, telephone expenses, postage, office equipment and furniture. Marketing includes conducting market research of public knowledge, attitudes and needs through surveys, personal interviews and/or public meetings. Program promotion through posters, newspaper advertisements, radio and/or television advertisements, and any other media that reaches the farm community is also part of marketing, as is public education through field demonstrations and public talks, posting notices at collection areas about proper rinsing and stacking, and similar activities. Table 4.1 provides an estimated budget for administration. These estimated costs are then combined in Table 4.2 with estimated operational expenses described in Chapter Three to provide a total program cost comparison, excluding disposal costs.

TABLE 4.1

Estimated Annual Costs of Program Administration

Staff		
Director	$33,154 - 40,039	(a)
Assistant Director	27,669 - 33,173	(b)
Secretary	21,712 - 25,211	(c)
Contingencies (10% of staff salary needs)	8,253 - 9,842	
Subtotal	90,788 - 108,265	
Office Overhead		
Office space	5,000	(e)
Telephone	2,500	
Postage	2,500	
Furniture and equipment	3,500	(f)
Marketing	50,000	(g)
Contingencies (10% of office overhead and marketing)	6,400	
Total	160,688 - 178,165	

Notes:

(a) Based on MGEA salary range for an Administrative Officer 3 (benefits not included)

(b) Based on MGEA salary range for an Administrative Officer 1 (benefits not included)

(c) Based on MGEA salary range for an Administrative Secretary 3 (benefits not included)

(d) Based on MGEA salary range for a Clerk-Typist 2 (benefits not included)

(e) Based on 500 square feet at $10.00 per square foot per year

(f) Based on $15,000 amortized over five years at a real interest rate of 5%

(g) Includes market research, public education and program promotion. A more accurate figure may be provided for marketing once the program is designed.

TABLE 4.2

Estimated Annual Costs of a Container Management Program

	Modified Voluntary Program	Deposit-Refund System	Direct Subsidy
Operational Costs ('000)	$733 - 739	$202 - 208	$584 - 587
Administrative Costs ('000)	$161 - 178	$161 - 178	$161 - 178
Total Annual Costs ('000)	$894 - 917	$363 - 386	$745 - 765
Potential Number of Containers Collected ('000)	400 (80% of total used annually)	475 (95% of total used annually)	450 (90% of total used annually)

Note: These figures do not include costs of container disposal.

Chapter V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY

Disposal of pesticide containers creates numerous hazardous and solid waste problems in agricultural Manitoba. Unrinsed containers retain residual chemicals which may eventually leach into the environment to contaminate both soil and water, and may affect the health of humans and wildlife exposed to these residues. Rinsed containers can create environmental problems because they are nonbiodegradable solid wastes that often litter fields, roads and watercourses. The combination of these characteristics eliminates most simple solutions to container disposal.

Several alternatives are available to resolve container disposal problems, and many of these alternatives have been considered or tried in jurisdictions outside of Manitoba. This study was requested to review the current problem in the Province and to consider implications of implementing various alternatives to address this problem. This research provides a basis on which the best alternative program can be chosen for the Province.

This study was requested and funded by the Manitoba Hazardous Waste Management Corporation, because pesticides (and perhaps residues in

unrinsed containers) are in many cases listed as Class 6 (poisonous and infectious substances) and sometimes Class 3 (flammable liquids) under the federal Transportation of Dangerous Goods Act. As such, disposal of these substances may become the responsibility of the Corporation. Manitoba Environment and Workplace Safety and Health may also have interest in data presented in this report, because this government department is currently responsible for container management, and is ultimately responsible for enforcing environmental regulations and protecting the environment.

Understanding the current status of pesticide container disposal in Manitoba is necessary before alternative resolutions can be properly evaluated. For this reason, Chapter Two of this report is devoted to identification of specific problems created by containers and determination of the magnitude of these problems in Manitoba. Basic requirements and parameters of a provincial container management program are identified through research of these data.

Pesticide container disposal is a problem in agricultural areas around the world, and many jurisdictions have tried a variety of solutions. Several European countries have established extensive programs to manage hazardous wastes: pesticide container disposal is accomplished through use of these existing infrastructures for waste collection and disposal. A number of states in the United States rely on voluntary collection programs, others choose to treat containers as normal solid waste, and one program uses economic incentives to collect rinsed containers for disposal. The results of these programs vary

considerably and are used to predict the effect of implementing similar programs in Manitoba, in light of provincial needs and parameters.

Alternative programs must also be considered in terms of operational costs. Annual expenses are estimated for various collection systems and for different management structures. Actual disposal costs are minimal in some cases (landfilling, metal recycling) and are dependent upon infrastructural developments in other cases (incineration, plastic recycling). These costs must ultimately be considered in combination with expected results of various programs to yield selection of the best overall container management strategy for Manitoba.

5.2 CONCLUSIONS

1. Assess the current status of the pesticide container problem in Manitoba.

Current practices of pesticide container disposal are detrimental to Manitoba's environment. Between 425,000 and 550,000 containers of pesticides are used each year in this province, and 80-90% of these containers are plastic. A loosely structured collection program succeeds in collecting as many as 300,000 containers each year; therefore, as many as 125,000 to 250,000 containers remain in the environment on an annual basis. A significant portion of containers are not rinsed of chemical residues, and these residues may be leaching into the soil and water. Many combustible containers are burned on farms, and containers collected through the voluntary program are often burned as well. Emissions from burning these containers may include a variety of toxic gasses which pollute the atmosphere. Manitoba is therefore in need of a better program to manage pesticide container disposal.

2. Review legislation and regulations which may affect Manitoba's policy development.

Several federal and provincial laws provide limited control over pesticide containers, directly and indirectly. Packaging and labelling of containers is directly controlled by federal legislation, and disposal of containers by licenced pesticide applicators is regulated by provincial legislation. Farmers are not required to obtain a licence for on-farm use. Provincial legislation requires education of workers handling hazardous materials and provides opportunity for public education on any environmental issues. Collection and storage of hazardous materials and of solid wastes are generally covered by provincial legislation as well. Disposal of these wastes is addressed by several federal and provincial acts; however, pesticide containers are not specifically listed as a controlled waste. Legal council is required to determine the technical application of these laws to pesticide containers. Uncertainty can be alleviated by requiring all pesticide users to rinse containers, and by identifying unrinsed containers as hazardous material.

3. Review research conducted on pesticide container management possibilities.

Two types of collection strategies are usually considered in the few reports which address container disposal. These strategies are a voluntary collection program and a deposit-refund system. In every case except one, the deposit-refund system has been rejected as too expensive and too cumbersome administratively. In each case where the deposit-refund program was rejected, actual costs were not calculated,

but the program was simply assumed to cost more than other alternatives. Public education, field demonstrations of rinsing techniques, and additional research are usually recommended as supplements to voluntary collection.

Pesticide containers are not significantly hazardous unless they have not been rinsed of toxic residues. Triple-rinsing is effective, but it is difficult and time-consuming. Pressure-rinsing removes residues much more quickly and efficiently, and punctures the container in the process. Ensuring proper rinsing (by either method) is an essential first step in safely disposing of containers. Burying unrinsed containers may be harmful to the environment, but no evidence has been presented to discourage landfilling of rinsed containers in properly designed landfills. Plastic container recycling is being actively pursued by government and industry; however, no recycling facility for handling these materials has been developed in Canada. If such a facility becomes technically and economically feasible, it will resolve problems of plastic container disposal. Metal containers can currently be recycled as scrap.

4. Examine programs currently implemented elsewhere in North America and in selected countries in other parts of the world.

Pesticide containers have been identified as a material warranting control by the Commission of the European Community; however, member states are not required to adopt regulations to control this waste stream. Several countries have implemented programs to control hazardous wastes, and pesticide container disposal is (or may be) accom-

plished by these programs. Most states in the United States treat containers as solid waste or support a voluntary collection program for rinsed containers, which are usually buried in engineered landfills. Federal law mandates triple-rinsing of all containers, but compliance with this law is not complete. Effectiveness of voluntary programs in the U.S. appears to be low, compared to Canadian voluntary programs.

The prairie provinces are the only Canadian jurisdictions that have formally addressed container collection. Alberta and Saskatchewan have developed extensive voluntary collection programs; however, collected containers are often not rinsed, and neither province has found an acceptable method to dispose of plastic containers. Containers in Alberta are shredded and stored for future disposal, and Saskatchewan shipped plastics to a recycler in Hong Kong after storing these materials for a number of years. Burial of pesticide containers is not allowed in either Alberta or Saskatchewan, and this restriction has significantly hampered disposal of collected containers in these provinces. No such restriction currently exists in Manitoba.

5. Investigate administrative and operational requirements, and suggest allocation of responsibilities for various components of selected programs.

Alternatives for container collection and disposal are judged according to five criteria, which are: environmental effectiveness, economic efficiency, political and administrative feasibility, flexibility, and compatibility with existing institutional frameworks. The most acceptable alternatives for collection are a modified voluntary program, a deposit-refund system, and a subsidy payment program. The

modified voluntary program would be more administratively feasible and more compatible with existing infrastructures than other alternatives. A deposit-refund system would be less expensive, more environmentally effective than other alternatives, and would guarantee that collected containers are properly rinsed. The direct subsidy program would be more environmentally effective than the voluntary program and administratively easier than the deposit-refund system. The best options for disposal appear to be recycling metal containers and burying plastic containers in approved landfills, if containers are rinsed and landfills are designed to protect groundwater.

Administration of a container management program can be accomplished publicly, privately, or jointly between public and private sectors. Key factors in determining the administrative orientation is the source of funding and source of decision-making authority. Each of these alternatives exhibits strengths and weaknesses that must be considered in terms of long-term program operation. The administration can be either centralized or decentralized, depending upon the scope and complexity of the overall program.

6. Determine industries' response to the most viable alternatives for Manitoba.

Manufacturers and packagers of pesticides are most interested in satisfying market demands, which is why plastic containers are so widely used. Pesticide users are starting to complain about container disposal problems, and industry is responding by changing chemical formulations and concentrations. These efforts are intended to eliminate or

reduce the volume of disposable containers used in the future. Bulk pesticide distribution is also being considered, but this practice does not meet the needs of many smaller farms. Burning containers is discouraged, and landfilling is considered the most acceptable disposal alternative. Voluntary collection is acceptable to many industry representatives, and opinions are mixed about a deposit-refund program. Some believe this alternative is the obvious choice, and others foresee many problems in administration of such a program. The pesticide industry as a whole seems concerned about container disposal problems and is interested in finding a resolution; however, most representatives believe that the government should be responsible for managing the problem.

7. Provide a summary analysis of the most acceptable alternatives for future consideration.

The best three alternatives appear to be:

a) a modified voluntary collection program in which containers are rinsed by collection personnel and buried in approved landfills (if plastic) or recycled (if metal). This program should be expected to cost $894,000 to $917,000 per year and may collect as many as 400,000 containers annually.

b) a deposit-refund program with plastic container burial in approved landfills and metal container recycling. This program should be expected to cost $363,000 to $386,000 per year and may collect as many as 475,000 containers annually.

c) A direct subsidy program that would operate similarly to the deposit-refund program and should cost $745,000 to $765,000 per year. This program should be expected to collect as many as 450,000 containers annually.

These figures represent rough estimates of program costs and do not include all financial aspects of program operation (for example, inter-

est generated by funds collected as deposits and held until being refunded under a deposit-refund system). Alternatives should be judged not only according to environmental effectiveness and economic efficiency, but also by political and administrative feasibility, flexibility to adapt to a changing market, and compatibility with existing infrastructures. Other alternatives require further research before they can be accurately compared to these programs.

5.3 RECOMMENDATIONS

1. Unrinsed pesticide containers should be regulated as hazardous material under Manitoba legislation. A definition of the degree of residue removal required to classify containers as non-hazardous should be included in the regulation.

2. Rinsed metal containers should continue to be recycled. Regulation should restrict the burying of rinsed plastic containers to Class I landfills in Manitoba, because these landfills are designed to maximize protection of groundwater from leachate contamination. Burial of unrinsed containers should be prohibited.

3. Current regulations should be reviewed to specify their applicability to the existing environment. Many aspects of container management may be controlled by existing laws, and complete understanding of existing regulation may identify gaps that should be addressed by new regulation.

4. Pesticide manufacturers and distributors should be lobbied to actively discourage low-temperature burning of plastic containers (which is prohibited at Class I landfills unless otherwise approved), because this environmentally harmful practice is widely used in rural Manitoba and in other areas.

5. A system should be initiated to monitor the actual number of pesticide containers sold each year and the number of containers subsequently collected. These data should eventually be averaged over two to three year periods to account for pesticides purchased in one year and used in the next year.

6. A public/private integrated administration should be formed to research alternative programs and to develop a program for the province and/or for the prairie province region.

7. A strong educational campaign should be initiated to inform farmers and other pesticide users of problems caused by improper disposal of containers, to promote proper rinsing practices, and to encourage delivery of rinsed containers to collection areas.

8. Research should be conducted to determine the degree of environmental contamination experienced at current container collection areas in Manitoba. This research should include soil and groundwater testing to monitor chemical leachates from residues in the containers.

9. More detailed research should be conducted to estimate program requirements for a deposit-refund system. This research should include a cost-benefit analysis, public meetings with farm groups and other interested parties, and improved methods to accurately field test containers for rinsing.

10. Research for methods to recycle plastic containers should be encouraged and supported by this administration. Other long-term solutions to container disposal problems should also be pursued.

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Appendix A

SUMMARY OF LEGISLATION AND REGULATIONS

A.1 INTRODUCTION

Pesticides and containers are addressed separately in several federal and provincial Acts and regulations; however, with the exception of one provincial regulation (MR 94/88R), pesticide containers are not specifically regulated in terms of disposal. Many of the regulations considered in combination may technically address this issue, but legal interpretations are not attempted by the author. The following discussion is intended only as a listing of legislation and regulations that may affect development of a collection and disposal program in Manitoba. Other applicable regulations may also be discussed in Hazardous Waste Management in Manitoba (Yee et al, 1985), and listed in the Guide to Manitoba's Hazardous Waste Legislation (Kucera, 1988) and in the Guide to Federal and Provincial Pollution Control Legislation in Manitoba (Richards and Hendrickson, 1986).

A.2 FEDERAL ENACTMENTS

Several federal Acts address environmental contamination, classification of dangerous goods, and regulation of pesticides. These Acts include the Canadian Environmental Protection Act, the Transportation of Dangerous Goods Act, and the Pest Control Products Act. Each of

these acts and/or regulations formed under these Acts will be briefly discussed in terms of effects on pesticides and containers.

A.2.1 The Canadian Environmental Protection Act (S.C. 1988, c. 22)

The Canadian Environmental Protection Act provides certain powers of regulation and guidance to the Minister of the Environment and to the Governor in Council. Specifically, Section 8(1) states that "...the Minister shall formulate

(a) environmental quality objectives specifying goals or purposes toward which an environmental control effort is directed, including goals or purposes stated in quantitative or qualitative terms;

(b) environmental quality guidelines specifying recommendations in quantitative or qualitative terms ...;

(c) release guidelines recommending limits ... for the release of substances into the environment ...; and

(d) environmental codes of practice ...".

Under Section 34(1) of the Act, "Where an order has been made to add a substance to the list of toxic substances in Schedule I, the Governor in Council may ... make regulations with respect to the substance, including regulations providing for or imposing requirements respecting

(p) the packaging and labelling of the substance or a product or material containing the substance; (or)

(q) the manner, conditions, places and methods of disposal of the substance or a product or material containing the substance, including standards for the construction, maintenance and inspection of disposal sites; ...".

Other sections which may be pertinent are Section 43, which restricts import or export of hazardous wastes (which may apply if pes-

ticide residues are legally defined as a hazardous waste), and Sections 71 and 72 which pertain to ocean dumping. These sections prohibit dumping into the ocean any materials or substances listed in Schedule III of the Act (which includes, under Part II, pesticides and their by-products, and containers and scrap metal), unless such dumping is specifically exempted from coverage by the Act by the Minister.

A.2.2 The Transportation of Dangerous Goods Act (S.C. 1980-81-82-83, c.36)

The Transportation of Dangerous Goods Regulations (SOR/85-77) under this Act lists and describes different classes of products which are regulated under the Act. Certain liquid and solid pesticides are identified as toxic under Schedule II, List II, and some of these are also listed as flammable. This regulation is adopted as a regulation under the Dangerous Goods Handling and Transportation Act of Manitoba.

A.2.3 The Pest Control Products Act (R.S.C. 1970, c.P-10)

This Act empowers the Governor in Council to make regulations under Section 5(k) "respecting the packaging, labelling and advertising of control products thereof". Section 2 defines a package, which "includes any container, wrapping, covering or holder in which any control product or other material is wholly or partly contained, placed or packed".

The Pest Control Products Regulations (C.R.C. 1978, c. 1253) under the Act also contains several pertinent sections for pesticide and container control. Section 2 defines a residue, which "means the ingredients of a control product that remain after the control product has been used and includes substances resulting from degradation or metabolism". Section 9(2) regards a device or ingredient which has not been previously assessed or evaluated for the purposes of these regulations. Under this section, the applicant (for a certificate of registration) "shall provide the Minister with the results of scientific investigations respecting

(ix) suitable methods for the disposal of the control product and its empty packages".

Section 27 details labelling requirements (and refers to CSA Standard Z143-1980), and Section 46 describes packaging requirements.

A.3 PROVINCIAL ENACTMENTS

Several provincial Acts also address the environment, restrictions involving dangerous goods, workplace safety and health, public health, and control of pesticides. These Acts include the Environment Act, the Dangerous Goods Handling and Transportation Act, the Workplace Safety and Health Act, the Public Health Act, and the Pesticides and Fertilizers Control Act. Each of these Acts and/or regulations under these Acts will be briefly discussed in terms of effects on pesticides and/or containers.

A.3.1 The Environment Act

(C.C.S.M. c. E125)

The Environment Act covers protection of the environment in general, and grants certain powers of regulation and control to the Minister of the Environment and the the Lieutenant Governor in Council. Included under Section 2(3), "the Minister may

(a) cause the preparation and production of informational material respecting the environment of the province and make the material available to the public;

(b) undertake, by means of grants or other assistance, support and encourage the development of educational programs or courses in the public education system, or educational programs for the public at large, respecting environmental management".

Section 41(1) details the types of regulations that may be passed under the act. Under this section, "...the Lieutenant Governor in Council may make regulations and orders,

(k) respecting the design, construction, adaptation, alteration, operation, maintenance and installation of systems, processes or works to abate or control pollution or other environmental damage ...;

(l) prescribing, setting standards or conditions for, or prohibiting the method of collection, treatment, distribution and disposal of pollutants;

(m) respecting the location of waste disposal grounds and landfills ...;

(p) respecting the disposal, reuse or recycling of any product or residual flow or packaging offered for sale in the province which may become a component of a wastestream;

(v) prohibiting litter and regulating disposal of litter".

Several of these regulations have already been passed into law.

MR 92/88 R (Litter Regulation) prohibits littering, unless in compliance with provisions of the Environment Act or the Dangerous Goods

Handling and Transportation Act. Section 2 states that "no person shall deposit or leave or cause or permit the depositing or leaving of litter upon any land, water or ice, unless

(a) the property is designated ... as an area for the disposal of litter ...;

(b) the litter is placed in a litter receptacle;

(c) the litter is deposited in a location designated for this purpose ... during special clean up days;

(d) the depositing or leaving is the result of an emergency; or

(e) the litter is placed for normal pick up service ...".

Section 1 defines litter as "... garbage, ..., rubbish, solid wastes or refuse, ..., scrap metal, ..., and special wastes, including, but not limited to ... containers, packages, bottles, cans ...". Under this same section, "'rubbish' means combustibles, consisting of miscellaneous burnable materials such as ... plastics, and non-combustibles consisting of miscellaneous materials ... such as tin cans, metals, ...". Special wastes are defined as "... hazardous wastes, consisting of any waste that may present a hazard to collection or disposal personnel or others, and includes wastes of a ... toxic nature, ...". Section 3 details responsibilities of a property owner or person in control such that "no litter accumulates upon that property" and that "... no litter blows, or is otherwise carried, from that property onto a public place or other private property".

MR 94/88 R (Pesticides Regulation) details some of the specific rules by which pesticides may be used. Of particular interest is Section 13, which states that, "Every pesticide applicator operating under a provincial pesticide use permit shall deposit effectively rinsed con-

tainers at the local pesticide container collection area or waste disposal grounds designated by the municipality." 'Effectively rinsed' is defined under Section 1 as meaning "rinsing out a pesticide container three times with a diluent used in the spray mixture or with a 30 second 200 kilopascal minimum pressure rinse or rinsing by any other approved method." Section 5 exempts Manitoba weed supervisors and municipal weed inspectors from obtaining a permit when using herbicides in accordance with provisions under the Noxious Weeds Act.

MR 98/88 R (Waste Disposal Grounds Regulations) details how and where waste disposal grounds may be constructed and operated. Under Section 8, "a waste disposal ground shall be

(a) located so that ... leachings ... are contained ... or do not contaminate water;

(b) located where there is a separation between the base of the deepest layer of solid waste and the groundwater table of at least 1.5 meters (5 feet); ...".

Under Section 10 of this regulation, "open burning in a Class I waste disposal ground is prohibited unless otherwise approved." Also under Section 10, "open burning in Class II and Class III waste disposal grounds is permitted if

(a) there is no burning of rubber tires; and

(b) the burning takes place in a trench or in a berm confined area."

Class I, II, and III disposal grounds are defined under Section 1 of the regulation. A Class I waste disposal ground "means a waste disposal ground serving a population of more than 5,000 persons". A Class II waste disposal ground "means a waste disposal ground serving a population of more than 1,000 but not more than 5,000 persons". A Class III

waste disposal ground "means a waste disposal ground serving a population of not more than 1,000 persons".

A.3.2 The Dangerous Goods Handling and Transportation Act (C.C.S.M. c. D12)

Several regulations under this Act may apply to treatment and/or handling of pesticide containers, especially if the containers are not properly rinsed.

MR 139/88 (Manifest Regulation) defines when a manifest must be completed for transportation and handling of specified materials. Section 2 exempts from this regulation solid wastes in quantities of 5 kg or less and liquid wastes of 5 L or less. Section 7 refers to multiple pickups within Manitoba, requiring the carrier to complete a manifest and keep records of any such pickups.

MR 172/85 adopts regulation SOR/85-77 under the Transportation of Dangerous Goods Act (Canada) as a regulation under the Dangerous Goods Handling and Transportation Act (Manitoba).

MR 175/85 (Generator Registration and Carrier Licencing Regulation) details registration and licencing requirements of persons creating, handling, storing or transporting hazardous materials. Section 3(1) states, "No person shall

(c) store or provide storage facilities for hazardous waste generated by another person;

unless that person has applied for and submitted ... an initial General Registration Report to the director, and obtained a provincial registration number issued by the department."

Section 1 defines 'generator' as "... any person who ... caused or allows to cause the creation or storage of hazardous waste". This section also defines a hazardous waste as "... a product, substance or organism that meets the criteria set out in ... Manitoba Regulation 282/87, ...".

MR 282/87 (Classification Criteria for Products, Substances and Organisms Regulation) defines the different classes of hazardous materials, referring in part to MR 172/854 (and ultimately to SOR/85-77) for the specification of what materials are considered dangerous or hazardous under this Act.

A.3.3 The Workplace Safety and Health Act (C.C.S.M. c. W210)

Two regulations under this Act may apply to the handling of pesticides and empty containers.

MR 52/88 (Workplace Hazardous Materials Information System Regulation) has limited application to products under the Pest Control Products Act (Canada), but does not supersede the requirements of labelling and provision of information under the federal Act (MEWSH, 1988). These limitations are specified under Section 2(2) of the regulation. The employer is still required to provide worker training if any such materials are present or used in the workplace (MEWSH, 1988). Section 4(1) states,

"An employer shall ensure that a worker who works with a controlled product or in proximity to a controlled product is informed about all hazard information received from a supplier concerning that controlled product as well as any further hazard information of which the employer

is aware or ought to be aware concerning that controlled product and its use, storage and handling."

The Guidance manual to this regulation (MEWSH, 1988) suggests that "a worker who works with a controlled product is any worker who stores, handles, uses, or disposes of a controlled product, or who supervises another worker performing these activities" (p. 5).

MR 53/88 (Workplace Health Hazard) also exempts pesticides from labelling and material data requirements under Section 4(2), as these requirements are provided under the Pest Control Products Act (Canada). These products, though, must still be stored and handled safely, and are not exempt from worker education and training (MEWSH, 1989). Section 9(1) states,

"An employer shall ensure that no fugitive emission is produced or disposed of and that no hazardous waste is produced, stored, handled or disposed of unless the applicable requirements of this part are Complied with."

Section 1 defines a fugitive emission as "a gas, liquid, solid, vapour, fume, mist, fog or dust containing a controlled product that escapes from ... a product or a device in the workplace ...". Section 10 describes worker education requirements if fugitive emissions are present.

A.3.4 The Public Health Act
(C.C.S.M. c. P210)

Two regulations under this Act may apply to the storage and disposal of pesticide containers.

MR 321/88 R (Collection and Disposal of Wastes Regulation) regulates the storage of wastes by an individual. Section 2(1) states, "The owner, occupier, or user of any presises shall maintain the premises ... in a sanitary and orderly condition, and ... shall ... comply with the following requirements:

(c) junk, including bottles, cans, containers, ... shall be stored in a sanitary and orderly manner and in a suitable location."

MR 326/88 R (Protection of Water Sources Regulation) prohibits disposal of wastes where such disposal may contaminate water. Section 2(1) states, "No person shall deposit or discharge into, or on to the bank of, any river, stream, lake, creek, spring, coulee, reservoir, pond, or dugout, or on the ice thereof, ... refuse of any nature ...".

A.3.5 The Pesticides and Fertilizers Control Act (C.C.S.M. c. P40)

This Act details requirements for the licencing and use concerning pesticides and fertilizers. Of the regulations that may be made under this Act, Section 8 states that "... the Lieutenant Governor in Council may make regulations and orders,

(m) prescribing the manner in which pesticides, fertilizers and their containers may be disposed of".

MR 216/87 R (Pesticides and Fertilizers Licence Regulation) details specific requirements under the Act. Section 7 states, "Disposal of pesticides and pesticide containers shall be carried out in compliance with the Clean Environment Act and the Public Health Act and regulations under those Acts." (note: the Clean Environment Act was

repealed in Section 56 of the Environment Act, upon passage of that Act on 17 July 1987). Section 8(2) states, "A farmer is not considered a commercial applicator when the total of pesticide application off his farm is less than 500 ha, and work is carried out for not more than three individuals in any year."

Appendix B

MAINE REGULATION 22 M.R.S.A./1471-Q

CHAPTER 21

PESTICIDE CONTAINER DISPOSAL AND STORAGE

PREFACE: Statutes governing the Board of Pesticides Control make it illegal for "any person to dispose of, discard or store any pesticides or pesticide containers in such a manner as may cause injury to humans, vegetation, crops, livestock, wildlife, beneficial insects or pollute any water supply or waterway; 7 MRSA § 606(2)(E). The Board°s statutes also require it "to regulate the return and disposal of limited and restricted use pesticide containers" by promulgating regulations to (1) establish a deposit to be collected pending return of the container, (2) require stickers to be affixed to all such containers at time of sale, (3) insure triple rinsing or equivalent of the containers, and (4) specify places where rinsed containers may be returned for refund, in addition to the place of business of the dealer; 22 MRSA § 1471(Q). These regulations shall be effective April 1, 1985.

SUMMARY: These rules set forth the regulations for the management of emptied pesticide containers for limited and restricted use pesticides. They establish deposit amounts, sticker requirements, triple rinse or equivalent procedures, and refund places and procedures. The rules are organized according to classification of the pesticide as to whether it was purchased in-state or out-of-state.

A. Limited and Restricted-Use Pesticides Purchased In-State

1. Scope. The rules in this Subchapter A apply to limited and restricted-use pesticides and their containers purchased from licensed Maine dealers. The following types of containers are exempt from these regulations but must be stored, handled and disposed of according to label directions and applicable D.E.P. regulations.

   a. Paper, cardboard and fiberboard containers and plastic bags.

   b. Containers of less than one-half pint volume.

   c. Sealed containers, refillable only by the manufacturer or distributor, provided that such containers are required to be returned by the applicator to the manufacturer or distributor, that a deposit of no less than $50 per container is charged by the manufacturer or distributor to the applicator or purchaser, and that the manufacturer or distributor establishes and carries out a monitoring

system which provides for the identification and tracking of each container.

2. Deposits. Dealers shall collect deposits in cash or posted credit charges on each pesticide container at the time of sale or delivery to the purchaser or its agent, as follows:

   a. Non-refillable containers

      (1) One-half pint to 30 gallons capacity -$5.00 per container

      (2) 30 gallons capacity and over - $10.00 per container

   b. Refillable containers. At their option, dealers may collect deposits greater than those required for non-refillable containers.

3. Stickers. Prior to or at the time of delivery of the pesticide to the purchaser or its agent, stickers obtained from the Board of Pesticides Control shall be affixed by dealers to pesticide containers.

   a. Dealers shall obtain stickers by making a request, on forms provided for that purpose, to the Board at least two weeks prior to anticipated need. Completed forms shall be forwarded to the Board of Pesticides Control, Deering Building, AMHI Complex, Augusta, Maine 04333. Arrangements for emergency pick up of stickers may be made by contacting the Board at 207/289-2731. Dealers will be billed and shall pay for the costs of printing and shipping stickers, as assessed by the Board.

   b. Dealers shall affix stickers prominently and securely to containers in a manner that will not obscure or interfere with any trademark or label instructions. Such stickers shall in no event be deemed a part of the label. If an unopened case of containers is to be sold and delivered to the purchaser or its agent, the dealer may securely attach or fasten a sufficient number of stickers (one for each container) to the exterior of the unopened case prior to delivery. In such event, the purchaser or his agent shall either affix stickers to containers immediately upon opening the case, or the containers shall at all times be kept with the case on which the stickers remain affixed, except during actual use of the containers, and shall be returned to the dealer or his agent as a unit for return of deposit and disposal.

c. Stickers, as supplied by the Board and completed by the dealer at the time of sale or delivery to the purchaser or his agent, shall identify the dealer and the purchaser and shall contain such other information as the Board shall require. Dealers shall keep a record of sticker numbers and corresponding purchasers for each container sold.

d. It shall be unlawful to remove, deface, or otherwise render illegible a sticker affixed to a container except at the time of recycling or disposal in accordance with these regulations.

4. Records. Dealers shall maintain records of all restricted or limited use pesticide sales subject to these regulations for a period of two calendar years. Information required includes the following:

a. the name and address of the purchaser (and agent, if any), and date of delivery

b. the registered name of the pesticide and the number and size of each container

c. the serial number of each sticker affixed to a container

d. the amount of the deposit paid or posted to credit

5. Triple rinse or equivalent. Pesticide containers shall be triple rinsed immediately by the applicator or someone under his direct supervision, or cleaned by another authorized method or procedure equivalent in residue removal effectiveness.

a. The standard triple rinse procedure is as follows:

(1) the emptied container shall be drained for at least thirty (30) seconds after steady flow of pesticide formulation has ceased and after individual drops are evident. Any pesticide formulation drained shall be added to the spray tank mix and shall be applied in accordance with label instructions.

(2) a solvent, usually water, specified by the manufacturer and capable of removing the pesticide residue shall be added to the drained container in an amount equal to ten percent (10%) of its capacity. The container then shall be shaken, agitated, or rolled vigorously in such fashion as to dislodge residues from the top, bottom and sides. The liquid residues (rinsate) shall be added as make-up to the

spray tank mix, and the container shall be allowed to drain for at least thirty (30) seconds after steady flow has ceased and after individual drops are evident.

(3) the above procedure shall be performed two more times, each time allowing the container to drain at least thirty (30) seconds and adding all rinsate to the spray tank mix, to be applied in accordance with label instructions.

b. In cases where undiluted formulations are used and rinsate cannot be added to the spray tank, the residue must be disposed of in accordance with label instructions.

c. Methods of rinsing or cleaning containers, other than the standard triple rinsing procedure described above, may be used provided they are shown to remove equivalent amounts of pesticide residues which can be disposed of in an environmentally safe manner. Any person proposing to use an equivalent method that has not been previously authorized by the Board shall first obtain the Board°s approval by providing data and information to document the cleaning effectiveness of the method and the environmental safety of residue disposal.

d. In the case of containers with removable inner liners that prevent contact between the pesticide and the container, removal of the liner shall be considered the equivalent of triple rinsing. The removed liners must be handled and disposed of according to the label and D.E.P. regulations. Liners removed from pesticides containers containing pesticides listed as hazardous waste by the D.E.P. are also considered hazardous waste unless the liners are triple rinsed with an applicable solvent or other method approved as equivalent by the D.E.P.

e. Following the rinsing, cleaning or liner removal procedure, plastic or metal containers not destined for return to manufacturers or shipment to reconditioners shall be punctured prior to disposal to insure they are empty and to prevent reuse. Glass containers are exempt from this puncture requirement.

6. Affidavits. The Board shall provide blank affidavit forms which purchasers or their agents must accurately complete and provide to the dealer or his representative prior to disposal and a refund of the deposit. No

deposit shall be returned unless this requirement is satisfied.

a. The following information must be recorded on the affidavit form:

(1) the name and address of the purchaser, and agent if any

(2) the registered name of the pesticide and the number and size of each container

(3) the serial number of each sticker affixed to a container

b. The following must be completed by the purchaser or his agent on the affidavit at the time the empty and properly rinsed containers are returned to an authorized collection, recycling or disposal place:

(1) The following certification to be signed by the purchaser or his agent and the person performing container rinsing "This is to certify under oath that the container(s) with the sticker number(s) listed herein has(have) been properly rinsed according to regulations adopted by the Board of Pesticides Control."

(2) The location and date containers were returned.

c. The information contained on the affidavit shall be true and correct. It shall be a violation hereof to sign or submit a false affidavit.

d. The dealer shall retain a copy of the completed affidavit for two years following return or may forward the same to the Board.

7. Return and refund.

a. Containers bearing the Board°s stickers that have been properly rinsed according the Board°s regulations, and that are accompanied by completed affidavits to that effect, shall be returned for refund of deposit as follows:

(1) to an authorized collection, disposal or recycling facility specified by the dealer, provided that arrangement for the use of such facility have been made by the dealer, or

(2) otherwise, to the place of business of the dealer who sold the pesticide.

b. Upon return of the containers and receipt of the affidavit as provided above, cash deposits shall be refunded by the dealer in cash, and deposits that were posted to credit accounts shall be credited to reduce such accounts, except that if such accounts have been paid in full prior to return, then refunds shall be in cash.

B. Limited and Restricted Use Pesticide Purchased Out-of-State

1. Scope. The rules in this Subchapter B apply to limited and restricted use pesticides and their containers purchased out-of-state and brought into the State other than for resale, and which are held for use or used within the State. The following types of containers are exempt from these regulations but must be stored, handled and disposed of according to label directions and applicable D.E.P. regulations.

   a. Paper, cardboard and fiberboard containers and plastic bags.

   b. Containers of less than one-half pint volume.

   c. Sealed containers, refillable only by the manufacturer or distributor, provided that such containers are required to be returned by the applicator to the manufacturer or distributor, that a deposit of no less than $50 per container is charged by the manufacturer or distributor to the applicator or purchaser, and that the manufacturer or distributor establishes and carries out a monitoring system which provides for the identification and tracking of each container.

2. Deposits. Any person who purchases or otherwise acquires pesticides in containers within the scope of the regulations in this Subchapter B shall pay deposits on the containers to the Board of Pesticides Control, as follows:

   a. All containers

      (1) One-half pint to 30 gallons capacity - $5.00

      (2) 30 gallons capacity and over - $10.00

   b. Deposits shall be in cash, check, or money order and must be paid at the time stickers are requested under paragraph 3.

3. Stickers. At the time that pesticides are received for use in this State, stickers must be obtained from the Board and shall be affixed to such containers by the purchaser or his agent, as follows:

   a. Stickers shall be obtained by making a request, on forms provided for that purpose, to the Board at least two weeks prior to anticipated need. Completed forms shall be forwarded to the Board of Pesticides Control, Deering Building, AMHI Complex, Augusta, Maine 04333. Arrangements for emergency pick up of stickers may be made by contacting the Board at 207/289-2731. All requests must be accompanied by cash, check, or money order in an amount to cover the deposits due and for the costs of printing and shipping the stickers, as assessed by the Board.

   b. Stickers shall be affixed prominently and securely to containers in a manner that will not obscure or interfere with any trademark or label instruction. Such stickers shall in no event be deemed part of the label

   c. It shall be unlawful to remove, deface, or otherwise render illegible a sticker except at the time of recycling or disposal of the container in accordance with these regulations.

4. Affidavits. The Board will provide blank affidavit forms to those seeking stickers for containers and the purchaser or his agent must complete such a form prior to returning containers for disposal.

   a. The following information must be completed on the affidavit form:

      (1) the name and address of the purchaser, and agent if any

      (2) the registered name of the pesticide and the number and size of each container

      (3) the serial number of each sticker affixed to a container

   b. The following must be completed by the purchaser or his agent on the affidavit at the time the empty and properly rinsed containers are returned to an authorized collection, recycling or disposal place:

      (1) the following certification to be signed by the purchaser or his agent and the person

performing container rinsing "This is to certify under oath that the container(s) with the sticker number(s) listed herein has(have) been properly rinsed according to regulations adopted by the Board of Pesticides Control."

(2) The location and date containers were returned.

c. The information contained on the affidavit shall be true and correct. It shall be illegal to sign or submit a false affidavit.

d. The completed and signed affidavit shall be submitted to the Board at the time a request is made for refund of the deposit.

5. Triple rinse or equivalent. Pesticide containers shall be triple rinsed immediately by the applicator or someone under his direct supervision, or cleaned by another authorized method or procedure equivalent in residue removal effectiveness.

a. The standard triple rinse procedure is set forth in Subchapter A, Section 5 a and b of this Chapter.

b. Methods of rinsing or cleaning containers, other than the standard triple rinsing procedure described above, may be used provided they are shown to remove equivalent amounts of pesticide residues which can be disposed of in an environmentally sound manner. Any person proposing to use an equivalent method that has not been previously authorized by the Board shall first obtain the Board's approval by providing data and information to document the cleaning effectiveness of the method and the environmental safety of residue disposal.

c. In the case of containers with removable inner liners that prevent contact between the pesticide and the container, removal of the liner shall be considered the equivalent of triple rinsing. All removed liners must be handled and disposed of according to the label and D.E.P. regulations. Liners removed from pesticides containers containing pesticides listed as hazardous waste by the D.E.P. are also considered hazardous waste unless the liners are triple rinsed with an applicable solvent or other method approved as equivalent by the D.E.P.

d. Following the rinsing, cleaning, or liner removal procedure, plastic or metal containers not designated for return to manufacturers or shipment to reconditioners shall be punctured prior to

disposal to insure they are empty and to prevent reuse. Glass containers are exempt from this puncture requirement.

6. Return for Refund.

   a. Containers bearing the Board°s stickers that have been properly rinsed and punctured according to the Board°s regulations shall be returned to an authorized recycling, collection or disposal facility, as follows:

      (1) completed and signed affidavits must accompany all containers returned

      (2) the place and date of return shall be confirmed by the operator of the recycling, collection or disposal facility.

   b. Requests for refund of deposits shall be made, on forms provided for that purpose, to the Board of Pesticides Control, Deering Building, AMHI Complex, Augusta, Maine 04333. All requests must be accompanied by properly completed and signed affidavits that account for stickers issued by the Board.

7. Out-of-State Dealer Option. Any out-of-state dealer may elect to act as if it were an in-state dealer under Subchapter A hereof. In that case such dealer shall apply for stickers from the Board and shall otherwise comply with the requirements of Subchapter A. Purchasers from such dealers and other handlers shall comply with Subchapter A. The provisions of this Subchapter B shall not apply in such case.

C. **Held-over Containers.** After April 1, 1985, it shall be unlawful for any person to possess a restricted or limited use pesticide container without a sticker issued by the Board and affixed to the container, except as specifically exempted under Subchapter A and B hereof and except for containers held by dealers for sale. Stickers for pesticide containers subject to this regulation in the possession of applicators or users on April 1, 1985 shall be obtained by making a request, on forms provided for that purpose, to the Board of Pesticides Control, Deering Building, AMHI Complex, Augusta, Maine 04333.

1. The request must contain the following information:

   a. The registered name of the pesticide, and the number of the containers.

b. The following certification "This is to certify that the pesticide containers described herein were in my possession on April 1, 1985," signed by the person requesting stickers.

2. Stickers issued by the Board under this Subchapter C shall be supplied without fee.

3. Stickers provided by the Board must be affixed to the containers described in the request as described in Subchapter B. Such stickers shall not be affixed to any other containers.

AUTHORITY: 22 M.R.S.A. § 1471-Q

EFFECTIVE DATE: April 1, 1985

AMENDMENT EFFECTIVE: May 18, 1986

June 27, 1988

Appendix C

PROPOSED DEPOSIT-REFUND SYSTEM FOR MINNESOTA

(Source: Minnesota Department of Agriculture, 1988)

PROGRAM

PESTICIDE CONTAINER DEPOSIT AND RETURN PROGRAM

Section 1. PURPOSE The purpose of this section is to insure the triple rinsing or equivalent of agricultural pesticide containers in accordance with MDA regulations and thereafter provide an incentive through a deposit system for the return and management of properly rinsed containers.

All pesticide containers of one (1) gallon or more in size, excluding products intended only for home or garden use, falling under the provisions of this rule shall have an official Minnesota Department of Agriculture sticker affixed to the container. The official Minnesota Department of Agriculture sticker shall be used to identify those containers for which a deposit is required.

Section 2. SCOPE. This law applies to all pesticide containers of content of one (1) gallon or more (excluding those packaged in a cardboard, fiberboard, or paper container) which are distributed or used within the state.

Section 3. DEPOSIT AMOUNT ESTABLISHED. The Minnesota Department of Agriculture shall, by regulation, establish a deposit amount for pesticide containers within the scope of this section. The actual deposit amount shall be sufficient to promote the return of the containers.

Section 4. DISTRIBUTORS COLLECT DEPOSITS. All pesticide distributors shall, at the time of sale or distribution, collect the container deposit established by the Minnesota Department of Agriculture for each pesticide container subject to this law.

Section 5. STICKERS REQUIRED. Upon the distribution of any pesticide container subject to this law, the pesticide distributor shall affix an official sticker supplied by the Minnesota Department of Agriculture to identify those containers. The stickers shall indicate that the deposit has been paid and shall be designed so that it identifies both the distributor and purchaser.

Section 6. DEPOSITS REFUNDED. Deposits will be refunded by pesticide distributors on all pesticide containers bearing the Minnesota Department of Agriculture's stickers at the place of business where the deposit sticker was attached or at a place otherwise established by regulation. All containers must be triple rinsed or the equivalent prior to return, or otherwise in accord with the MDA's regulations.

Section 7. AUTHORITY TO ADOPT RULES. The commissioner may promulgate rules and take such other actions as is deemed necessary to carry out the provisions of this law.

RULES

SUMMARY: These rules set forth the regulations for the management of emptied pesticide containers. They establish deposit amounts, sticker requirements, triple rinse or equivalent procedures, and refund places and procedures. The rules are organized according to classification of the pesticide as to whether it was purchased in-state or out-of-state.

A. Agricultural Pesticides Purchased In-State

1. Scope. The rules apply to pesticide containers of one (1) gallon or more in size, excluding products intended for home or garden use, and their containers purchased from licensed Minnesota dealers. Paper, cardboard and fiberboard containers are not subject to these regulations but must be stored, handled and disposed of according to label directions and applicable regulations.

2. Deposits. Dealers shall collect deposits in cash or posted credit charges on each pesticide container at the time of sale or delivery to the purchaser or its agent, as follows:

   a. Non-refillable containers

      (1) less than 30 gallons capacity
      $ 5.00 per container

      (2) 30 gallons capacity and over
      $10.00 per container

   b. Refillable containers. At their option, dealers may collect deposits greater than those required for non-refillable containers.

3. Stickers. Prior to or at the time of delivery of the pesticide to the purchaser or its agent, stickers obtained from the Minnesota Department of Agriculture (MDA) shall be affixed by dealers to pesticide containers.

   a. Dealers shall obtain stickers by making a report, on forms provided for that purpose, to the MDA at least two weeks prior to anticipated need. Completed forms shall be forwarded to the Pesticide Regulatory Section, Minnesota Department of Agriculture, 90 West Plato Boulevard, St. Paul, Minnesota 55107. Arrangements for emergency pick up of stickers may be made by contacting

the MDA at (612) 296-8547. Dealers will be billed and shall pay for the costs of printing and shipping stickers, as assessed by the MDA.

b. Dealers shall affix stickers prominately and securely to containers in a manner that will not obscure or interfere with any trademark or label instruction. Such stickers shall, in no event, be deemed a part of the label. If an unopened case of containers is to be sold and delivered to the purchaser or agent thereof, the dealer may securely attach or fasten a sufficient number of stickers (one for each container) to the exterior of the unopened case prior to delivery. In such event, the purchaser or his agent shall either affix stickers to containers immediately upon opening the case, or the containers shall at all times be kept within the case on which the stickers remain affixed, except during actual use of the containers, and shall be returned to the dealer or his agent as a unit for return of deposit and disposal.

c. Stickers, as supplied by the MDA and completed by the dealer at the time of sale or delivery to the purchaser or his agent, shall identify the dealer and the purchaser and shall contain such other information as the MDA shall require. Dealers shall keep a record of sticker numbers and corresponding purchasers for each container sold.

d. It shall be unlawful to remove, deface, or otherwise render illegible a sticker affixed to a container except at the time of recycling or disposal in accordance with these regulations.

4. Triple rinse or equivalent. Pesticide containers shall be triple rinsed immediately by the applicator or someone under his direct supervision, or cleaned by another authorized method or procedure equivalent in residue removal effectiveness.

a. The standard triple rinse procedure is as follows:

(1) The emptied container shall be drained for at least thirty (30) seconds after steady flow of pesticide formulation has ceased and after individual drops are evident. Any pesticide

formulation drained shall be added to the spray tank mix and shall be applied in accordance with label instructions.

(2) A solvent, usually water, specified by the manufacturer and capable of removing the pesti cide residue shall be added to the drained con tainer in an amount equal to ten percent (10%) of its capacity. The container shall be shaken, agitated, or rolled vigorously in such fashion as to dislodge residues from the top, bottom and sides. The liquid residues (rin sate) shall be added as make-up to the spray tank mix, and the container shall be allowed to drain for at least thirty (30) seconds after steady flow has ceased and after individual drops are evident.

(3) The above procedure shall be performed two more times, each time allowing the container to drain at least thirty (30) seconds and adding all rinsate to the spray tank mix, to be ap plied in accordance with label instructions.

b. In cases where undiluted formulations are used and rinsate cannot be added to the spray tank, the resi due must be disposed of in accordance with label instructions.

c. Methods of rinsing or cleaning containers, other than the standard triple rinsing procedure described above, may be used provided they are shown to remove equivalent amounts of pesticide residues which can be disposed of in an environmentally safe manner. Any person proposing to use an equivalent method that has not been previously authorized by the MDA shall first obtain the MDA's approval by providing data and information to document the cleaning effec tiveness of the method and the environmental safety of residue disposal.

d. In the case of containers with removable inner lin ers that prevent contact between the pesticide and the container, removal of the liner shall be consid ered the equivalent of triple rinsing. The removed liners must be handled and disposed of according to the label and MDA regulations. Liners removed from

pesticides containers containing pesticides listed as hazardous waste are also considered hazardous waste unless the liners are triple rinsed with an applicable solvent or other method approved as equivalent by the MDA.

e. Following the rinsing, cleaning or liner removal procedure, plastic or metal containers not destined for return to manufacturers or shipment to recondi tioners shall be punctured prior to disposal to in sure they are empty and to prevent reuse. Glass containers are exempt from this puncture require ment.

5. Return and refund.

a. Containers bearing the MDA's stickers that have been properly rinsed according to the MDA's regulations, shall be returned for refund of deposit as follows:

(1) to an authorized collection, disposal or recy cling facility specified by the dealer fur nished to the purchaser or his agent, provided that arrangements for the use of such facility have been made by the dealer, or

(2) otherwise, to the place of business of the dealer who sold the pesticide.

b. Upon return of the containers as provided above, cash deposits shall be refunded by the dealer in cash, and deposits that were posted to credit ac counts shall be credited to reduce such accounts, except that if such accounts have been paid in full prior to return, then refunds shall be in cash.

B. Agricultural Pesticides Purchased Out-of-State

1. Scope. The rules apply to pesticides of one (1) gallon or more in size, excluding products intended only for home and garden use and their containers purchased out-of-state and brought into the State other than for re sale, and which are held for use or used within the State. Pesticides packaged in cardboard, fiberboard or paper containers are not subject to these regulations, but must be stored, handled and disposed of according to label directions and applicable regulations.

2. Deposits. Any person who purchases or otherwise acquires pesticides in containers within the scope of the regula tions shall pay deposits on the containers to the MDA as follows:

   a. All containers

      (1) less than 30 gallons capacity
      $ 5.00 per container

      (2) 30 gallons capacity and over
      $10.00 per container

   b. Deposits shall be in cash, check, or money order and must be paid at the time stickers are requested un der paragraph 3.

3. Stickers. At the time that pesticides are received for use in this State, stickers must be obtained from the MDA and shall be affixed to such containers by the purchaser or his agent, as follows:

   a. Stickers shall be obtained by making a request, on forms provided for that purpose, to the MDA at least two weeks prior to anticipated need. Completed forms shall be forwarded to the Pesticide Regulatory Section, Minnesota Department of Agriculture, 90 West Plato Boulevard, St. Paul, Minnesota 55107. Arrangements for emergency pickup of stickers may be made by contacting the MDA at (612) 296-8547. All requests must be accompanied by cash, check, or money order in an amount to cover the deposits due and for the costs of printing and shipping the stickers, as assessed by the MDA.

   b. Stickers shall be affixed prominently and securely to containers in a manner that will not obscure or interfere with any trademark or label instruction. Such stickers shall, in no event, be deemed part of the label.

   c. It shall be unlawful to remove, deface, or otherwise render illegible a sticker except at the time of recycling or disposal of the container in accordance with these regulations.

4. Triple rinse or equivalent. Pesticide containers shall

be triple rinsed immediately by the applicator or someone under his direct supervision, or cleaned by another au thorized method or procedure equivalent in residue removal effectiveness.

a. The standard triple rinse procedure is set forth in these rules.

b. Methods of rinsing or cleaning containers, other than the standard rinsing procedure described above, may be used provided they are shown to remove equivalent amounts of pesticide residues which can be disposed of in an environmentally sound manner. Any person proposing to use an equivalent method that has not been previously authorized by the MDA shall first obtain the MDA's approval by providing data and information to document the cleaning effectiveness of the method and the environmental safety of residue disposal.

c. In the case of containers with removable inner liners that prevent contact between the pesticide and the container, removal of the liner shall be considered the equivalent of triple rinsing. All removed liners must be handled and disposed of according to the label and regulations. Liners removed from pesticides containers containing pesticides listed as hazardous waste unless the liners are triple rinsed with an applicable solvent or other method approved as equivalent by the MDA.

d. Following the rinsing, cleaning, or liner removal procedure, plastic or metal containers not designated for return to manufacturers or shipment to recondition ers shall be punctured prior to disposal to insure they are empty and to prevent reuse. Glass containers are exempt from this puncture requirement.

5. Return and Refund.

a. Containers bearing the MDA's stickers that have been properly rinsed and punctured according to the MDA's regulations shall be returned to an authorized recy cling, collection or disposal facility, and the place and date of return shall be confirmed by the operator of the recycling, collection or disposal facility.

b. Requests for refund of deposits shall be made, on forms provided for that purpose, to the Pesticide Regulatory

Section, Minnesota Department of Agriculture, 90 West Plato Boulevard, St. Paul, Minnesota 55107.

6. Out-of-State Dealer Option. Any out-of-state dealer may elect to act as if it were an in-state dealer. In that case, such dealer shall apply for stickers from the MDA and shall otherwise comply with the requirements of this rule.

RULES DISCUSSION

Before a state mandated pesticide container deposit and return program can be instituted, some important questions must be resolved. These concerns include:

1. Liability: The potential for spills, leaks and contamination would be inherent with any pesticide container storage. This potential would exist regardless of how clean empty pesticide containers may be;

2. Apprehensive Public: Local governments and the public are concerned about potential hazards and may not tolerate massive empty pesticide container storage at a local commercial business;

3. Inadequate Storage Facilities: Dealers may not currently have existing storage space or have the ability to develop existing storage space for empty pesticide containers;

4. Apprehensive Dealers: Dealers may neither want the legal responsibility nor possess the technical expertise required to implement such a program. For example, how to determine if a customer's containers are properly cleaned?

5. Distribution Impediments: The insertion of the dealer as a fee collector between the MDA and the farmer or commercial applicator would ultimately strain the dealer/consumer relationship;

6. Absence of Collection Sites: The lack of established collection sites for areas where dealers are unable or unwilling to collect and/or store empty pesticide containers;

7. Expense: The establishment and implementation of such a program would require state involvement. The potential large expense, especially concerning staff time and resources needs to be examined.

Appendix D

ALBERTA COLLECTION DEPOT SPECIFICATIONS

(Source: Alberta Environment, 1988)

DESIGN GUIDELINES AND SPECIFICATIONS

PESTICIDE CONTAINER COLLECTION SITES

December, 1988

Alberta
ENVIRONMENT

PESTICIDE CONTAINER COLLECTION SITE
DESIGN NARRATIVE

A. General Comment

This narrative is to complement the accompanying design drawings. It is impossible to provide detailed specifications to cover all field conditions in the province. Therefore the drawings and the narrative provides for options to adjust to local conditions and constraints.

It is recommended that professional engineering assistance be utilized to develop the final design to environmentally safe standards.

The intent is to provide an environmentally safe site having: (1) containment, (2) security, and (3) water control. With the options provided, it will be possible to produce an environmentally safe site incorporating local conditions and locations.

B. General Site Specifications

1.0 Site Geology and Geography

The pesticide container collection site should ideally be located at an established Regional Landfill where the soil and groundwater conditions have been identified. If there is no Regional Landfill within the municipality, then the following guidelines should be considered in the selection process for a pesticide container collection site.

a) The site should not be located within the boundaries of a city, town or village;

b) The site should not be located within 30 metres of an open body of water;

c) The site should not be located within 100 metres of any well used as a potable water supply;

d) The site should not be located within 500 metres of any facility where food is prepared, served or stored, or of any dwelling being used for human habitation;

e) The site location and construction shall be of a type and quality that will prevent livestock and/or wildlife from gaining access to the facility;

f) The site should preferrably be located in an area where shallow geologic materials exhibit a hydraulic conductivity of 1×10^{-7} cm/s or less, such as an unfractured clay.

g) The site should be located to minimize the chances of catching on fire, and must be readily accessible for fire fighting and other emergency procedures;

h) The site shall be chosen to minimize the potential for environmental damage including any threats to the quality of surface water and groundwater; and to the health of humans, animals and plants for normal operation of the site;

2.0 Precipitation/Evaporation

One of the major problems encountered in operating a pesticide container collection site is dealing with unwanted water in the facility. Different areas in the province are subjected to different climatic conditions. This includes varied rain and snowfall patterns, along with different levels of evaporation.

There are a variety of solutions to this problem. In areas where evaporation is limited, or is exceeded by precipitation, installation of a shelter to prevent rain and snowfall from accumulating within the site may be the appropriate solution. In areas where precipitation and evaporation are in balance, or evaporation exceeds precipitation, utilization of shallow evaporation ponds to remove water accumulations may be appropriate. The objective is to manage precipitation in such a manner as to prevent environmental contamination without affecting operation and maintenance of the site.

3.0 Prevention of Surface Water and Groundwater Contamination

In order to prevent contamination of surface water and groundwater, design considerations for a pesticide container collection site must include a base impervious to downward water and pesticide movement, as well as a surrounding containment berm. The base of the site should be constructed of a material which will not react with or absorb any pesticide residue. A properly prepared clay foundation or a synthetic liner will effectively prevent any subsurface contamination. A sloped base, evaporation ponds and circumferential berm will aid in the containment, collection and evaporation of any accumulated precipitation and pesticide residue. If a shelter is utilized for rainfall protection, then the need for evaporation ponds is obviously eliminated.

4.0 Site Security

Security of pesticide container collection sites refers to three main areas: retention of containers within the confines of the site, limiting access to the site (where this is desired), and overcoming problems arising when wind blows containers out of the site. Two options which have been identified as suitable are chain link fences and some type of containment associated with a shelter.

Chain link fences, due to their strength and durability, have been found to be very appropriate for this use, even when container sites are full. Other fencing options have numerous drawbacks which limit their appropriateness. The barbed wire option noted in the detailed drawings is directed toward the inside of the site for the express purpose of retaining wind blown containers.

. . . . 3

The use of shelters is a relatively new concept for pesticide container storage sites, and could be utilized where the benefits would outweigh the costs. Fences or walls associated with the shelter should be constructed so that wind does not affect the stacked containers. Ideally, one wall should be on the windward side of the structure.

Integration of both concepts (chain link fence and shelter) may also be a viable option and overcomes both problems of container retention and prevention of precipitation accumulation.

Limitation of access, if so desired, can be easily achieved by ensuring that gates are lockable. Alternatively, if only vehicular access is to be restricted, a 1 metre man-gate could be built into the fence to allow for pedestrian access.

5.0 Site Maintenance

The pesticide container collection site is intended to be relatively maintenance free. The following steps should be taken to ensure an efficient operating system:

a) (re)stacking containers because of a strong wind or uncooperative depositors;

b) separating containers into categories, ie. metal and plastic;

c) removal of cardboard shipping boxes from the collection site to a sanitary landfill;

d) pumping out the evaporation pond (should it be full) to an appropriate receiving facility; and,

e) general maintenance to ensure overall site integrity.

Removal of containers on a regular basis will obviously assist in the maintenance of the site. It is anticipated that regularly scheduled shredding or crushing and removal of containers will occur in the future.

C. Construction Specifications

1.0 Site Size Selection Criteria

Table C.1 sets a suggested size in relation to the quantity of containers collected at the site. The size of the site is also dependent upon maintenance activities, and assumes a certain amount of organization of the containers. A basic size for most municipalities would be 20m x 20m; however, this could be scaled larger or smaller based on the municipality experience.

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TABLE C.1

Number of Containers (1)	Volume (m^3) (2)	Minimum Area Required (m^2)	Approximate Compound Size (m)	Optional Drive-Thru Roadway (m^2) (3)	Optional Drive-Thru Total Area (m^2)	Optional Drive-Thru Approximate Compound Size (m)
5,000	75	65	8 x 8	40	105	10 x 11
10,000	150	125	11 x 11	55	180	13 x 14
15,000	225	190	14 x 14	70	260	16 x 16
20,000	300	250	16 x 16	80	330	18 x 19
25,000	375	315	18 x 18	90	405	20 x 20
30,000	450	375	19 x 20	95	470	22 x 22
35,000	525	440	21 x 21	105	545	23 x 24
40,000	600	500	22 x 23	110	610	25 x 25
45,000	675	565	24 x 24	120	685	26 x 27
50,000	750	625	25 x 25	125	750	27 x 28

NOTES:

(1) Categorical breakdown of containers:
75% of total containers are plastic
90% - 10 litre size
10% - 20 litre size

25% of total containers are metal
20 litre size

(2) Containers stacked to a height of 1.2 m.

(3) Roadway 5m wide, same as double swing gate.

The 'drive-thru' is an operational option, and necessities a larger site to compensate for the area taken up by the roadway (Drawing 2).

2.0 Base

The purpose of the base is to channel and contain all runoff, thereby providing protection for the surrounding land, subsurface soil and groundwater.

The base and berm must be impervious to provide this protection. Either a clay foundation or a synthetic liner shall be used to meet this objective. The availability and cost of clay will help determine which system is feasible. If a suitable clay does not exist on the site or is not within an economically feasible hauling distance (Drawing 4) a Very Low Density Polyethylene Liner should be installed. Liner specifications and construction instructions may be found on Drawings 5 and 6.

In the cross section A-A (Drawing 3), another alternative is that the top of the berms be rounded rather than flat in order to ensure containment of moisture and liquid from containers stacked along the fence.

3.0 Precipitation/Evaporation

As was explained earlier, excess moisture has been identified as a problem in some areas of the province. Two options have been identified: a roofed structure that directs precipitation away from the site, or shallow evaporation ponds within the site.

The configuration of the structure and choice of building material may vary, but shall generally meet the column, truss, bracing and roof sheathing guidelines as listed on Drawings 9-12. The structure should also meet the Canadian and Alberta Building Codes.

Configurations of the structure may resemble pole barns, hay storage sheds, machinery storage sheds, or other similar structures. The dimensions of the structure will vary according to site location, storage requirements and potential utilization.

Evaporation ponds, the other option to deal with excess rainfall, are constructed as an integral part of the site. Specifications for these are found in Drawing 2-3, but in general they should be shallow and large enough in area to expedite evaporation. The operational and maintenance requirements for the site should be kept in mind when designing and constructing the evaporation ponds. Portable fencing (i.e. corral panels) could be placed around the evaporation ponds to prevent containers from entering this area, as well as for safety considerations.

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4.0 Containment Structures

The purpose of the containment structure is to keep the containers within the site boundary and to aid in the organization of the containers. Whether a chain-link fence or a shelter is constructed, the integrity of the clay foundation or synthetic liner shall not be compromised by perforation by columns or posts.

4.1 Chain-Link Fence

The chain-link fence shall meet the design and installation specifications as stated on Drawing 8. At least one 5m double swing gate must be installed. If the 'drive-thru' option is selected, two 5m double swing gates must be installed. If restrictions on vehicular access is desired, then a 1 m pedestrian gate could be installed. Barbed wire overhang (optional) should be directed inwards.

4.2 Shelter

The choice of wall sheathing will depend upon local needs. Galvanized metal sheathing is identified in Drawing 9, but could be replaced with suitable alternatives such as 10mm plywood or chain-link fence. A minimum of one enclosed wall should be erected on the windward side of the structure. If more than one wall is enclosed, ensure suitable allowances are made for ventilation, such as a 0.5m spacing at the top and bottom of the sheathing.

Another option is to have the chain link fence form the walls and have this become an integral part of the shelter. If sufficient roof overhang is provided, all rainwater will be kept from the site.

5.0 Groundwater Monitoring Wells

Each site will be equipped with a groundwater monitoring system which will consist of one well hydraulically upgradient and another downgradient of the site. One downgradient well will suffice in an area where information from existing monitoring wells has established ambient shallow groundwater chemistry. No monitoring system is required for sites underlain by clay materials and where the water table depth is greater than 10m below ground surface.

Construction and installation specifications for monitoring wells are contained in Drawing 7.

. . . . 7

6.0 Material and Service Contacts

6.1 Liners

Look in local Yellow Pages under Plastic Products.

The optimum liner is a custom sized one-piece Very Low Density polyethylene liners which can be folded, shipped directly to the site and installed by local labor. No complicated seaming is required as with High Density polyethylene or other products. PVC liners are not recommended because they are not sufficiently chemical resistant.

6.2 Chain-Link Fences

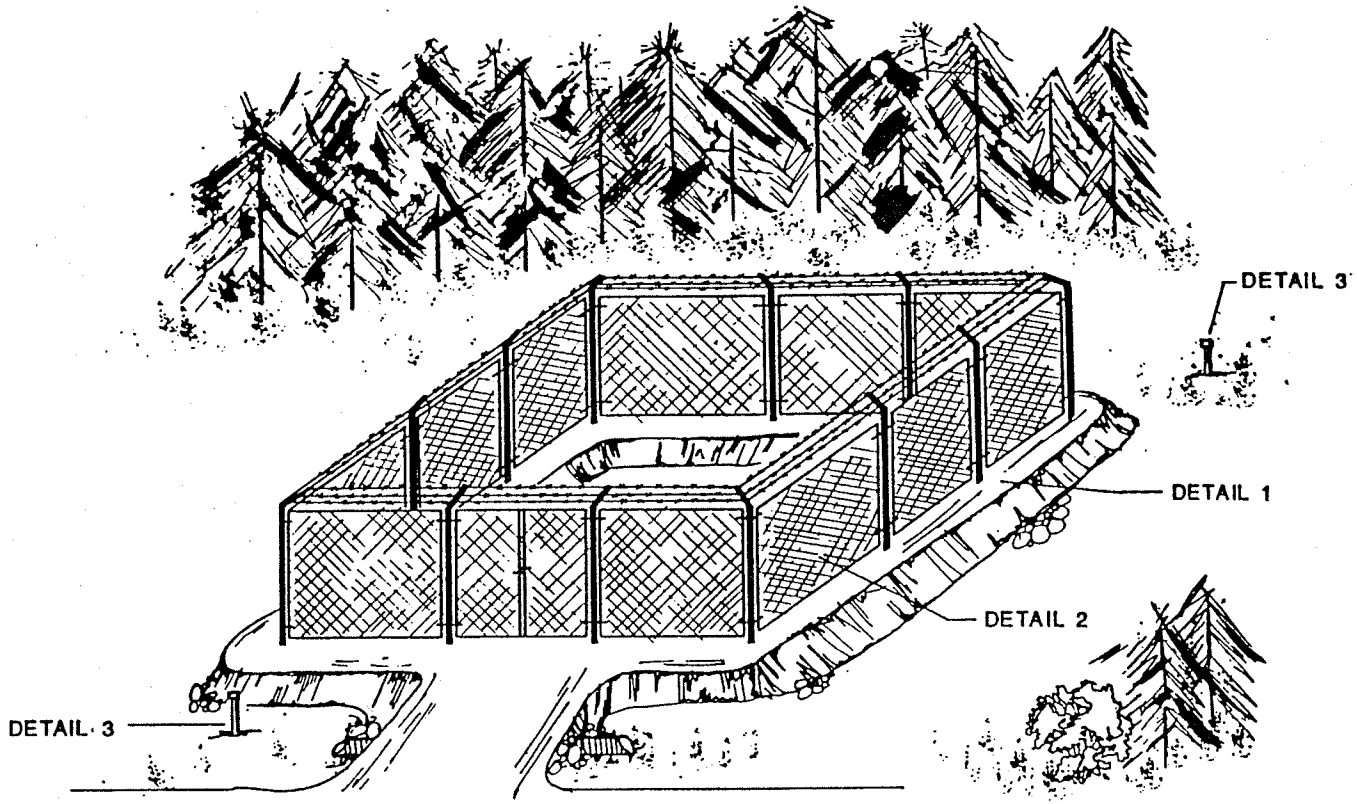
Many manufacturers and suppliers throughout the province. Look in local Yellow Pages under Fences.

6.3 Shelters

Contact local farm building supply outlets. Look in local Yellow Pages under Building.

6.4 Groundwater Monitoring Wells

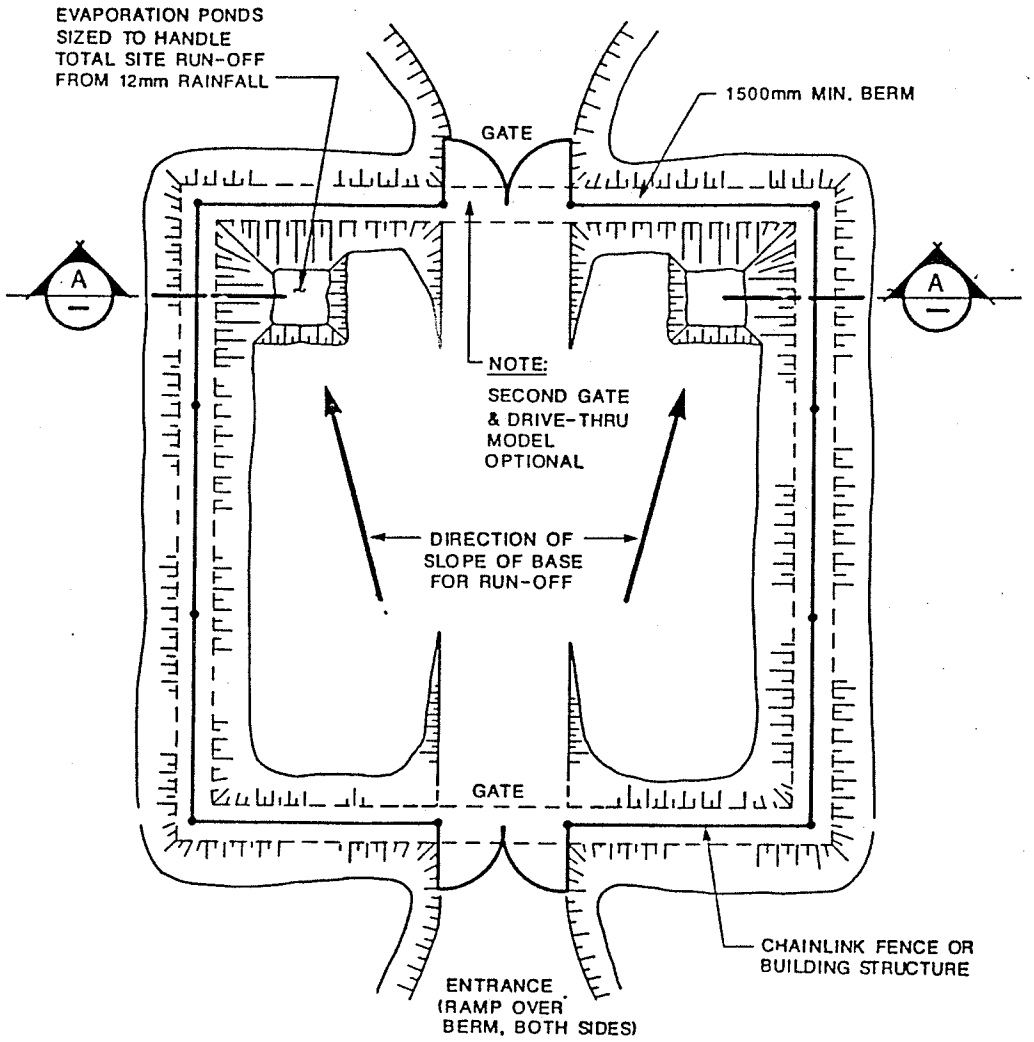
Numerous contractors throughout the province. Look in local Yellow Pages under Drilling Contractors. As pesticide container collection sites are usually underlain with clay, an auger rig would be suitable in most cases.



Drawing 1

FENCED PESTICIDE CONTAINER COLLECTION SITE-TYPICAL

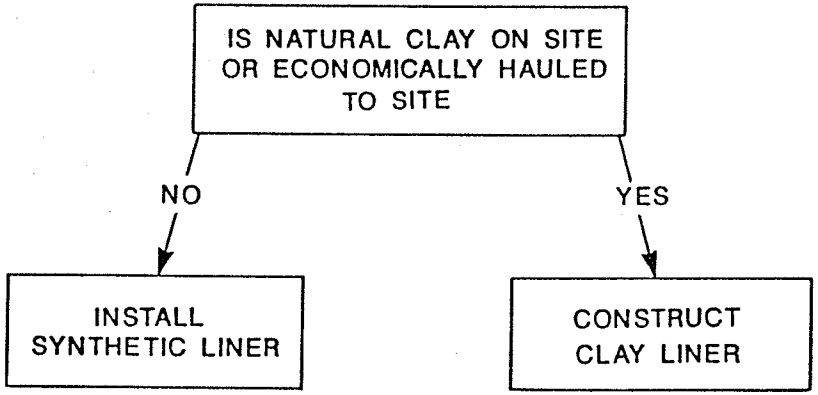
N.T.S.



FOUNDATION – BERM AND LINERS

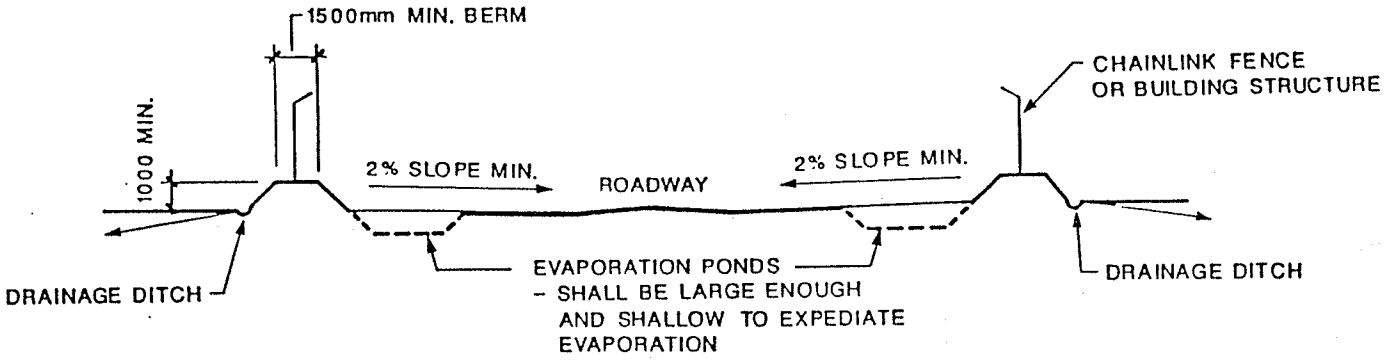
N.T.S.

Drawing 2



DECISION MATRIX REGARDING LINER

Drawing 4



NOTE:

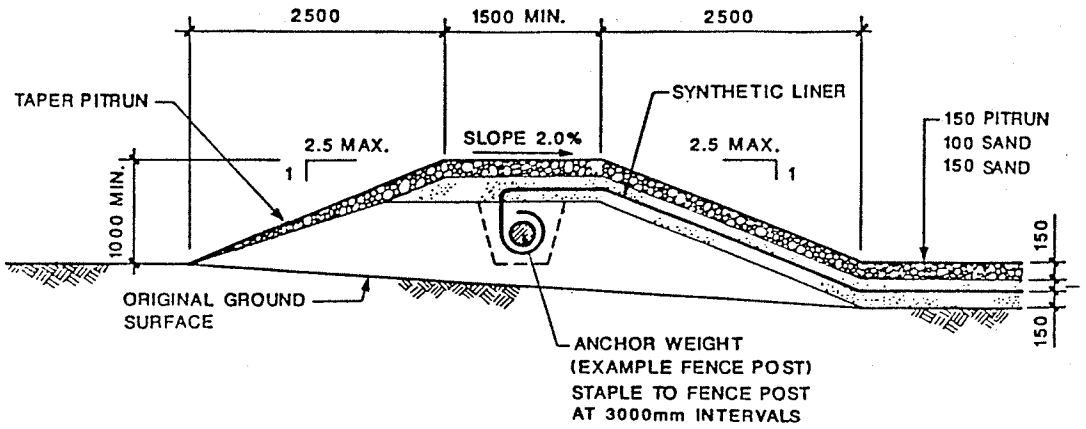
EVAPORATION POND TO HAVE 500mm MIN. COMPACTED CLAY OR SYNTHETIC LINER SAME AS BASE OF STORAGE AREA
NOT REQUIRED IF SITE IS COVERED

TYPICAL CROSS-SECTION

SECTION A-A

N.T.S.

Drawing 3



BERM AND SYNTHETIC LINER

1 : 500

Drawing 5

NOTES:

1. ENTIRE SITE STRIPPED OF TOPSOIL PRIOR TO CONSTRUCTION AND SURFACE PREPARED (SCARIFY AND COMPACT)

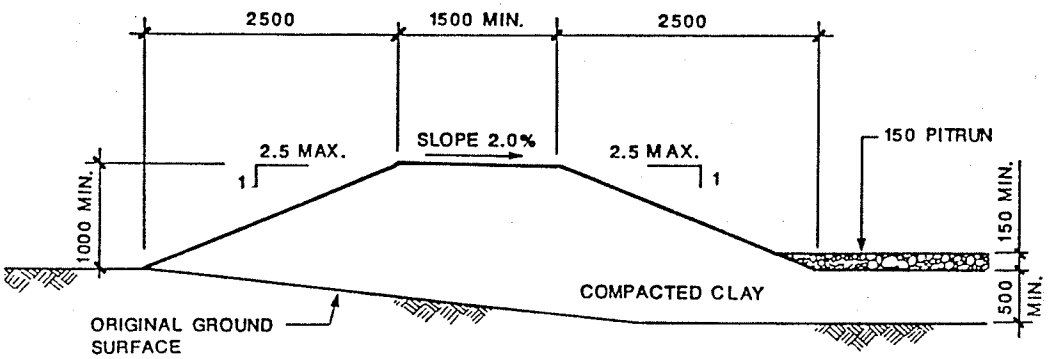
2. LINER SPECIFICATION
   - VERY LOW DENSITY POLYETHYLENE OR EQUIVALENT
   - 30 mil MINIMUM THICKNESS
   - INSTALLED AND TESTED AS PER MANUFACTURER'S SPECIFICATIONS

3. CONSTRUCTION:
   - CONSTRUCT BASIC BERM: SHAPE AND COMPACT TO 95% STANDARD PROCTOR (MINIMUM COMPACTION)
   - PLACE 150mm SAND AND COMPACT
   - LAY LINER,KEY IN AND WEIGHT LINER IN TRENCH
   - BACKFILL TRENCH AND COVER LINER WITH SAND (100mm)
   - COVER WITH 150 mm PITRUN

4. PITRUN SPECIFICATION
   - 25mm MAXIMUM SIZE
   - COMPACTED TO 95% - 98% STANDARD PROCTOR (MODERATE COMPACTION)

5. SAND SPECIFICATION - TO BE CLEAN AND FREE OF DEBRIS AND ROCKS

6. IF GRASS IS TO BE PLANTED, PLACE 150 mm TOPSOIL ON TOP



BERM AND CLAY LINER

1: 500

NOTES:

1. ENTIRE SITE STRIPPED OF TOPSOIL PRIOR TO CONSTRUCTION & SURFACE PREPARED (SCARIFY AND COMPACT)

2. CLAY SPECIFICATION
   - PLASTIC CLAY
   - HYDRAULIC CONDUCTIVITY = 1.0×10^{-7} cm/s OR LESS
   - COMPACTED TO 98% STANDARD PROCTOR
   - PLACED IN MAXIMUM 150 mm LIFTS

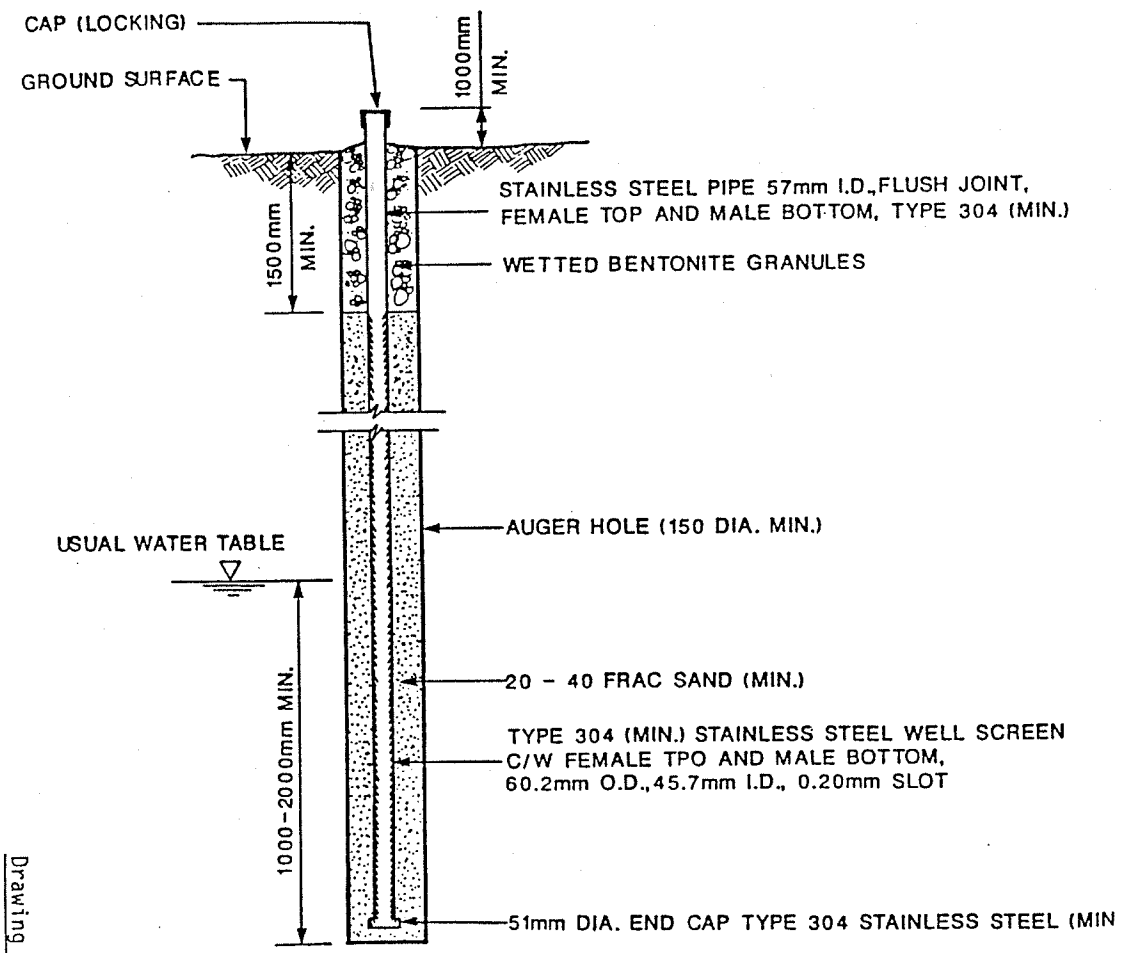
3. PITRUN SPECIFICATION
   - 25mm MAXIMUM SIZE
   - COMPACTED TO 95 - 98% STANDARD PROCTOR (MODERATE COMPACTION)

4. IF GRASS IS TO BE PLANTED, PLACE 150 mm TOPSOIL ON TOP

5. IF CONTAINER SITE IS COVERED, THEN ONLY 50 mm MIN. PITRUN

6. IF SITE HAS NATURAL CLAY, BASE OF STORAGE AREA AND BERM TO BE ON UNDISTURBED MATERIAL, BERM TO BE CONSTRUCTED OUT OF NATIVE MATERIAL AND COMPACTED TO 98% OF S.P.D. (MODERATE COMPACTION)

Drawing 6



Drawing 7

GROUNDWATER MONITORING WELLS

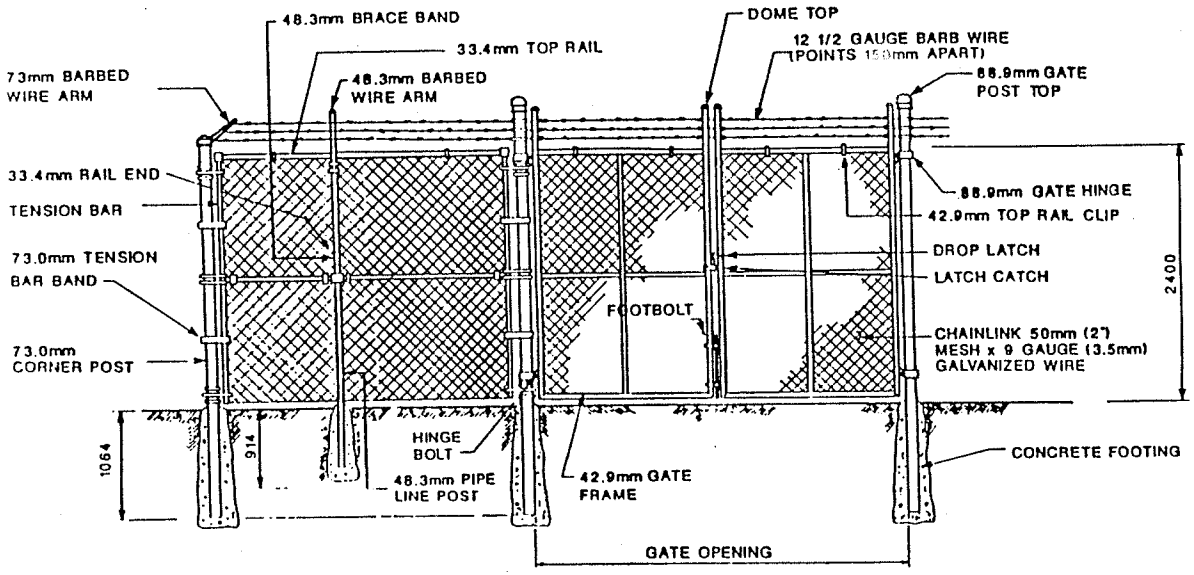
N.T.S.

CONSTRUCTION DETAILS :

1. MONITOR PIPE AND SCREEN TO BE STEAM CLEANED AND RINSED WITH ACETONE PRIOR TO INSTALLATION
2. TEFLON OR SILICON BASED LUBRICANT ONLY TO BE USED. LEAD BASED THREAD LUBRICANTS MAY NOT BE USED
3. DRILLING EQUIPMENT TO BE THOROUGHLY STEAM CLEANED PRIOR TO AND AFTER COMPLETION OF EACH BOREHOLE

NOTES :

1. QUANTITY REQUIRED - 2 (TWO)
2. SITE LOCATION
   - 1 (ONE) WELL HYDRAULICALLY UPGRADIENT OF THE SITE
   - 1 (ONE) WELL HYDRAULICALLY DOWNGRADIENT OF THE SITE
3. DEPTH OF WELL DEPENDENT UPON SOIL TYPE AND WATER TABLE LOCATION



CHAINLINK FENCE DETAIL

Drawing 8

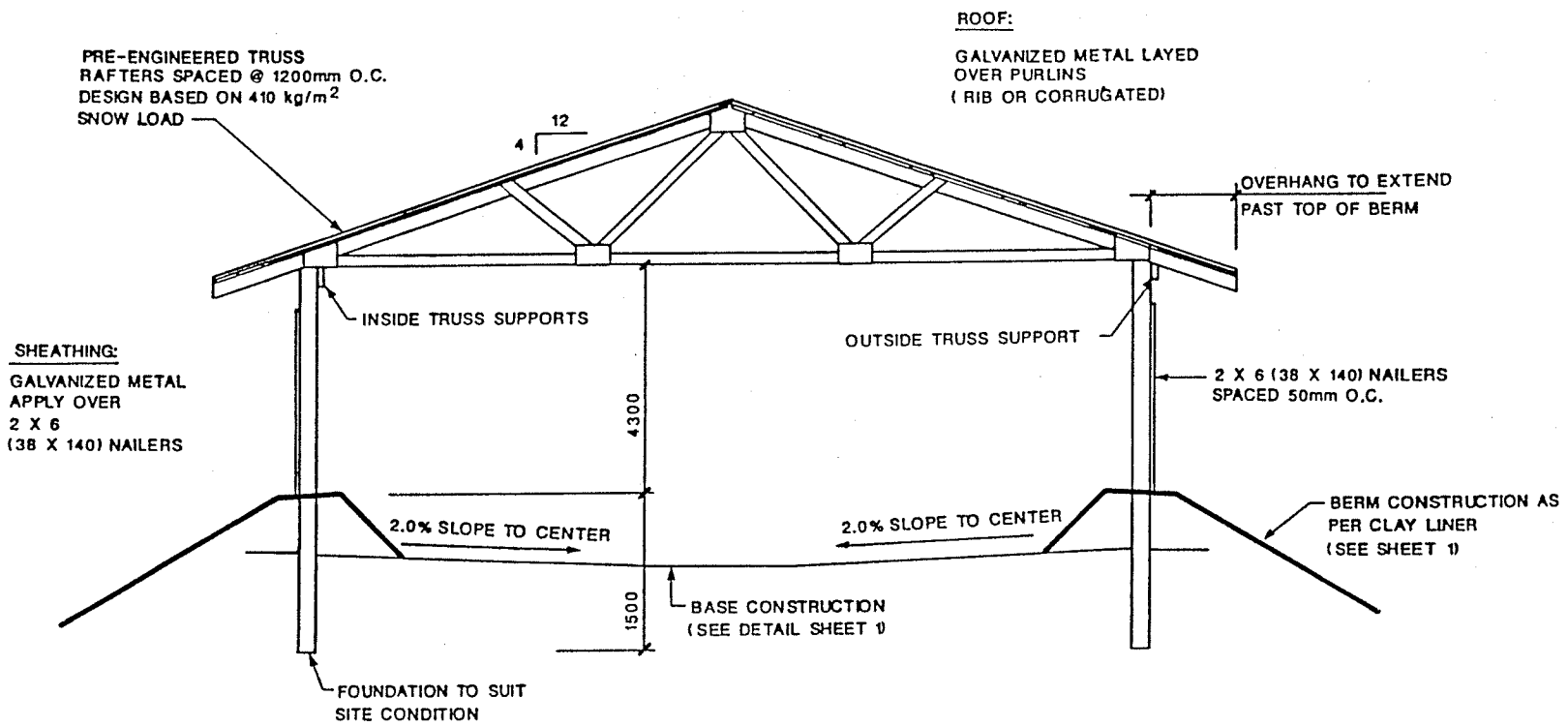
MINIMUM SPECIFICATIONS - CONSTRUCTION (NO. 3 - MEDIUM)

HEIGHT:	2.4 m (8') OVERALL FABRIC HEIGHT PLUS BARBED WIRE OVERHANG (OPTIONAL)
FABRIC:	CHAINLINK 50 mm (2") MESH x 9 GAUGE (3.5 mm) GALVANIZED WIRE TO ASTM - A392-81-CLASS 1
LINE POSTS:	48.3 mm O.D. (1 7/8") GALVANIZED PIPE COMPLETE WITH POST TOPS (BARB WIRE OVERHANG ARM OPTIONAL - 3 STRAND CAPACITY)
TOP RAIL:	33.4 mm O.D. (1 3/8") GALVANIZED PIPE COUPLED WITH SLIP ON RAIL SLEEVES FOR EVERY STANDARD LENGTH
CORNER POSTS:	73.0 mm O.D. (2 7/8") GALVANIZED PIPE
GATE POSTS:	88.9 mm O.D. (3 1/4") GALVANIZED PIPE
GATE:	5 m DOUBLE SWING GATE FRAMES-42.9 O.D. (1 11/16") GALVANIZED PIPE WELDED CONSTRUCTION TO MATCH FENCE. COMPLETE WITH ALL NECESSARY HARDWARE SUCH AS HOLDBACKS, LOCKING DEVICE AND HINGES.
FITTINGS:	ALL FITTINGS ARE TO BE MADE OF FIRST GRADE MATERIAL. TIE WIRE TO BE 9 GAUGE ALUMINUM
BOTTOM WIRE TENSION:	9 GAUGE (3.5 mm) GALVANIZED STEEL
BARBED WIRE:	OPTIONAL 12 1/2 GAUGE (2.49 mm) DOUBLE STRAND, 4 POINT BARBS, 150mm SPACING, GALVANIZED.
POST SPACING:	LINE POSTS MAX. 3.0 m (10')
CONCRETE FOOTING:	175 MPa STRENGTH AT 28 DAYS (SULPHATE RESISTANT CEMENT TYPE 50 IS OPTIONAL)

MINIMUM DEPTH AND DIAMETER OF POST HOLES IN NORMAL SOIL

	DIAMETER	DEPTH
CORNER POSTS	300 mm (12")	1064 mm (3' - 6")
LINE POSTS	250 mm (10")	914 mm (3' - 0")

INSTALLATION - TO BE IN ACCORDANCE WITH CAN2 - 138.3 M80

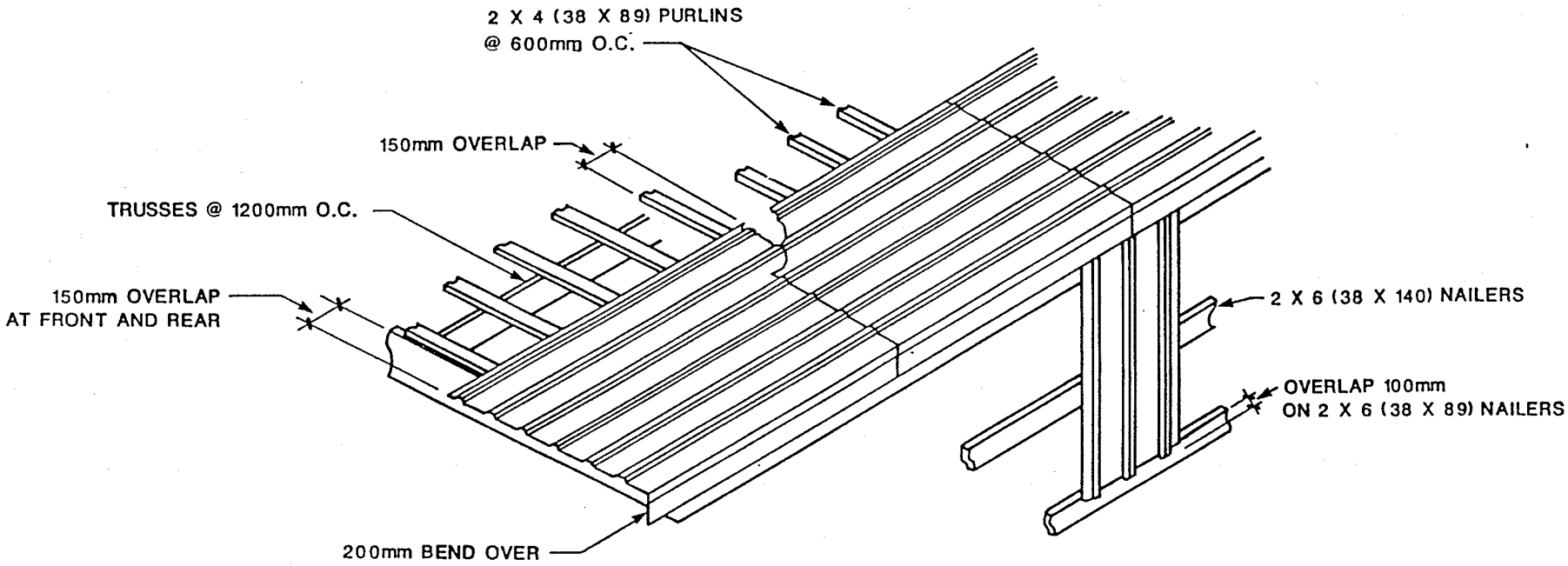


COLUMNS:	150mm MINIMUM TOP DIAMETER
COLUMN SPACING:	3700mm MAXIMUM
EAVE HEIGHT:	4300mm MAXIMUM
TRUSSES:	1200mm O.C. MAXIMUM SPAN - 12m

STRUCTURAL FRAME DETAIL

N.T.S.

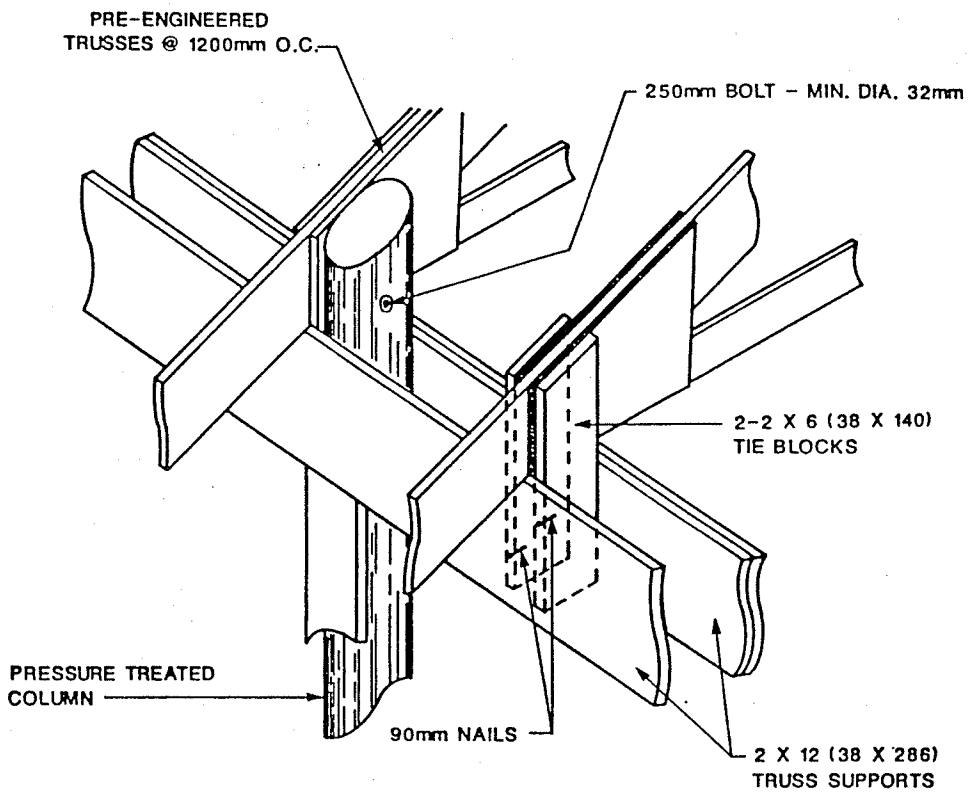
Drawing 9



STEEL SHEETING DETAIL

N.T.S.

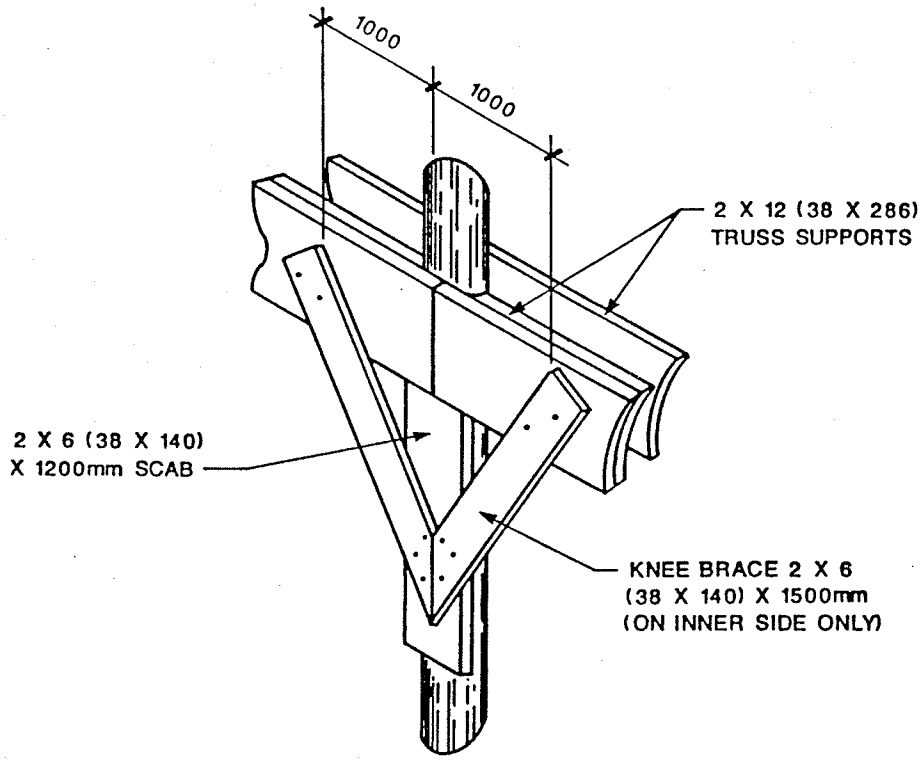
Drawing 10



Drawing 11

TRUSS ATTACHMENT DETAIL

N.T.S.



BRACING DETAIL

N.T.S.

Drawing 12