



**FIRST-TIER ASSESSMENT OF THE RISKS ASSOCIATED WITH
PESTICIDES USED IN GOULBURN-MURRAY IRRIGATION AREAS**

by

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September 2003

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2003

Citation

Kookana, R S, Barnes, M B, Correll, R L and Kibria, G. (2003). First-Tier Assessment of the Risks Associated with Pesticides Used in Goulburn-Murray Irrigation Areas - A Pesticide Risk Reduction Program for G-MW Channels. Report prepared under a research collaboration agreement between G-MW & CSIRO. *Goulburn-Murray Rural Water Authority (G-MW), Tatura and CSIRO, Adelaide.*

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Acknowledgments

The authors acknowledge the help and cooperation received from following :

G-MW: Ross Gledhill (Shepparton), David Hellsten (Pyramid-Hill), Tony Caia, Gary Whyte (Central Goulburn), Glen Stanmore, Ian Hetherington (Torrumbarry), Geoff Enever (Rochester), Glen Robertson (Murray Valley), Irrigation Services (Tatura, Kerang), Asset Services (Tatura), Kevin Krake (Baker Petrolite) and Peter Butcher, Mark Finlay, Dr Anne Graesser, Kevin Linton, Greg Smith, Jeff Parry (EMPA2 Reference Team Members)

CSIRO: Danni Oliver, Anne Boutros

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1. EXECUTIVE SUMMARY

The Commonwealth Scientific Industrial & Research Organisation (CSIRO) was engaged by Goulburn Murray Rural Water Authority (G-MW) to make a **first-tier assessment** of the potential risks associated with pesticides used in G-MW Irrigation Areas to water quality and through water quality changes to humans, stock, aquaculture, food industries, pastures, and aquatic flora and fauna and aquatic ecosystems. Twenty four different scenarios for potential pesticide impacts were identified by G-MW. The assessment for these was made by the authors using intellectual property and tools available in CSIRO, G-MW's pesticide survey data and raw data collected by G-MW Project Supervisor and field staff.

The 24 scenarios considered in this risk assessment study represent different combinations of locations, land use, exposure pathways and receiving environment for water from channels in the six irrigation areas of the G-MW (Pyramid-Boort, Rochester-Campaspe, Torrumbarry, Murray Valley, Shepparton and Central Goulburn).

This report provides the first-tier assessment for a range of scenarios based on the available pesticide use data in six irrigation areas of G-MW. The validity of the results is dependent on the quality of input data and the assumptions made in the assessments. These assumptions have been discussed in the report, where appropriate. A number of recommendations (see page 57) both for management practice and for future research have also been made.

The study is based on the basic principles of risk assessment, taking into account the hazard (toxicity) associated with a given pesticide and the pathways through which the receptor organisms is likely to be exposed to the hazard. The receptors were placed in four major groups as follows:-

<i>Receptor group</i>	<i>Hazard/Toxicity Indices used</i>
<i>Mammals (humans & animals)</i>	LD ₅₀ (Lethal dose for 50% mortality) for rats
<i>Aquaculture (fish)</i>	LC ₅₀ (Lethal concentration for 50% mortality) for rainbow trout
<i>Aquatic ecosystem (macro-invertebrates)</i>	LC ₅₀ for Daphnia and EC ₅₀ for Algae
<i>Pastures</i>	Phytotoxicity pasture crops (rye grass, clover)

Refer to Table 4-2 on page 13 for an explanation of LD₅₀ and LC₅₀.
The results based on these toxicity indices are presented in Tables 4-22, 4-23.

The exposure pathways assessed were: (i) **drift** during application, (ii) **drainage discharge** [including runoff, erosion or drift and pumped discharge following heavy rain], (iii) accidental **spills**, and (iv) **unlawful acts** such as washing of spraying equipment in supply channels.

The **methodologies** used in various assessments were designed specifically to include important factors governing risks via drift and accidental spills. The risk from spray drift, spills and unlawful acts was assumed (amongst other factors) to be directly proportional to the toxic load of the pesticide. The toxic load was calculated from the amount of the pesticide used multiplied by the fraction of the active ingredient multiplied by the toxicity index. Consideration was also given to the formulation,

i.e. whether the pesticide was applied as a liquid or a solid, and the application method. For calculating the risk of pesticide **discharge into drainage** water via runoff, erosion or drift, an existing risk assessment index, named **Pesticide Impact Rating Index (PIRI)**, designed by CSIRO for this purpose was used. However, a **new methodology** was developed for calculating **the pesticide risk from drift, spills and unlawful acts**.

Input data on pesticide use in various land uses in different districts, the volume of pesticide used, method application, soil properties, crop irrigation requirement were supplied by Goulburn-Murray Water (G-MW). The toxicity data were obtained from various sources, largely from published literature, compiled in PIRI database. Some algal toxicity data on pesticides were also compiled by one of the authors (G Kibria). The long-term climatic data were taken from the Bureau of Meteorology.

Results for (i) **drift** during application, (iii) accidental **spills**, and (iv) **unlawful acts** are essentially summarised in Table 5-22 which shows the **combined risk for each receptor and across receptors**. The **top 10 pesticides** found to pose the highest overall risk from these sources are also listed below starting with the pesticide with the highest risk.

azinphos-methyl
copper hydroxide
parathion methyl
chlorpyrifos
omethoate
esfenvalerate
methomyl
thiram
bifenthrin
mancozeb

These pesticides are primarily used in **fruit and vegetable** production in G-MW Irrigation Areas, located mainly in the Shepparton, Central Gouburn and Murray Valley Irrigation Areas (given in the report as Goulburn-Murray Valley or GMV). The only other high risk insecticide, omethoate, is used in pastures, which is a much more wide spread landuse in various districts.

In terms of relative risk among pesticides, azinphos-methyl poses 20 times more risk than the next on the list, copper hydroxide, according to our calculations. Similarly, azinphos-methyl poses 40 times more risk than parathion methyl and 100 times more risk than omethoate.

Further work is required to take into account the persistence of the pesticides. For example, copper is persistent, and over time this may accumulate in the system and thus increase its relative risk compared to a pesticide with a shorter half-life.

The relative risk of off-site migration of pesticides via **run-off** from irrigated area was also assessed. Please note that it was **not included in the combined risk**, as the run-off does not normally reach the irrigation channels, especially because the irrigation channels are almost universally at a higher elevation than surrounding land. However, at certain locations, not provided with a G-MW drainage service, irrigation customers are sometimes permitted to pump flood waters that accumulate following heavy rain into adjacent irrigation channels. The locations and the types of irrigated cultures where this occurs are precisely known.

The relative risk to pastures (potential crop damage) from pesticides is also reported. Generally, risk to pastures was found to be low, partly due to the dilution effect that is expected to occur in the irrigation channels.

A summary of major findings and major recommendations are given below.

MAJOR FINDINGS

I : Pesticides rated to be high risk to mammals (humans, stock, domestic use and food) via drift, drainage discharge, spills and unlawful acts

- *Drift* : Aziphos-methyl, parathion methyl and omethoate were found to be associated with the highest risk of drifting into waterways and potentially affecting mammals. These three pesticides fall under the 'very high' risk category. The other pesticides that are considerable of relatively high risk are methomyl, ziram, copper hydroxides, thiodicarb, mancozeb, and thiram. The pesticides that are of high risk categories to mammals are used mostly in fruit and vegetables production, in particular in the Goulburn-Murray Valley Areas (Central Goulburn, Shepparton, Murray Valley Irrigation Areas).
- *Drainage discharge*: Pesticides that have high risk of off site migration through drainage water include omethoate, pirimicarb, paraquat, endosulfan, pendimethalin, phosmet, phorate, methomyl, molinate, and thiobencarb. These pesticides are used in various farming practices. While these pesticides may have potential of mobility with drainage water via runoff risking mammals and stock, there is minimal chance that such pesticides may contaminate G-MW channels as all channels are usually at higher elevation than surrounding land and most drainage occurs into natural carriers.
- *Spills*: Four pesticides have the highest risk of spilling into waterways and affecting mammals, these include azinophos-methyl, parathion-methyl, omethoate, methomyl. These pesticides have high mammalian toxicity were used mostly in fruit and vegetable production in particular in the Goulburn Murray Valley Areas
- *Unlawful acts*: Aziphos-methyl, parathion-methyl and phorate have the highest risk via unlawful acts of getting into waterways and affecting mammals. They were used more in fruit and vegetable production mainly in the Goulburn-Murray Valley areas

II : Pesticides rated to be high risk to Aquaculture via drift, spills, and unlawful acts

- *Drift*: Organophosphate pesticides (chlorpyrifos, azinophos-methyl), pyrethroids (esfenvalerate, bifenthrin, taufluvinate) and fungicides (copper hydroxide) were assessed to be of high risk via drift to aquaculture throughout the G-MW Irrigation Areas
- *Spills*: Of the large number of pesticides assessed for risk to aquaculture via spill, organophosphate pesticides (chlorpyrifos, azinophos-methyl), pyrethroids (esfenvalerate, bifenthrin, taufluvinate) and fungicides (copper hydroxide) were rated to be of high risk to aquaculture throughout the G-MW Irrigation Areas. Majority of these pesticides were used in fruits, viticulture and vegetables growing areas
- *Unlawful acts*: Pesticides with the highest risk getting into waterways and affecting aquaculture via unlawful acts were chlorpyrifos, azinophos-methyl, bifenthrin, copper hydroxide, esfenvalerate, trifluralin, and endosulfan. These pesticides were used throughout the G-MW Irrigation Areas in fruit, vegetable, crops, pastures, viticulture.

III : Pesticides rated to be of high risk to Aquatic Ecosystem (Environment) via drift, spills and unlawful acts

- *Drift*: Metiram, chlorothalonil, atrazine, and diquat were rated to be highest risk scoring's of drifting into waterways and affecting the aquatic ecosystem (algae). These pesticides were used in fruit, vegetable, cereals, pasture and lucerne and viticulture production throughout the G-MW Irrigation Areas. Pesticides which have the highest risk of drifting and affecting aquatic ecosystem (*Daphnia* or Crustaceans) were azinphos-methyl, copper hydroxide, chlorpyrifos and parathion methyl and are often used in fruit, vegetable or viticulture production
- *Spills*: Diquat was assessed to be of very high risk via spills and affecting aquatic environment (algae), whereas azinphos-methyl, parathion-methyl and omethoate have the potential of very high risk to aquatic environment (*Daphnia*). Diquat is used in irrigated pasture, e.g. lucerne, whereas azinphos-methyl, parathion-methyl are used in stone & pome fruit production. Diquat was not identified in high risk categories for any other receptors via drift or spills or unlawful acts
- *Unlawful acts*: Atrazine, chlorothalonil and metiram appear to have the highest risk via unlawful acts affecting aquatic ecosystem (algae), whereas azinphos-methyl, copper hydroxide and chlorpyrifos were rated to be highest risk to aquatic ecosystem (*Daphnia*).

IV : Pesticides rated to be of high risk to Pastures via drift, spills and unlawful acts

- *Drift & drainage discharge*: A total of 15 herbicides were assessed to have medium to higher risk to pastures, of which molinate and glufosinate ammonium salt were rated to have some potential risk (medium) to pastures. It should be mentioned here that current assessment with sulfonyleureas herbicides have resulted to suggest low risk to pastures, this may be due to current low use in the Irrigation Areas, however, the risk may be higher if these herbicides are used more intensively or their use increases.

V : Combined pesticide risk calculated across drift, spills and unlawful acts

- The combined risk assessment of different receptors (humans, aquaculture, aquatic ecosystems) showed that 83% of pesticides rated to have 'very high risk' were used in fruits and vegetables production. The pesticides rated to have 'very high' risks were azinphos-methyl, copper hydroxides, parathion-methyl, and chlorpyrifos. The pesticides rated to 'high risk' were omethoate, esfenvalerate, methomyl, thiram, bifenthrin and mancozeb.

MAJOR RECOMMENDATIONS

Recommendations relevant to Mammals (humans, stock, domestic use and food processing)

- The current study found that pesticides such as organophosphates (azinphos-methyl, parathion-methyl, omethoate and phorate) and carbamates (methomyl) are of high risks to mammals. These pesticides are used mainly in fruits and vegetables production and should be monitored downstream of channels where fruit and vegetable are intensively grown. G-MW authority should encourage best management practices to reduce spray drift and accidental spills of pesticides, in cooperation with Government departments such as Department of Primary Industry (DPI) and Department of Sustainability & Environment (DSE).

Recommendations relevant to Aquaculture

- It is suggested that G-MW should identify key areas used for aquaculture and the dominant landuse in proximity to those areas. Furthermore, aquaculture establishments should be monitored for high risk pesticides such as organophosphate (chlorpyrifos, azinphos-methyl), organochlorine (endosulfan), pyrethroid (esfenvalerate, bifenthrin), fungicide (copper hydroxides), and herbicide (trifluralin) . A higher tier risk assessment is needed for which the risk from these pesticides to aquaculture species needs to be measured in a simulated laboratory based experiment for its acute and chronic toxicity.

Recommendations relevant to Aquatic Ecosystem (Environment)

- Aquatic ecosystems receiving channel outfalls should be monitored for organophosphates (azinphos-methyl, chlorpyrifos), fungicides (copper hydroxide, metiram). Majority of these pesticides is used in fruit and vegetable production.

Recommendations relevant to Pastures and horticultural crops

- Herbicides such as molinate and glufosinate ammonium and sulfonylureas herbicides (depending on their use) should be monitored in channels supplying water to leguminous pastures (e.g. lucerne, medics) and other sensitive crops (such as canola, chickpeas, fababeans). For high value crops such as tomatoes, viticulture and other horticultural crops, a more detailed risk assessment needs to be made for herbicides used on these crops.

Recommendations relevant to combined risk (drift, spills, unlawful acts)

- The current combined risk assessment did not include drainage discharge pathways with the understanding that G-MW irrigation channels are at higher elevation than the surrounding irrigated areas and therefore there is likely little possibility of the irrigation drainage water affecting plants and other receptors via contaminated irrigation run-off. However, it is suggested that in the future risk assessment (2nd tier), this may be carefully considered as discharge into natural waterways may affect water quality and aquatic species living in natural carriers/drains.

General recommendations

- G-MW should give considerations to an audit of pesticides used patterns across the different farming sectors in the six irrigation areas. It is suggested that collection of pesticides use data should continue, with special emphasis on the Torrumbarry (Kerang) and Pyramid-Boort (Boort) where agriculture is expanding (eg. onion in Kerang and olives and tomatoes in Boort)
- Persistent pesticides (those pesticides with a long half-life) which show bioaccumulation and biomagnification potential and food chain effects should be considered in future 2nd tier assessments
- Where possible, monitoring should be carried out to assess the realistic risks to mammals, aquaculture, aquatic ecosystem. To reduce cost and increase efficiency initial focus may be placed on a number of 'high risk' pesticides identified in fruit and vegetable production. It is recommended that the pesticide residue be monitored in the vicinity or upstream of aquaculture establishments and down stream of intensive fruit and vegetable production areas.

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RECOMMENDATIONS

Recommendation 1. That Goulburn-Murray Water consider an audit of pesticides use patterns across the different farming sectors in the six Irrigation Areas.	58
Recommendation 2. Persistence of pesticides should be considered in future 2 nd tier risk assessments.	58
Recommendation 3. Cumulative risks of persistent pesticides need further investigation.	58
Recommendation 4. The collection of pesticide use data should continue, with emphasis on usage by new crops (including onion seed and olives).	59
Recommendation 5. The pesticides listed in Table 6-1 be monitored to validate the findings of the current 1 st tier risk assessment.	59
Recommendation 6. Pesticide monitoring should be concentrated where fruit and vegetable are grown.	60
Recommendation 7. A 2 nd tier risk assessment be carried out for fruit and vegetable landuses.	60
Recommendation 8. Pesticide information for citrus and onion seed, and on tomatoes in the Pyramid-Boort irrigation area be obtained.	60
Recommendation 9. The G-MW water authority encourage best-practice to reduce spray drift and accidental spills.	60
Recommendation 10. Identify key areas used for aquaculture and the dominant landuse in proximity to those areas.	61
Recommendation 11. Aquaculture establishments should be monitored for those pesticides identified as posing a high risk (as define in Table 6-2).	61
Recommendation 12. If pesticide is detected in an aquaculture establishment, a 2 nd tier risk assessment that includes chronic effects should be undertaken.	61
Recommendation 13. Aquatic ecosystems should be monitored for those pesticides identified as posing a high risk (those shaded red in Table 6-1).	62
Recommendation 14. Where possible, monitoring should be combined to assess the risks to mammals and aquaculture, to reduce cost and increase efficiency.	63
Recommendation 15. Pesticide risks to pasture are generally low and should be given a relatively low priority.	63
Recommendation 16. Sufonylureas herbicide use should be carefully assessed, especially upstream or in proximity of leguminous pastures.	63
Recommendation 17. For high value crops such as tomatoes, viticulture and other horticultural crops, separate risk assessment needs to be made for herbicides used on these crops.	63
Recommendation 18. Data should be obtained on the fate of the Drainage Discharge (run-off). If adequate data are not available, a study should be commissioned to obtain those data.	64
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3. Background and scope of the report

Goulburn-Murray Water (G-MW) suspected that water supply channels can potentially be contaminated with pesticides and may become unfit for human consumption, stock drinking, irrigation, food processing and aquaculture as well as could have an impact on aquatic biota living in natural waterways. Because of expected risks, CSIRO was engaged by the Goulburn Murray Rural Water Authority (G-MW) to make a first-tier assessment of the risks associated with pesticide contamination of irrigation channel water used in G-MW's Irrigation Areas by humans, stock, aquaculture, food industries, pastures, and aquatic flora and fauna and aquatic ecosystems. The assessment was made for 24 different scenarios that were identified by G-MW, using intellectual property and tools available in CSIRO and utilising G-MW raw and confidential data and information.

The 24 different scenarios considered in this risk assessment study represented different combinations of locations, landuse, exposure pathways and receiving environment for water from channels in all six G-MW Irrigation Areas (Pyramid-Boort, Rochester-Campaspe, Torrumbarry, Murray Valley, Shepparton and Central Goulburn). The map and major townships located in these districts are provided in Appendix 1. The details of various scenarios considered are listed in Appendix 2, along with the section where each can be found.

This report provides the first-tier assessment for a range of scenarios based on the available pesticide use data in the six G-MW Irrigation Areas. The validity of the results is dependent on the quality of input data and the assumptions made in the assessments. These have been discussed in the report, where appropriate. The limitations of the study and recommendations for future action have also been included.

4. Methodology used in the project

General methods used in this study and the input data used in various assessment are covered in this section. However, some specific methods and tools used for various scenarios have been provided in separate section specific to a topic.

The study is based on the basic principles of risk assessment, taking into account the hazard (toxicity) associated with a given pesticide and the pathways through which the receptor organisms is likely to be exposed to the hazard. A prerequisite to the risk assessment process is to identify the species/asset to be protected, as the risk is largely dependent on this. Consequently, in consultation with G-MW, the first step was to identify scenarios for risk assessment, based on the receptor organisms (e.g. mammals, aquaculture, environment) and the associated sources of hazard (landuse) and exposure pathways (e.g. drift, accidental spill). In summary, various receptors were placed in four major groups (described below in Table 4-1) and the risk assessment methodologies have been described in the following section.

Please note that validation of the risk estimation is generally not directly possible. In some cases, chemical analyses can be used to assess whether a chemical is in detectable concentrations in a water

body. The likelihood of the pesticide migrating offsite in a detectable concentration is referred to as the **mobility assessment**. Note that **mobility** does not take into account the toxicity of the pesticide.

4.1 Receptors

Table 4-1. The summary of various scenarios assessed during the risk assessment

<i>Receptor group</i>	<i>Exposure / contamination pathway</i>	<i>Landuse</i>	<i>Locations</i>
Human Consumption	Accidental spill in water, Drift	Fruit, Viticulture,	Each of the six G-MW Irrigation Areas
Stock Consumption	Drainage water discharge into channels	Vegetables, Pastures and Crops	See NOTE below
Domestic use	Unlawful acts		
Food processing Industry			
Aquaculture	Drift Accidental spills	All pesticides used in G-MW	Combined assessment for whole G-MW
Aquatic ecosystem (Environment)	Drift Accidental spills	All pesticides used in G-MW	Combined assessment for whole G-MW
Pastures	Drift Drainage water Discharge into channels	Herbicides only	Combined assessment for whole G-MW

NOTE – Drift, Spills and Unlawful Acts risk assessment for mammals were across all 6 Irrigation Areas combined, not for each area.

4.1.1 Humans and animals (Mammals)

The dominant scenario was the use of G-MW water supply for human and stock consumption, domestic use and use in the food processing industry. This group of receptors was covered by taking the mammalian toxicity of pesticides into account. For this group of receptors, pesticide use in various production systems (such as irrigated pastures and crops, fruit and orchards, vegetable) in the six major irrigation areas of G-MW was assessed. The exposure pathway considered here included accidental spills, drift, illegal acts and drainage water discharge leading to contamination of the supply channels.

4.1.2 Aquaculture

Another important asset considered in risk assessment was aquaculture – represented by toxicity of pesticides to fish. While the toxicity of a pesticide varies with the species of fish, our experience indicated that there is a strong correlation between fish species. Therefore, rainbow trout (for which toxicity data for most pesticides are available) was used as an indicator of general fish toxicity in this

study. Toxicity of pesticides to the food chain of fish was covered by including waterflea (*Daphnia*) and algae. The key exposure pathway considered here was drift and accidental spill in the supply channels or the fish farms. The assessment was carried out for the combined list of all pesticides used in the G-MW.

4.1.3 Aquatic ecosystem (environment)

This study was primarily focussed on the risks to humans and animals via drinking water and water used by the food processing industry as well as aquaculture. The risks to broader environment were not the focus of this study. However, the aquatic ecosystem was covered partially by various scenarios assessed in the study. As in the case of aquaculture, fish, water flea (macro-invertebrates) and algae (base of the food chain) represented the different trophic levels of aquatic ecosystem. However, the risk to other aquatic organisms (frogs) and birds was not assessed in this study.

4.1.4 Plants (Pastures and other crops)

Risk of pesticides to pastures as receptors of irrigation supply water was assessed in terms impact of herbicides on the pasture production. This is because certain herbicides used in other production systems are not always compatible and can damage the pastures if irrigated with water contaminated with herbicides. This assessment was made for all herbicides used in the G-MW region. The risk to animals due to any contamination of pasture fodder was outside the scope of this assessment.

4.2 Input data

4.2.1 Locations and Farming practices in different irrigation areas

The six irrigation areas selected for this study were namely,

- (i) Shepparton, (ii) Central Goulburn, (iii) Murray Valley, (iv) Rochester Campaspe (R),
- (v) Pyramid-Boort (P-B) and (vi) Torrumbary (T), Trseco and Nyah.

The major farming practices in the areas and farming census data has been given in Appendix 3 and Appendix 4.

4.2.2 Pesticide use data

Pesticide use data (amounts used, application rates and the method of application) for various land use in G-MW Irrigation Areas is provided in Appendix 5. Shepparton, Central Goulburn and Murray Valley Irrigation Areas were combined for pesticide use data as Goulburn Murray Valley based on Krake, Brewel and Kibria (2001).

4.2.3 Pesticide toxicity data to mammals, fish, water flea and algae

The toxicity data for mammals were represented by LD₅₀ for rats, for fish by LC₅₀ for rainbow trout and for *Daphnia* (water flea) and for algae by EC₅₀ for various species such as *Selenastrum capricornutum* and *Scenedesmus subspicatus*, depending on the availability of the data for a given pesticide. The above-mentioned toxicities are explained in Table 4-2. These toxicities were collected from various sources and are part of the database in Pesticide Impact Ranking Index ([PIRI](#)) software. They are listed in Appendix 7.

Table 4-2 Definitions of Toxicities used by receptor group

<i>Receptor group</i>	<i>Hazard/Toxicity Indices used</i>	<i>-Explanation</i>
<i>Mammals (humans & animals)</i>	LD ₅₀ for rats	-Lethal dose where 50% of experimental rats died
<i>Aquaculture (fish)</i>	LC ₅₀ for rainbow trout	-Lethal concentration where 50% of rainbow fish died under experimental conditions
<i>Aquatic ecosystem (macro-invertebrates)</i>	LC ₅₀ for Daphnia	-Lethal concentration where 50% of Daphnia die died under experimental conditions
	and EC ₅₀ for algae	-Effective concentration where algae reduced by 50%

4.2.4 Soil types and irrigation requirements

The information on soil types in various areas was collected from Technical Bulletin No 22 of Department of Agriculture, Victoria (Skene, 1971) and other information supplied by G-MW. A summary of major soil types of the irrigation areas has been given in Appendix 6. Similarly the irrigation requirements for various crops was supplied by G-MW (Table 4-3) The long-term climatic data (rainfall, temperature) for various irrigation areas were obtained from the Bureau of Meteorology (www.bom.gov.au). The data were averages over a period of 50 years or more, depending on when the record started at a given station.

Table 4-3 Average water requirement for various cropping systems in the G-MW

<i>Crop</i>	<i>Water requirement/ Applied (ML/Ha)</i>	<i>Number of irrigations</i>	<i>Irrigation</i>	<i>period</i>
1. Perennial pastures / Lucerne	10-10.5	20 / 14	Nov. to March	
2. Annual Pastures	3.6	6	March to Nov.	
3. Wheat / Barley	2.4	4	Sept. to Nov.	
4. Maize	9	14	Nov. to Feb.	
5. Sorghum / Sunflower /Millet	7.5	12	Dec. to Feb.	
6. Rice	12.5-13		Oct-April	
7. Stone fruits	4.5-6.7		Aug. to March	
8. Pome fruits	3.95-10		Aug. to March	
9. Olives	5.0-5.5		Aug. to March	
10. Vineyard	4.5		Sep. to March	
11. Tomatoes	4.5-5 (drip)	50-80	Sep. to April	
	6-8 (furrow)	10	Sep. to April	
12. Onion	3-4 (drip)		May-Nov.	
	5-7.5 (furrow)			

Information based on : David Thomas, Dept of Agriculture & Rural Affairs Kerang; Abdi Qassim, DPI, Tatura; Martin van der Sluys Secretary, Victorian Rice Growers Association; Henry Schneider, DPI, Cobram; Michael Campi, Timbercorp, Boort; Geoff Enever, G-MW, Rochester; Lizz Mann, APTRC, Shepparton

4.3 Risk Estimation Method

4.3.1 Estimation of the risk of DRIFT

Pesticide drift can affect neighbouring non-target areas. These areas may be areas under agriculture or horticulture, where there is potential for the drift to cause significant harm. An example of this is when there is drift from herbicides to a vulnerable crop. Drift can also affect drinking water, especially via rainwater tanks, and other water bodies.

This section of the report concentrates on contamination of surface waters by the drift. This contamination has the potential of adversely affecting water quality. This in turn may cause lethal (eg. fish kills) or sub-lethal effects (eg. poor growth and reproduction) on aquatic organisms living in channels, creeks and rivers. Water contaminated with pesticide drift can be unsuitable for aquaculture.

The effect of the spray drift on aquaculture may be directly on the fish, or it may have an indirect effect via algae or invertebrates both through reduction in the food supply and through

biomagnification. Increased stress on the fish could lead to a greater vulnerability to disease and lower growth rates.

Spray drift is controlled largely by environmental conditions, and secondarily by droplet size. The the risk of spray drift cannot be accurately formulated, especially when the conditions at the time of spraying are not known. Some ranking of the risks can be made on the basis of pesticide data and on the manner in which it is applied. (See Appendix 5 for pesticide data and application method)

A **new methodology** has been developed for this project that uses available data. While precise conditions are not known, it is likely that over a period of time, some averaging of conditions will occur. Other factors like droplet size then become increasingly important. The methodology used is outlined and illustrated below.

The risk from spray drift is considered (amongst other factors) to be directly proportional to the toxic load of the pesticide. The toxic load can be considered as the product of the amount of the pesticide used multiplied by the fraction of the active ingredient multiplied by a toxicity factor. Consideration is also taken as to whether the pesticide is applied as a liquid or a solid and the application method used. For convenience each of these components is calculated as a score that is on a logarithmic scale. These scores are then added to give an overall risk score for accidental drift of pesticides. Details of the component scores are given below.

- **Amount of pesticide:** this is the total amount of pesticide that is sold by distributors. The score is the log of the number of litres or kilograms purchased. Please note that this amount is unaffected by the dilution used before application;
- The score for **active ingredient** is the log of the percentage active ingredient;
- The **toxicity score** is calculated from LD50 (mammal) or LC50 (invertebrate or fish) or EC50 (algae) expressed as mg kg⁻¹ as shown below in Table 4-4. Toxicity data used in this study were obtained from the PIRI database or from the current study. Details are shown in Appendix 7.

Table 4-4 Toxicity Scores for different species

Species	Formula
Mammal (Rat)	5 - log LD50
Rainbow Trout	2.5 - log LC50
Algae	3 - log EC50
Daphnia	1.5 - log LC50

LD50 =dose required to kill 50% of test organisms;

LC50 =concentration required to kill 50% of test organisms;

EC50= median effective concentration

Different formulas for toxicity scores were required for different species to get about the same proportion of High and Very High overall ratings.

- **Application method risk scores** were formulated using G-MW's practical experience on the relative risk component of different application types (Table 4-5). The boom spray was taken as a relative standard and given a component risk score of 1 (which is zero on a log scale). High risk applications such as air blast were given a component score of 30 (approximately 1.5 on the log10 scale), and a low risk application such as a wiper was given a very low

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

component score of 0.00001 (or –5 on the log10 scale).

The next step was to allocate an application method score to each pesticide depending on the application method(s) used. Where there were several application methods, the risk component was averaged using a weighting (shown in Table 4-5) that reflected the amount of pesticide that was applied by that method. For example, where a spray may be applied sometimes with a knapsack spray or alternatively with a boom spray, it is assumed that most of the spray would be from the boom spray. The application method scores used are shown in Table 4-6. Logarithms to the base 10 of this score were used

Table 4-5 Application Method-Drift Risk Score Components including weightings used.

<i>Application Method</i>	<i>Risk score component</i>	<i>Weighting</i>
Air Blast	30	1
Low volume Air blast	30	1
Misting machine	10	1
Boom Spray	1	1
Low volume boom spray	1	1
Dip	0.00001	1
Soil incorporation	0.00001	1
Immersion	0.00001	1
Soil applied granular form	0.00001	1
SCWIRT (Soluble chemical water injection in rice technique)	0.00001	1
CDA (Control droplet application)	0.00001	0
Wiper equipment	0.00001	0
Knapsack	0.00001	0

Note. Application methods with weighting of 0 were ignored in risk score averages. For example the 3rd application method listed in Table 4-6. Air Blast, Boom Spray, Knapsack receives drift ranking score of $15.5 = (30+1)/2$. Knapsack (0.00001) is ignored.

Table 4-6 Application Method-Drift Risk Score Used

Application Method	Drift Ranking
Air blast	30
Air blast, Boom spray	15.5
Air Blast, Boom Spray, Knapsack	15.5
Boom spray, Air Blast	15.5
Boom Spray, Knapsack, Air Blast	15.5
Low volume Air blast, Boom sprayer, Knapsack	15.5
Misting machine	10
Boom spray, Misting machine	5.5
Misting machine, Boom Sprayer	5.5
?, Boom spray, Knapsack	1
Boom spray	1
Boom spray, Knapsack sprayer	1
Boom spray, Wiper equipment, CDA (Control droplet application)	1
Low volume boom spray	1
Spray & dip	0.500005
Dip	0.00001
Immersion	0.00001
SCWIRT (soluble chemical water injection in rice technique)	0.00001
Soil applied granular form	0.00001
Soil applied granular herbicide	0.00001
Soil incorporation	0.00001

- The **total risk score** is then formed by summing the component scores namely; the quantity score, the active ingredient score, the application method score and the toxicity score. Note that this score is the log of the product of the un-logged components.
- Finally an **overall rating** of the risk score is given for each pesticide. For drift risks scores in the following ranges were designated very high, high, moderate low or very low using the classes defined in Table 4-7. Ranges were designed to get approximately 5% in High and 10% Very High overall ratings.

Table 4-7 Drift - Risk Score Rating ranges

Total Score	Overall Rating
< 5	Very Low
5 - 6	Low
6 - 9.5	Moderate
9.5 - 11	High
≥ 11	Very High

The score derived implicitly assumes that:

1. The value threatened by each pesticide is similar (a reasonable approximation to the truth);
2. The drift of each pesticide type is equally likely given the application rate – this is an approximation as it does not take into account (amongst other things) the properties of the carrier.

3. The risk components from the application method as shown in Table 4-5 are reasonable.

4.3.2 Estimation of the risk of DRAINAGE DISCHARGE (runoff)

[PIRI](#) (Pesticide Impact Rating Index) is a simple index that integrates different factors influencing the off-site migration potential of pesticides. PIRI considers site conditions (e.g. soil type, topographic conditions, water input), pesticide use patterns (type of pesticides, their application rates and frequency of application), pesticide properties (mobility and persistence) and their toxicity to receptor organisms. In the present study, fish (rainbow trout), water flea (*Daphnia*) and algae were considered in the assessment. The toxicological data for some pesticides were not available, especially for algae and therefore these assessments could not be made in some cases. Refer to Appendix 7, which shows the gaps as blanks in the toxicity table.

4.3.3 Estimation of the risk of SPILLS

Pesticide spills can threaten human health and cause significant environmental contamination. In this section we consider the risk estimation of a spill and then risk mitigation of spills.

Spills could occur in either the diluted or undiluted form. We consider that the greatest risk comes from an accidental spill of undiluted pesticide, perhaps in transport, storage or mixing. By contrast, an accident involving say a burst hose on a sprayer would soon be detected, and the amount of pesticide lost would be decreased by the dilution factor.

This section therefore concentrates on the undiluted forms of the pesticides. The remarks do apply to the diluted forms as well.

The estimation of the risk of spills cannot be formulated directly. A new methodology has been developed for this project. This is outlined and illustrated below. The methodology developed is a similar to that for estimating the risk of drift.

The risk of spills and other accidents is considered to be directly proportional to the toxic load of the pesticide. The toxic load can be considered as the product of the amount of the pesticide used multiplied by the fraction of the active ingredient multiplied by the toxicity factor. Consideration is also taken as to whether the pesticide concentrate is a powder or a liquid. For convenience each of these components is calculated as a score that is on a logarithmic scale. These scores are then added to give an overall risk score for accidental spills of pesticides. Details of the component scores are given below.

- **Amount of pesticide:** this is the total amount of pesticide that is sold by distributors. The score is the log of the number of litres or kilograms purchased. Note that this amount is unaffected by the dilution used before application;
- The score for **active ingredient** is the log of the percentage active ingredient;
- The score for the form of the active ingredient is -1 for powder or 1 for **liquid** – the rationale for this was that most of a powder (we assumed 99%) would be recoverable from a spill whereas most of a liquid would be lost – the difference between a score of -1 and $+1$ represents a 100 fold difference;
- The **toxicity score** is calculated from LD50 or LC50 expressed as mg kg^{-1} of algal, invertebrate, fish and mammalian toxicity as shown previously in Table 4-4.

- The risk **score** is then formed by summing the component scores namely; the quantity score, the active ingredient score, the liquid accident score and the toxicity score. Note that this score is in effect the log of the product of the un-logged components.
- Finally an **overall rating** of the risk score is given for each pesticide. Spills risk scores greater than 10 were designated ‘Very High’, greater than 9 were high and so on as shown in Table 4-8. Ranges are slightly different to those used for drift overall ranges. Once again ranges were designed to get approximately 5% in Very High and 10% High overall ratings. Notice the same toxicity score formulas were used for both Spills and Drift Risk Assessment.

Table 4-8 Spills - Risk Score Rating ranges

Total Score	Overall Rating
<6	Very Low
<7	Low
<9	Moderate
<10	High
≥10	Very High

The score derived implicitly assumes that

1. The value threatened by each pesticide is similar (a reasonable approximation to the truth);
2. The spill of each liquid type is equally likely. Note volume is included in risk score, therefore spills of frequently used pesticides have higher risk ratings.

4.3.4 Estimation of the risk of **UNLAWFUL ACTS**

Unlawful acts are defined by regulations that may be controlled by Local, State or Commonwealth authorities. One set of regulations is shown in Appendix 8. A complete search of all relevant regulations and statutes is beyond the scope of this report.

Commission of an unlawful act in many cases poses an acute and immediate risk (e.g. use of a spray that is not permitted), whereas in other cases the risk may be to the regulatory system (for example keeping of records), and failure to comply with may not in itself pose a threat.

Some of the significant types of unlawful acts that could affect the risk from pesticides include

- A Unlawful use of pesticides -
 - i Malicious use. Malicious uses of pesticides include extortion and sabotage. No estimate of the risk from this source is offered in this report.
 - ii Use of unregistered pesticides (or use in an unregistered manner). The use of unregistered pesticides cannot be quantified in the same manner as for spills and spray drift because there would be no records of such events. Some quantification of the risk might be obtained from prosecution records, but that would be an under-estimate. No estimate of the risk from this source is offered in this report.
 - iii Excessive rates of application. Incorrect usage (e.g. excess application rate) may occur.
 - iv Use at the incorrect time. Unlawful timing of sprays may have offsite effect, such as excess pesticide residues in produce, or deaths of non-target insects (including honey bees).
- B Unlawful disposal -
 - v Disposal of concentrated pesticide. In many cases, the amount of pesticide purchased will not be the exact quantity required for the application. The excess may then be stored or disposed of in an appropriate manner. Storage must be undertaken only if strict guidelines are followed (The facility must be secure from theft, fire, flood etc.) Disposal of the concentrated pesticide requires special facilities that may not be present on the property. There will

therefore be a cost associated with the disposal. There will be a temptation to illegally dispose of excess or superseded chemicals in some cheap manner.

- vi Disposal of diluted pesticide. There is likelihood that a user of a pesticide will have excess diluted material in the spray vat. The excess material may be disposed of by spraying some other area to use up the excess, but this is an expense and could have unwanted side effects. Illegal disposal of spray materials has been known to occur and there have been prosecutions. The amount of illegal disposal is not known, and thus the risk cannot be estimated with the available data.
- vii Washings from applicators. Spray equipment needs to be washed after use on a paved area, and the washings disposed of in an appropriate (lawful) fashion. The risk from this source could be assessed if data were available on how often equipment is washed in an unsuitable area, and also on the disposal of the washings.
- viii Handling of containers used for pesticides. Regulations require a triple rinsing of pesticide containers. As with the spray equipment, data are required on how frequently thorough washing occurs, and on the fate of the washings.

There are no data available on the use of **unregistered pesticides** or inappropriate use of pesticides. It may be feasible to design a survey to assess this. **Prosecution data** may offer some assessment of this risk.

Some indication of the risk of unlawful acts from registered pesticides could be developed using a similar philosophy to that used for spills. The components in that case would be as follows

- **Quantity of pesticide** used, translated to a score of $\log(\text{kg per year})$;
- Fraction of **active ingredient** (log %)
- **Toxicity** of the pesticide ($5 - \log(\text{LD50})$) or similar as per Table 4-4)
- Function of **cost and disposal cost** of pesticide.

The effect of disposal cost of undiluted pesticides, diluted pesticides and pesticide containers has not been formulated at this stage. Some indication of the risk from unlawful acts in the categories iii - viii can be estimated using the above method. However since **no information on costs** was provided, **the sum of the first three components only** were used as a preliminary indicator of a **first tier unlawful acts risk assessment**.

As for Spills and Drift first tier risk assessment, an **overall rating** of the risk score is given for each pesticide. For unlawful act risks scores in the following ranges were designated very high, high, moderate low or very low using the classes defined in Table 4-9. Ranges are slightly different to those used for drift and spills overall ranges. Once again ranges were designed to get approximately 5% in Very High and 10% High overall ratings. Notice the same toxicity score formulas were used for unlawful acts, Spills and Drift Risk Assessment.

Table 4-9 Unlawful Acts Risk Scores Overall Rating

Total Score	Overall Rating
<5	Very Low
<6	Low
<9	Moderate
<10	High
≥10	Very High

The score derived implicitly assumes that:

1. The value threatened by each pesticide is similar (a reasonable approximation to the truth);
2. Unlawful Acts involving each pesticide type is equally likely. This is an approximation as it does not take into account (amongst other things) the properties of the carrier. Note volume is included in risk score; therefore unlawful acts involving frequently used pesticides have higher risk ratings.

4.3.5 Estimation of Combined Risk

4.3.5.1 Combining pathways

Ideally we want to determine the combined risk for each receptor. This can be readily calculated across drift, spills and unlawful acts. In the next phase of work, drainage discharge (runoffs) could also be incorporate into this combined risk score.

The combined risk score was defined as follows. The combined score included the overall drift score, the overall spills score and the overall unlawful acts score for each receptor. Spills and Unlawful Acts were weighted low (0.25 and .125 respectively). The score was divided by 1.375 (sum of the weightings = 1+ 0.25+0.125) to bring it back to something like the original scale.

This is also spelt out as a formula below.

$$\text{Combined (Drift, Spills and Unlawful Acts) Risk Score} = \frac{(\text{Drift Score} + 0.25 * \text{Spills Score} + 0.125 * \text{Unlawful Acts Score})}{1.375}$$

The combined risk score for this first tier risk assessment was translated into a **rating** for each pesticide. The following ranges were designated very high, high, moderate low or very low using the classes defined in Table 4-10.

Table 4-10 Combined Risk Rating Ranges

Overall Rating	Total Score
Very Low	<6
Low	<7
Moderate	<10
High	<11
Very High	>11

4.3.5.2 Combining receptors

As well as combining pathways within a receptor group, we want to determine the combined risk across the receptors. The combination of the scores is rather subjective as hazards were measured differently for different receptors; LC50 was used for rainbow trout and daphnia, LD50 for rats and EC50 for algae.

Combining pathways is also difficult because there are missing values. For example, for 62% of the 66 pesticides, algal toxicities (EC50) were not available. 18% of pesticides had no Daphnia LC50s.

The combined risk score took into account the availability of the data – the rainbow trout data are available for all comparisons, but the algal data are not available for most comparisons. We have therefore weighted the receptor scores by the number of toxicity data points there were for that receptor. Daphnia had a weighting of 0.82 (82%) and algae of 0.38 (38%). A standard weighted average was then used to form the risk index combined across receptor groups. Where there were no data for the toxicity of a pesticide to a particular receptor, the weight was set to zero.

Thus the **overall combined risk (4.3.5.2) across receptors** was calculated as shown below.

Overall combined risk across all receptors (Sum*) =

Either (Rat Score + Rainbow trout Score + 0.82* Daphnia Score + 0.38 Algae Score) / 3.2

Or (Rat Score + Rainbow trout Score + 0.82* Daphnia Score) / 2.82, for algae EC50 missing

Or (Rat Score + Rainbow trout Score + 0.38* Daphnia Score) / 2.38, for Daphnia LC50 missing

Or (Rat Score + Rainbow trout Score) / 2, where both algae EC50 and Daphnia LC50 missing.

5. Risk estimates for different receptor groups in G-MW area

5.1 Mammals (humans, stock, domestic use and food processing industry)

The results of risk assessment for this group of receptors (represented by mammalian toxicity) from various pathways such as drift, accidental spill discharge of drainage water to supply channel and illegal acts has been provided below.

5.1.1 DRIFT

The results of the risk scoring for drift are shown in Appendix 9 and Appendix 10. Table 5-1, an extract of the complete table (Appendix 9), is included here to aid understanding of the method explained previously. From the table extract, azinphos-methyl appears to have the highest risk of drifting into water ways and affecting mammals.

Table 5-1 Estimation of total drift risk ranking for 12 pesticides based on mammalian toxicity

Pesticide	Overall Rating	Volume	Quantity Score ^a	Active % Product	Active Ingredient Score ^b	Application Method (Table 3 5)	Application Drift Score ^c	LD50 Rat Appendix 7	Rat Toxicity Score ^d	Rat Total Score
pirimicarb	Moderate	1000	3.00	50%	1.70	Air blast	1.48	147	2.83	9.01
fenthion	Moderate	2000	3.30	55%	1.74	Air blast	1.48	250	2.60	9.12
mancozeb	Moderate	240000	5.38	75%	1.88	Low volume Air blast, Boom sprayer, Knapsack	0.74	5000	1.30	9.30
sulfur	Moderate	80000	4.90	50%	1.70	Air blast	1.48	5000	1.30	9.38
thiram	High	14000	4.15	80%	1.90	Air blast	1.48	620	2.21	9.73
thiodicarb	High	4000	3.60	80%	1.90	Air blast	1.48	66	3.18	10.16
copper hydroxide	High	400000	5.60	26%	1.41	Air Blast, Boom Spray, Knapsack	1.19	1000	2.00	10.21
ziram	High	50000	4.70	76%	1.88	Air blast	1.48	320	2.49	10.55
methomyl	High	6350	3.80	100%	2.00	Air blast, Boom spray	1.19	17	3.77	10.76
omethoate	Very High	24286	4.39	80%	1.90	Boom spray, Air Blast	1.19	25	3.60	11.08
parathion methyl	Very High	17000	4.23	50%	1.70	Air blast	1.48	6	4.22	11.63
azinphos-methyl	Very High	80000	4.90	50%	1.70	Air blast	1.48	9	4.05	12.12

^aQuantity score (log of volume), ^b ingredient score (log of active % product), **Application method** (see Table 4-5)

^cApplication drift score (log of risk score component), ^dRat toxicity score = 5 – log(LD50), **Rat total score** = a+b+c+d

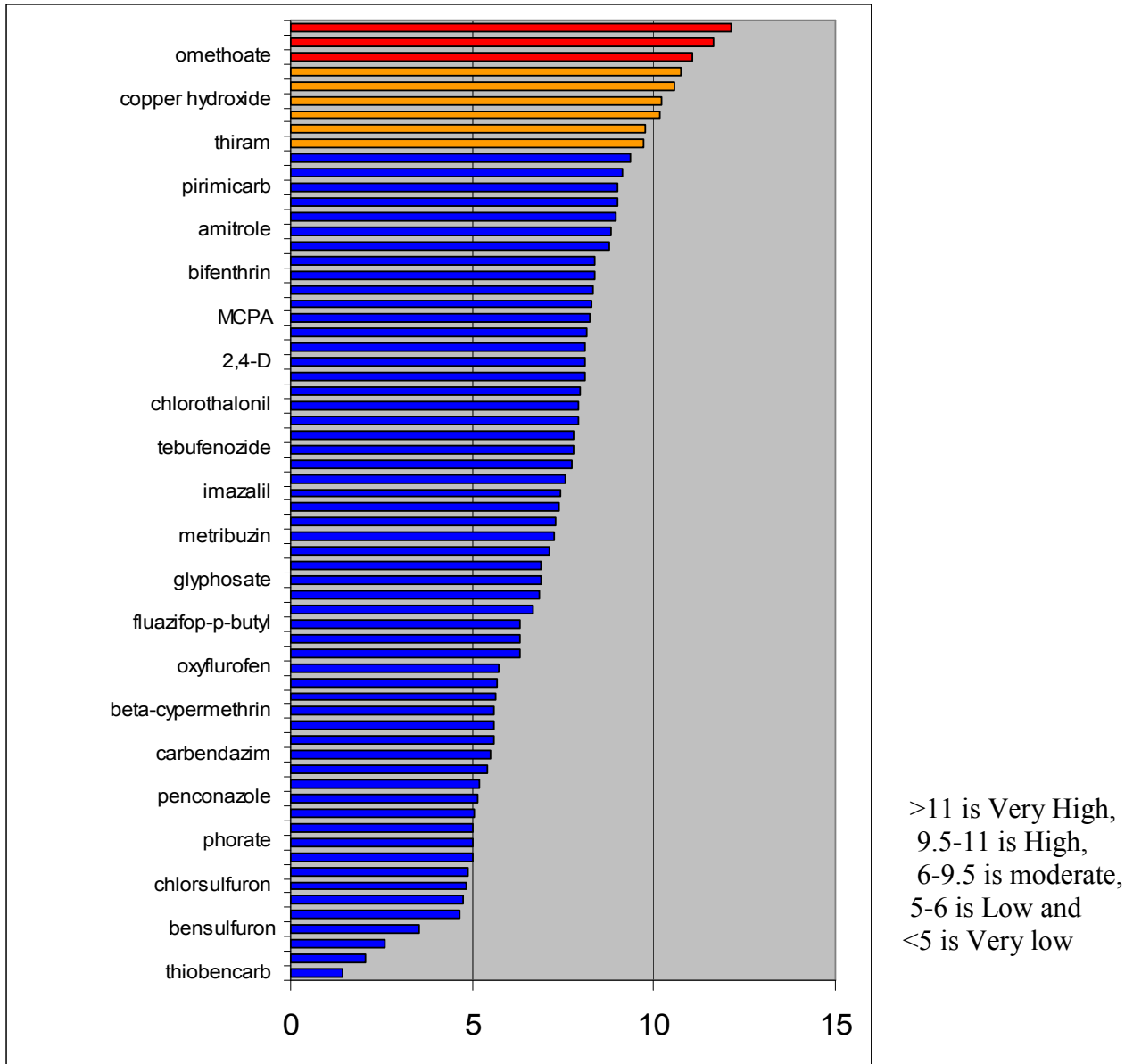


Figure 5-1 Mammalian Drift Risk Rating Graph

A plot of the risk to mammals against the rank of the risk is shown in Figure 5-1. The plot indicates that three pesticides have a higher rating than the others. These three (Azinphos-methyl, parathion-methyl and omethoate) were accordingly given a ‘Very High’ rating and are shown in an expanded version in Figure 5-2.

The risk of azinphos-methyl (Very High) was about 20 times (i.e. $10^{(12.12-10.76)}$) that of methomyl (High), and about 500 times (i.e. $10^{(12.12-9.38)}$) that of sulphur (moderate), so the **risk from different pesticides is markedly different**. Values are from Table 5-1.

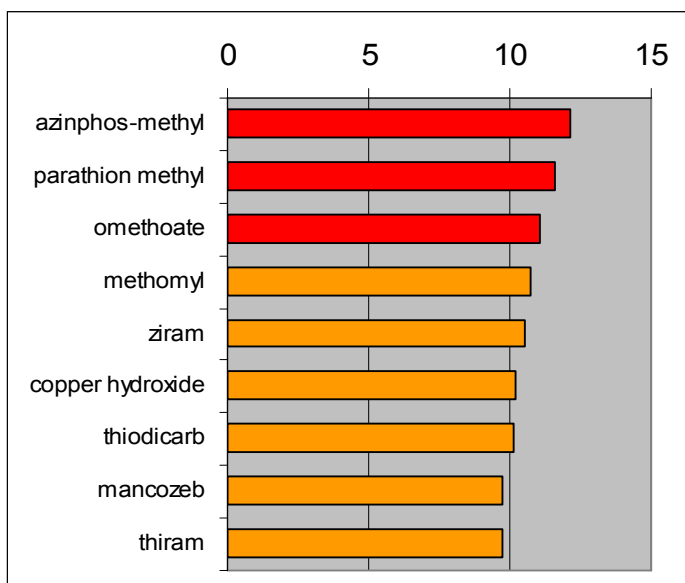


Figure 5-2 Mammalian High and Very High Drift Ratings

Pesticides with “High” or “Very High” drift risk ratings are displayed in table format alongside landuse and the areas applied in Table 5-2.

Table 5-2 Drift- Highest Mammalian (Rat) Pesticide Risk Ratings with Land-use

Pesticide	Mammalian Rating	Land Use	Areas
azinphos-methyl	Very High	Stone fruits, pome fruits	GMV
parathion methyl	Very High	Stone fruits, pome fruits	GMV
omethoate	Very High	Irrigated pasture, Lucerne	P-B, GMV, T, R
methomyl	High	Tomatoes, vegetables, viticulture	GMV, T
ziram	High	Stone fruits, pome fruits	GMV
copper hydroxide	High	Vegetables, viticulture	R
thiodicarb	High	Vegetables (tomatoes), vegetables	GMV, R
mancozeb	High	Stone fruits, pome fruits, viticulture, irrigated cereals (wheat, oats, canola, faba beans), vegetables, irrigated pasture	T, R, P-B
thiram	High	Stone fruits, pome fruits	GMV

GMV - Central Goulburn, Shepparton and Murray Valley, R- Rochester Campaspe, P-B -Pyramid-Boort and T-Torrumbary

The pesticides with high risk to mammals via drift exposure pathway (azinphos-methyl, parathion, omethoate, methomyl, ziram, thiram, copper, mancozeb, thiodicarb) are used more in fruit and vegetable production in the irrigation area, located mainly in the Goulburn-Murray Valley. Of the

above pesticides, only omethoate, an insecticide used in pastures, was widely used across spread of land uses in various areas, probably during winter/spring.

5.1.2 DRAINAGE DISCHARGE into water supply channels

This pathway of contamination of water supply was assessed for various irrigation areas and landuse combinations. The results of the risk assessment are presented for each irrigation area for the major landuses.

For each type of landuse the mobility assessment for the irrigation area using the largest number of pesticides have also been shown. Therefore, for various sections under different landuses, the area that is discussed first is not the same.

5.1.2.1 *Irrigated Pastures*

5.1.2.1.1 Pyramid-Boort

A large number (23) of pesticides are listed to be used in the irrigated pastures in the Pyramid Boort area. (Note there are 28 pesticides listed, but only 23 are used in P-B.) Mobility of pesticides used in pasture in the area was assessed through PIRI and results are shown below (Figure 5-3). Five pesticides used in irrigated pastures (atrazine, diquat, mancozeb, simazine and pendimethalin) were rated to have high or very high risk of off-site migration through drainage water. Four pesticides (2,4-D, omethoate, endosulfan and MCPA) were rated to have medium potential risk of off-site migration. The remaining fourteen pesticides were assessed to be of low migration risk.

Many of these pesticides are commonly used in pasture production in other areas also.

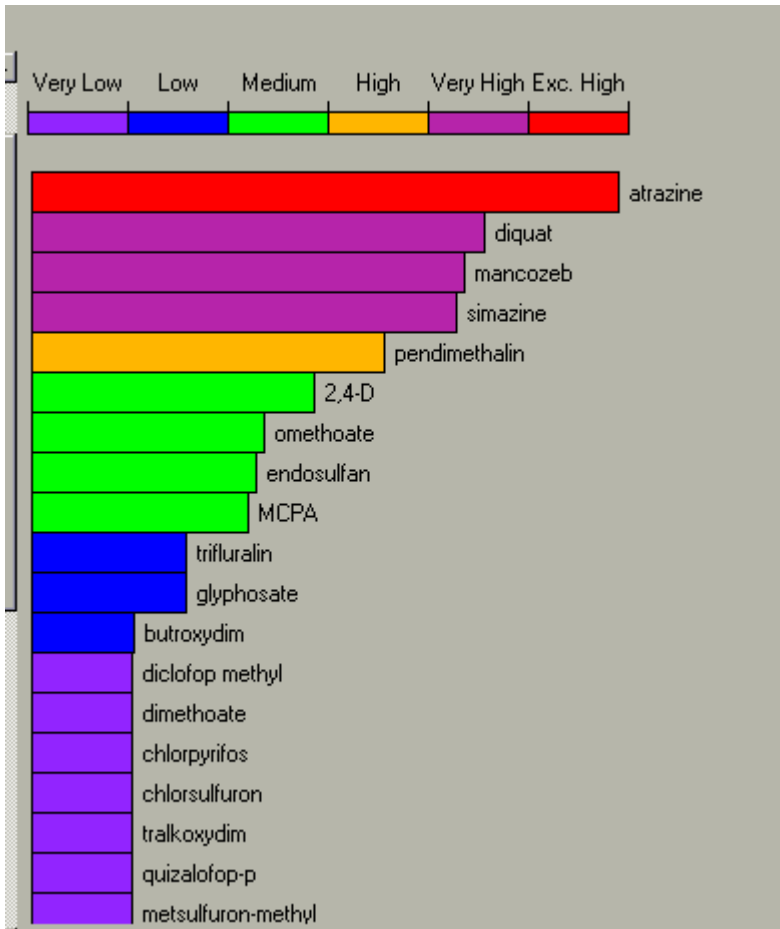


Figure 5-3 Mobility assessment for pesticides used under irrigated pasture in Pyramid-Boort area, the results presented here obtained through use of PIRI software. Factors such as soil type, pesticide mobility & persistence, pesticide toxicity were included in the assessment.

For assessment of risk to human and animals through water use, both mobility and toxicity factors were taken into account. On this basis, four pesticides (omethoate, endosulfan, pendimethalin and phosmet) were rated to be of potential high risk, in this P-B area. Seven other pesticides were rated to be of medium risk (Table 5-3).

5.1.2.1.2 Torrumbarry

Similar to Pyramid Boort area a large number of pesticides (17) were noted to be in use in the Torrumbarry area (Table 5-3). Omethoate, endosulfan, and phosmet were rated to be potentially high risk chemicals in the area, and five others (diquat, 2,4-D, MCPA, diuron and bromoxynil) were rated of medium risk. Remaining 9 pesticides were classed into low risk for mammals.

5.1.2.1.3 Goulburn Murray Valley

Risk rating for mammals (Table 5-3) showed that omethoate is the only compound used in irrigated pastures in this area that shows potential high risk to mammals, both by virtue of its high mammalian toxicity and medium mobility.

5.1.2.1.4 Rochester-Campaspe

Two pesticides (omethoate and diquat) used under irrigated pasture in Rochester irrigation area were rated to have high or medium risks respectively to the mammalian receptor group (Table 5-3). Diuron

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

herbicide was rated to have medium potential risk. Remaining 3 pesticides were rated to have low risk.

Table 5-3 Irrigated Pasture - Drainage Discharge Risk Ratings based on mammalian toxicity

Rating	Pesticide	Dosage (kg or litres product/ha)	Toxicity LD50 Rat	Areas where used
High	omethoate	1	25	Pyramid-Boort, Goulburn Murray Valley, Rochester, Torrumbarry
High	endosulfan	4	70	Pyramid-Boort, Torrumbarry
High	pendimethalin	9	1050	Pyramid-Boort
High	phosmet	0.35	113	Torrumbarry
Medium	diquat	2.8	231	Pyramid-Boort, Rochester, Torrumbarry
Medium	2,4-D	1.6	639	Pyramid-Boort, Goulburn Murray Valley, Torrumbarry
Medium	atrazine	3.3	1869	Pyramid-Boort
Medium	MCPA	2	900	Pyramid-Boort, Goulburn Murray Valley, Torrumbarry
Medium	dimethoate	0.375	290	Pyramid-Boort
Medium	diclofop methyl	1	481	Pyramid-Boort
Medium	butroxydim	0.28	1635	Pyramid-Boort
Medium	diuron	4.5	3400	Rochester, Torrumbarry
Medium	bromoxynil	2	190	Pyramid-Boort, Torrumbarry
Low	bifenthrin	0.125	54.5	Pyramid-Boort, Torrumbarry
Low	tralkoxydim	0.5	934	Pyramid-Boort, Torrumbarry
Low	mancozeb	6	5000	Pyramid-Boort, Torrumbarry
Low	simazine	1.5	5000	Pyramid-Boort, Rochester
Low	trifluralin	2.1	5000	Pyramid-Boort, Torrumbarry
Low	glyphosate	3	5600	Pyramid-Boort, Goulburn Murray Valley, Rochester
Low	quizalofop-p	0.3	1182	Pyramid-Boort, Goulburn Murray Valley, Rochester
Low	chlorpyrifos	0.5	3000	Pyramid-Boort, Torrumbarry
Low	chlorsulfuron	0.02	5545	Pyramid-Boort, Torrumbarry
Low	diflufenican	1	2000	Pyramid-Boort, Torrumbarry
Low	metsulfuron-methyl	0.01	5000	Pyramid-Boort, Torrumbarry
Low	Dimethoate	0.375	290	Goulburn Murray Valley
Low	fluazifop-p-butyl	1	2451	Pyramid-Boort, Goulburn Murray Valley, Torrumbarry
Low	propaquizafop	0.3	5000	Pyramid-Boort, Goulburn Murray Valley,
Low	alpha-cypermethrin	0.064	250	Pyramid-Boort, Goulburn Murray Valley,

5.1.2.2 Irrigated Crops (wheat, oats, canola, faba-beans and others)

5.1.2.2.1 Torrumbarry

A total of 14 pesticides were identified under current use in irrigated crops in the Torrumbarry irrigation area. An assessment for their mobility showed that only two pesticides (mancozeb and endosulfan) were considered to have medium or high risk of movement (Figure 5-4). From the mammalian toxicity point of view, only endosulfan was rated to have significant risk in this area. All other pesticides were rated to be of low risk.

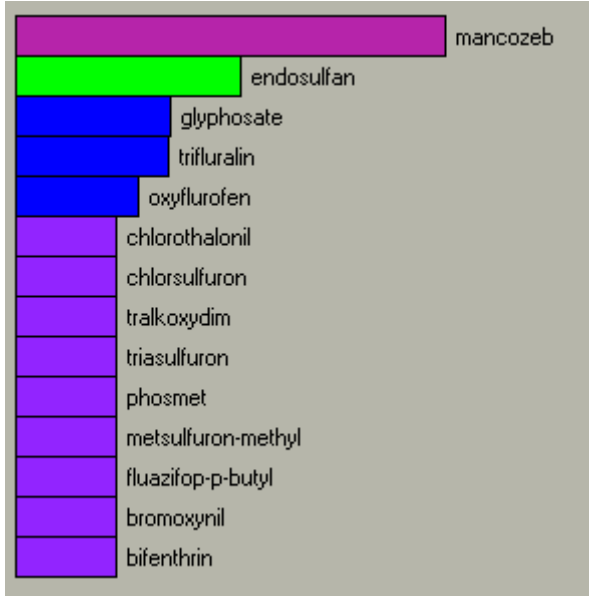


Figure 5-4 Mobility rating for pesticides used in irrigated cropping in Torrumbarry irrigation area

5.1.2.2.2 Pyramid-Boort

Ten pesticides were noted to be used in the Pyramid-Boort irrigated cropping area. Of these, only endosulfan was rated to be of high risk. Two other pesticides, MCPA and Butroxydim were rated to be of medium risk to mammals. All other pesticides were of low risk category.

5.1.2.2.3 Rochester-Campaspe

There is significant area (about 2800 ha) under irrigated crops (summer and winter grains) in the Rochester- Campaspe irrigation area. However, currently no information on pesticide use on for the irrigated crops is available for the irrigation area. Such information should be collected in future.

5.1.2.3 Stone fruit, Pome fruit

5.1.2.3.1 Goulburn Murray Valley

Mobility of 22 pesticides used in stone and pome fruits in Goulburn Murray Valley were assessed and only four were rated to have high to very high risk of off-site migration through drainage water (Figure 5-5). These were: pendimethalin, mancozeb, dalapon and primicarb. Three other pesticides (paraquat, copper and glufosinate ammonium) were rated to have medium potential risk of off-site migration. The remaining pesticides were of low risk.

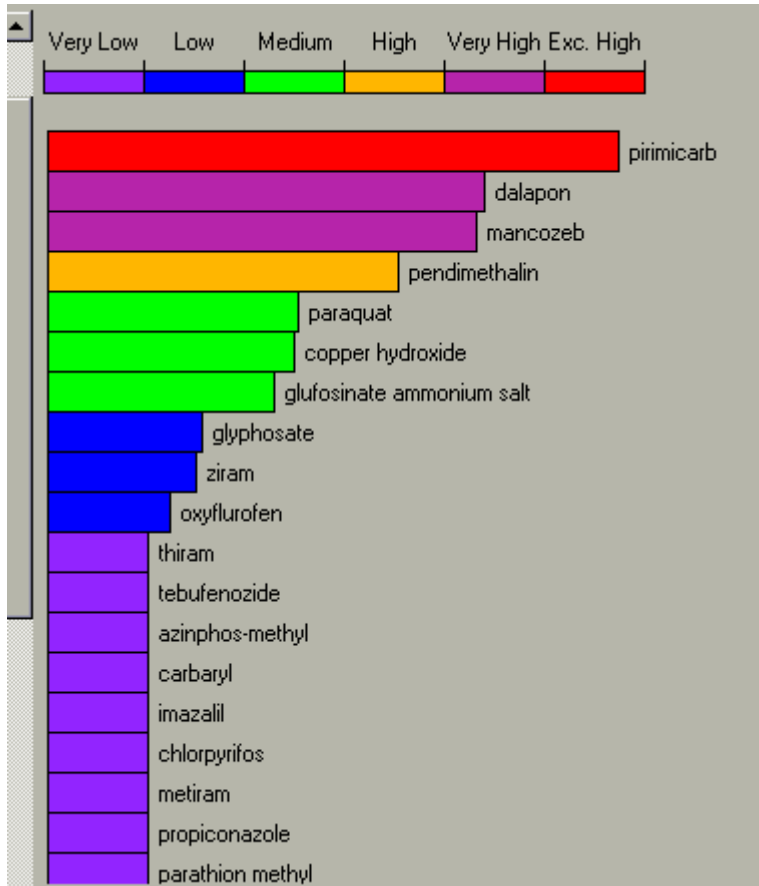


Figure 5-5 Potential mobility assessment for pesticides used in fruit production in Goulburn Murray Valley

Risk rating for mammals (Table 5-4) showed that pirimicarb and paraquat are the two compounds that have the high risk of potential migration in drainage water and toxicity to mammals in this area. While, both compounds have high mammalian toxicity, paraquat is likely to move with eroding clay or organic matter particles only. Pirimicarb, on the other hand, is more likely to move in runoff water. The two other extremely toxic compounds used in this industry are parathion and azinphos methyl. Despite their low risk for mobility in drainage water, these products can potentially pose significant risk due to their very high toxicity to mammals. Seven other compounds in the medium risk category are listed in Table 5-4.

5.1.2.3.2 Torrumbarry

Only four pesticides were found to be used in the Torrumbarry area. Of these, omethoate and paraquat were assessed to have high risk whereas pendimethalin was rated a medium risk to mammals. Imidacloprid was rated to have low risk.

Table 5-4 Stone fruit, Pome fruit Drainage Discharge Mammalian Risk Rankings. Data for dosage were derived using field data.

Rating	Pesticide	Dosage (kg or litres product/ha)	Toxicity LD50 Rat	Areas where used
High	omethoate	1	25	Goulburn Murray Valley, Torrumbarry
High	pirimicarb	1.1	147	Goulburn Murray Valley,
High	paraquat	0.5	157	Goulburn Murray Valley, Torrumbarry
Medium	copper hydroxide	4	1000	Goulburn Murray Valley
Medium	pendimethalin	9	1050	Goulburn Murray Valley, Torrumbarry
Medium	glufosinate ammonium salt	5	1620	Goulburn Murray Valley
Medium	parathion methyl	0.2	6	Goulburn Murray Valley
Medium	azinphos-methyl	0.5	9	Goulburn Murray Valley
Medium	imazalil	0.13	227	Goulburn Murray Valley
Medium	ziram	0.3	320	Goulburn Murray Valley
Medium	carbaryl	0.4	500	Goulburn Murray Valley
Medium	thiram	0.15	620	Goulburn Murray Valley
Low	imidacloprid	0.05	450	Goulburn Murray Valley, Torrumbarry
Low	propiconazole	0.05	1517	Goulburn Murray Valley
Low	chlorpyrifos	0.5	3000	Goulburn Murray Valley
Low	mancozeb	6	5000	Goulburn Murray Valley
Low	oxyfluorfen	4	5000	Goulburn Murray Valley
Low	tebufenozide	0.172	5000	Goulburn Murray Valley
Low	glyphosate	3	5600	Goulburn Murray Valley
Low	dalapon	1	7570	Goulburn Murray Valley
Low	metiram	0.4	10000	Goulburn Murray Valley
Low	carbendazim	0.2	15000	Goulburn Murray Valley

5.1.2.4 Vegetables (tomatoes)

5.1.2.4.1 Rochester-Campaspe

A total of 14 pesticides were found to be used in vegetable-growing in this area. The assessment for their potential mobility is provided in Figure 5-6. Mancozeb, methomyl, phorate and metribuzin were rated by PIRI to have high potential mobility in the area. Copper and endosulfan were rated on medium mobility rating.

On the basis of mobility and toxicity to mammals, three compounds (phorate, endosulfan and methomyl) were rated as high-risk chemicals in this area. Copper and metribuzin were assessed as medium risk and rest were found to have low potential risk (Table 5-5).

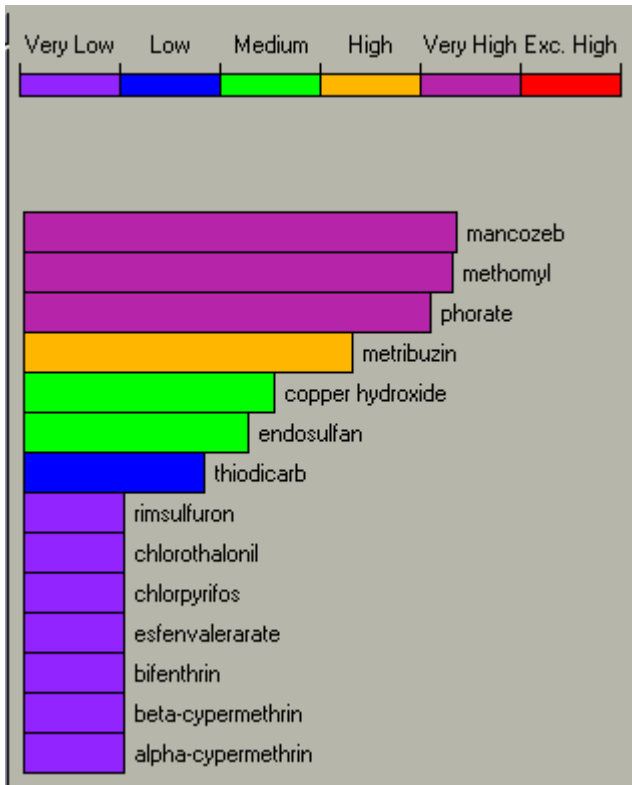


Figure 5-6 Mobility assessment for pesticides used in vegetable production in Rochester-Campaspe area

5.1.2.4.2 Goulburn-Murray Valley

Out of seven pesticides that are known to be used in this tomato-growing area, the compound that tops the risk rating is methomyl insecticide. It can potential enter into waterways and has high toxicity to this group of receptor organisms. Copper fungicide and metribuzin herbicide were rated to present medium risk.

5.1.2.4.3 Torrumbarry

According to the pesticide survey, only 3 pesticides (mancozeb, chlorpyrifos and fluazifop-butyl) were listed to be used in vegetable production in this area, which appears to be too few for high input crops such as vegetables. All three were found to be of low risk to mammals (Table 5-5).

5.1.2.4.4 Pyramid-Boort

There is about 500 ha under tomatoes in the Pyramid-Boort irrigation area. However, currently no information on pesticide use on tomatoes is available for the irrigation area. Such information should be collected in future.

Table 5-5 Vegetables Drainage Discharge Risk Rankings based on mammalian toxicity

Rating	Pesticide	Dosage (kg or litres product/ha)	Toxicity LD50 Rat	Areas where used
High	Phorate	0.2	1.6	Rochester
High	endosulfan	4	70	Rochester
High	methomyl	0.4	17	Goulburn Murray Valley, Rochester
Medium	copper hydroxide	4	1000	Goulburn Murray Valley, Rochester
Medium	metribuzin	0.47	2000	Goulburn Murray Valley, Rochester
Low	thiodicarb	1.4	66	Goulburn Murray Valley, Rochester
Low	Bifenthrin	0.125	54.4	Rochester
Low	Esfenvalerate	0.38	75	Rochester
Low	alpha-cypermethrin	0.064	250	Rochester
Low	beta-cypermethrin	0.47	166	Rochester
Low	thiodicarb	1.4	66	Goulburn Murray Valley, Rochester
Low	fenthion	0.75	250	Goulburn Murray Valley
Low	Chlorthalonil	0.55	10000	Rochester, Torrumbarry
Low	Chlorpyrifos	0.5	3000	Rochester, Torrumbarry
Low	Mancozeb	6	5000	Rochester, Torrumbarry
Low	Rimsulfuron	0.2	5000	Rochester
Low	fluazifop-p-butyl	1	2451	Goulburn Murray Valley
Low	sulfur	2	5000	Goulburn Murray Valley

5.1.2.5 Viticulture

5.1.2.5.1 Goulburn Murray Valley

A total of nine pesticides were identified to be used in viticulture in this area. The assessment for potential mobility of these pesticides showed that except three pesticides (glyphosate, oryzalin and chlorpyrifos), all other pesticides were rated to have medium or higher risk of movement with runoff or drainage water Figure 5-7. Several of these pesticides are also used in viticulture in Torrumbarry irrigation area.

From the point of view of risk to mammals, metalaxyl fungicide and two commonly used herbicides (paraquat and diquat) were assessed to be the compounds with highest risk (Table 5-6) pesticides among those used in viticulture in the Goulburn Murray Valley. Pendimethalin and copper are the two other compounds falling in the medium category. Metalaxyl and pendimethalin are more likely to move in drainage water than paraquat and diquat herbicides. However the mammalian toxicity of the latter is much higher.

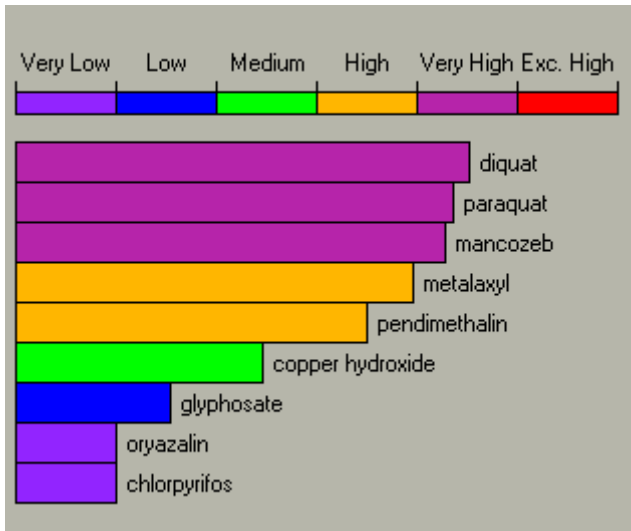


Figure 5-7 Mobility rating for pesticides used in viticulture in the Goulburn Murray Valley

5.1.2.5.2 Torrumbarry

In the Torrumbarry area, two pesticides (methomyl and diquat) were found to be of high potential risk to mammals. The remaining 5 pesticides were assessed to be of low risk.

5.1.2.5.3 Pyramid-Boort

There is about 300 ha under viticulture in the Pyramid-Boort irrigation area. However, currently no information on pesticide use on viticulture is available for the irrigation area. Such information should be collected in future. Additionally, most drainage discharge occurs into natural waterways, except few which are allowed to pump out drainage water into channels in extreme events (eg. storm events) Additionally, most drainage discharge occurs into natural waterways, except few which are allowed to pump out drainage water into channels in extreme events (eg. storm events)

Table 5-6 Viticulture Drainage Discharge Risk Rankings based on mammalian toxicity

Rating	Pesticide	Dosage (kg or litres product/ha)	Toxicity LD50 Rat	Areas where used
High	methomyl	0.4	17	Torrumbarry
High	metalaxyl	1.5	633	Goulburn Murray Valley
High	paraquat	2.8	157	Goulburn Murray Valley
High	diquat	2.8	231	Goulburn Murray Valley, Torrumbarry
Medium	pendimethalin	9	1050	Goulburn Murray Valley
Medium	copper hydroxide	4	1000	Goulburn Murray Valley
Low	chlorpyrifos	0.5	3000	Goulburn Murray Valley, Torrumbarry
Low	penconazole	0.15	2125	Torrumbarry
Low	mancozeb	6	5000	Goulburn Murray Valley, Torrumbarry
Low	sulfur	2	5000	Torrumbarry
Low	glyphosate	3	5600	Goulburn Murray Valley, Torrumbarry
Low	oryzalin	1.6	10000	Goulburn Murray Valley

5.1.2.6 Rice and Millet

5.1.2.6.1 Torrumbarry

Under rice and millet production systems, altogether eight pesticides were noted to be used in the Torrumbarry irrigation area. Of these molinate, thiobencarb and MCPA has high potential of mobility with drainage water (Figure 5-8), fluroxypyr was not included because of lack of data.

From the standpoint of mammalian toxicity, thiobencarb was rated to be a pesticide with high risk, whereas MCPA herbicide and fipronil insecticide were classed as medium risk to mammals. Clomazone, bensulfuron methyl herbicides and chlorpyrifos insecticide were rated to be of low risk.

Molinate was not found in the list of pesticide used in rice in this area. However, in the authors' experience, this herbicide is very common in the rice growing area, and may be important for this area also.

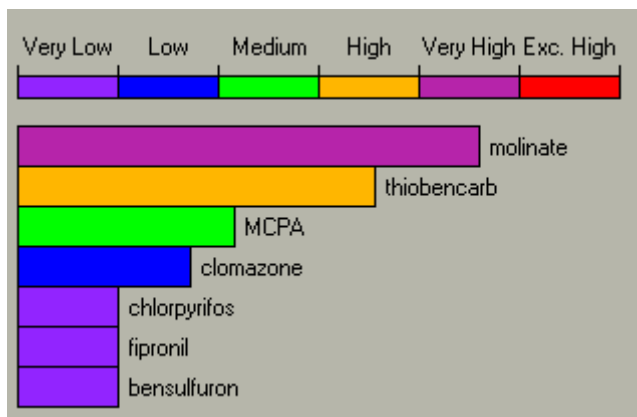


Figure 5-8 Mobility of pesticides with drainage water in rice production system

5.1.2.6.2 Goulburn-Murray Valley

Under rice production system, two out of the four pesticides used in this area showed high risk of potential movement with water draining the fields as well as moderate toxicity to mammals. Molinate and thiobencarb are the compounds with high risk, whereas fluroxypyr was rated medium risk and bensulfuron methyl herbicide was rated to be of low risk.

Table 5-7 Rice and Millet - Drainage Discharge Risk Rankings based on mammalian toxicity

Rating	Pesticide	Dosage (kg or litres product/ha)	Toxicity LD50 Rat	Areas where used
High	molinate	3.75	369	Goulburn Murray Valley
High	thiobencarb	5	1300	Goulburn Murray Valley, Torrumbarry
Medium	MCPA	2	900	Torrumbarry
Medium	fipronil	0.25	100	Torrumbarry
Medium	fluroxypyr	1	2405	Goulburn Murray Valley
Low	clomazone	0.6	1369	Torrumbarry
Low	chlorpyrifos	0.5	3000	Torrumbarry
Low	bensulfuron-methyl	0.085	5000	Goulburn Murray Valley, Torrumbarry

5.1.3 SPILLS

The results of the risk scoring for spills are shown in Appendix 11 and Appendix 12. Table 5-8, an extract of the complete table (Appendix 11), is included here to aid understanding of the method explained previously.

Table 5-8 Extract - Spills Pesticide Risk Ranking based on Mammalian toxicity

Pesticide	Mammalian Overall Rating	Volume	Quantity Score	Active % Product	Active % Score	Liquid Score	LD50 Rat	Rat Toxicity Score	Rat Total Score
2,4-D	High	12000	4.08	70%	1.85	1	639	2.19	9.12
alpha-cypermethrin	Low	6000	3.78	0%	-0.80	1	250	2.60	6.58
amitrole	Moderate	35000	4.54	20%	1.30	1	1100	1.96	8.80
ammonium glufosinate salt	Low	30000	4.48	20%	1.30	-1	1620	1.79	6.57
atrazine	Moderate	30000	4.48	90%	1.95	-1	1869	1.73	7.16
azinthos-methyl	Very High	80000	4.90	50%	1.70	1	9	4.05	11.65

Liquid score - liquid = 1; powder -1, solid = -1

A plot of the risk to mammals against the rank of the risk is shown in Figure 5-9. The plot indicates that four pesticides have a higher rating than the others. These four were accordingly given a ‘Very High’ rating and are shown in an expanded plot in Figure 5-10. Note that on the natural scale, the risk to mammals from spills of azinphos-methyl is about 100 times that of thiodicarb. Figure 5-10 has the risks on the log scale.

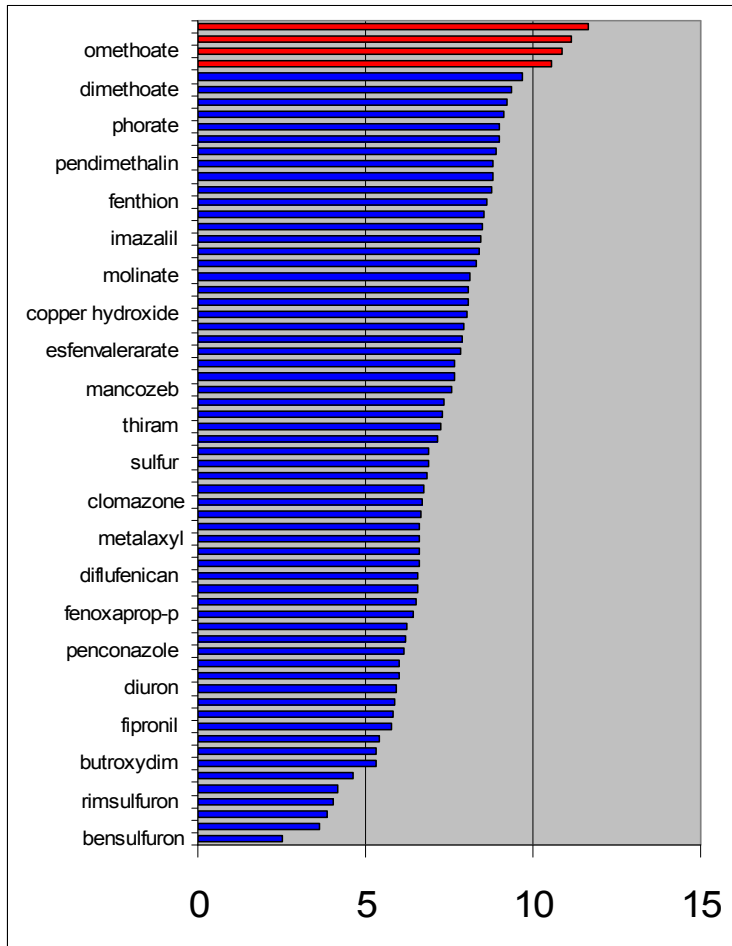


Figure 5-9 Mammalian Spills Pesticide Risk Scores (Risk scores based on Table 3-8)

From Figure 5-10, **azinphos-methyl** appears to have the **highest risk of spilling** into waterways and affecting **mammals**. Azinphos-methyl also had the **highest risk for drift** into waterways and affecting **mammals**.

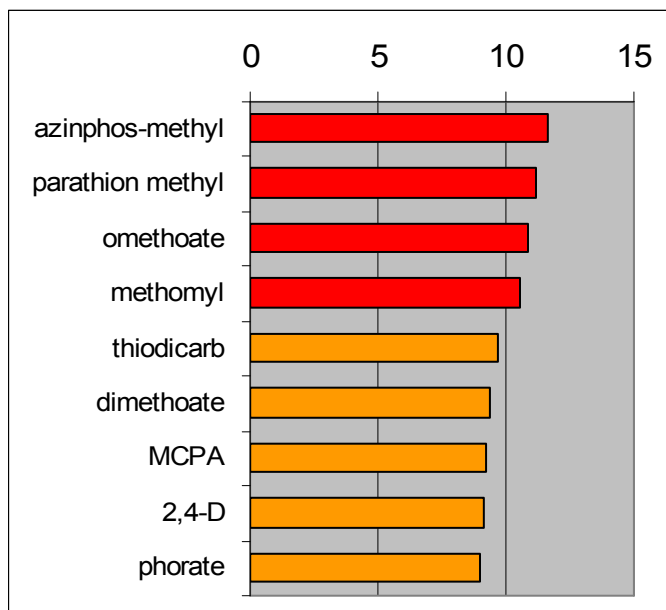


Figure 5-10 Spills- Very High & High Mammalian (Rat) Pesticide Risk Ratings

Pesticides with “High’ or ‘Very High’ drift risk ratings are displayed in table format alongside landuse and the areas applied in Table 5-9.

Table 5-9 Spills -Highest Mammalian (Rat) Pesticide Risk Ratings with Landuse

Pesticide	Rating	Land Use	Areas
azinphos-methyl	Very High	Stone fruits, pome fruits	GMV
parathion methyl	Very High	Stone fruits, pome fruits	GMV
omethoate	Very High	Irrigated pasture, irrigated pasture (fat lambs, cattle, dairy), Lucerne	P-B, GMV, T, R
methomyl	Very High	Tomatoes, vegetables, viticulture	GMV, T
thiodicarb	High	Vegetables (tomatoes), vegetables	GMV, R
dimethoate	High	Irrigated pastures, stone fruits, pome fruits	P-B, GMV, T
MCPA	High	Irrigated pasture, Irrigated cropping (rice & millet)	P-B, GMV, T
2,4-D	High	Irrigated pasture	GMV, P-B
phorate	High	vegetables	R

GMV -Central Goulburn and Murray Valley, R- Rochester Campaspe, P-B -Pyramid-Boort and T -Torrumbary

The pesticides with high mammalian toxicity are used more in fruit and vegetable production in the irrigation area, located mainly in the Goulburn-Murray Valley. Only omethoate, dimethoate insecticides are used in pastures, which is much more wide spread land use in various areas. 2,4-D and MCPA herbicides (many of these products are used from May 15 to August 15 when there is no

water in channels) with moderate toxicity to mammals but are used in very high volume in pastures and crops. Therefore the overall risk is high for these compounds.

5.1.4 UNLAWFUL ACTS

The results of the risk scoring for unlawful acts are shown in Appendix 13 and Appendix 15. Table 5-8, an extract of the complete table (Appendix 13), is included here to aid understanding of the method explained previously.

The model explained previously via the following formula.

$$\text{Unlawful Acts Risk Score for Mammals} = \log(\text{volume}) + 2 + \log(\% \text{ active}) + (5 - \log \text{LD50(Rat)})$$

Note the constants 2 and 5 were used to make overall scores comparable to those calculated for drift and spills.

Recall that this unlawful acts risk scoring is very rough, additional information on **cost and disposal cost** of pesticides **will improve this risk score**.

Table 5-10 Extract – Unlawful Acts –Pesticide Risk Rating Calculation Sheet

Pesticide	Volume	Quantity Score	Active % Product	Active % Score	Sub Score	LD50 Rat	Rat Toxicity Score	Rat Total Score
dimethoate	21340	4.33	30%	1.48	5.8	290	2.54	8.34
mancozeb	240000	5.38	75%	1.88	7.3	5000	1.30	8.56
thiodicarb	4000	3.60	80%	1.90	5.5	66	3.18	8.69
copper hydroxide	400000	5.60	26%	1.41	7.0	1000	2.00	9.02
ziram	50000	4.70	76%	1.88	6.6	320	2.49	9.07
methomyl	6350	3.80	100%	2.00	5.8	17	3.77	9.57
omethoate	24286	4.39	80%	1.90	6.3	25	3.60	9.89
phorate	8000	3.90	20%	1.30	5.2	2	4.80	10.00
parathion methyl	17000	4.23	50%	1.70	5.9	6	4.22	10.15
azinphos-methyl	80000	4.90	50%	1.70	6.6	9	4.05	10.65

From Figure 5-11, **azinphos-methyl** appears to have the **highest risk via unlawful acts** of getting into waterways and affecting **mammals**. Azinphos-methyl also had the **highest risk for drift and spills** into waterways and affecting **mammals**.

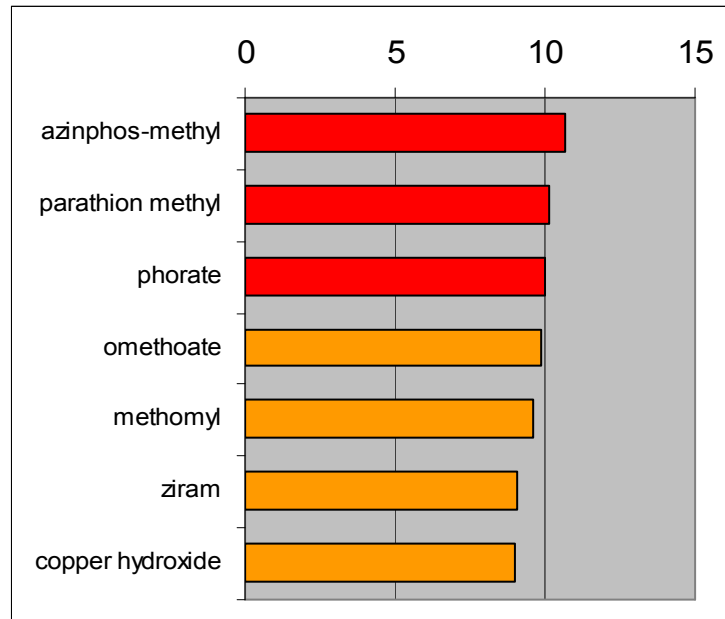


Figure 5-11 Unlawful Acts-Highest Mammalian Pesticide Risk Ratings for Mammals
(Risk scores is based on Table 3-9)

Pesticides with “High” or ‘Very High’ drift risk ratings are displayed in table format alongside landuse and the areas applied in Table 5-11.

Table 5-11 Unlawful Acts-Highest Mammalian Pesticide Risk Ratings with Landuse

Pesticide	Rating	Land Use	Areas
azinphos-methyl	Very High	Stone fruits, pome fruits	GMV
parathion methyl	Very High	Stone fruits, pome fruits	GMV
phorate	Very High	vegetables	R
omethoate	High	Irrigated pasture, Lucerne	P-B, GMV, T, R, T
methomyl	High	Tomatoes, vegetables, viticulture	GMV, T
ziram	High	Stone fruits, pome fruits	GMV
copper hydroxide	High	Vegetables, viticulture	R

GMV -Central Goulburn and Murray Valley, R- Rochester Campaspe, P-B -Pyramid-Boort and T- Torrumbary

Once again the pesticides with high mammalian risk tended to be used more in fruits and vegetable production in the irrigation area, located mainly in the Goulburn-Murray Valley. Only omethoate (an insecticide) is used in pastures, which is the most widespread landuse in various areas.

5.2 Aquaculture

The results of risk assessment for this group of receptor environment from various pathways such as accidental spill, drift, discharge of drainage water to supply channel and illegal acts has been provided below. Aquaculture risk assessment was based on Rainbow Trout toxicity, because toxicity (LC50) was available for Rainbow Trout.

5.2.1 DRIFT

The results of the risk scoring for drift are shown in Appendix 9 and Appendix 10, which includes three different receptor groupings (mammalian, aquaculture and aquatic ecosystem). Figure 5-12 and Table 5-12 show the highest risk scorings of drifting into waterways and affecting aquaculture (Rainbow Trout).

From Figure 5-12, **chlorpyrifos** appears to have the **highest risk via drifting** into waterways and affecting **aquaculture (Rainbow Trout)**. **Chlorpyrifos** also appears to have the **high risk via spills** into waterways and affecting **aquaculture** (as shown in next section). Rainbow trout was used as an indicator of general fish toxicity in this study, because toxicity data for most pesticides is available on rainbow trout, and experience indicates that there is a strong correlation between fish species.

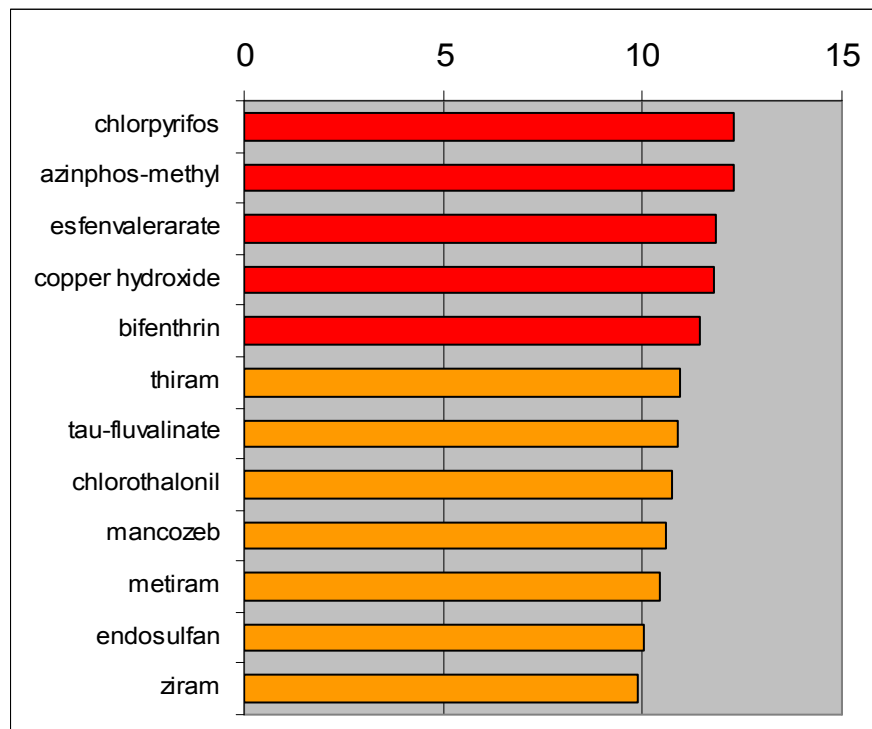


Figure 5-12 Drift -Highest Pesticide Risk Ratings for Aquaculture (Rainbow Trout)

Pesticides with “High’ or ‘Very High’ drift risk ratings are displayed in table format alongside landuse and the areas applied in Table 5-12.

Table 5-12 Drift -Pesticide Risk Ratings with Landuse for Aquaculture (Rainbow Trout)

Pesticide	Rating	Land Use	Areas
chlorpyrifos	Very High	Stone fruits, pome fruits, viticulture, crops (canola, wheat, lucerne, barley, clover, rice & millet), vegetables, pasture	GMV, T, Pyramid Hill (PB), R, T
Azinphos-methyl	Very High	Stone fruits, pome fruits	GMV
esfenvalerate	Very High	Vegetables	R
copper hydroxide	Very High	Vegetables, viticulture	R,
bifenthrin	Very High	crops (canola, wheat, lucerne, barley, clover, oats, faba beans), vegetables, irrigated pasture	T, R, T
thiram	High	Stone fruits, pome fruits	GMV
tau-fluvalinate	High	Stone fruits, pome fruits	T
chlorothalonil	High	Irrigated cereals (wheat, oats, canola, faba beans), vegetables	R, T
mancozeb	High	Stone fruits, pome fruits, viticulture, irrigated cereals (wheat, oats, canola, faba beans), vegetables, irrigated pasture	T, R, T, Boort
metiram	High	Stone fruits, pome fruits	GMV
endosulfan	High	Irrigated pasture, vegetables, irrigated cropping (canola, wheat, lucerne, barley, clover, oats, faba beans)	P-B, P-B, R, T
ziram	High	Stone fruits, pome fruits	GMV

GMV -Central Goulburn, Shepparton and Murray Valley Irrigation Areas, R- Rochester Campaspe, P-B -Pyramid-Boort and T- Torrumbarry

Of the large number of pesticides assessed for risk to aquaculture throughout the G-MW area, organophosphate pesticides (chlorpyrifos, azinphos methyl) and pyrethroids (esfenvalerate, bifenthrin, taufluvinate) were rated to be of high risk, together with copper fungicides. The high risk pesticides included endosulfan insecticide and several fungicides (thiram, mancozeb, metiram, chlorothalonil, ziram). Majority of these were used in fruits, viticulture and vegetable growing areas, with some exceptions such as endosulfan which is used much more widely.

5.2.2 SPILLS

The results of the risk scoring for spills are shown in Appendix 11 and Appendix 12. The complete calculation table (Appendix 12) shows all spills calculations for each receptor groups including aquaculture.

Pesticides with highest risk of spilling for Aquaculture (Rainbow trout) are shown in Figure 5-13. Pesticides with “High’ or ‘Very High’ drift risk ratings are displayed in table format alongside landuse and the areas applied in Table 5-13.

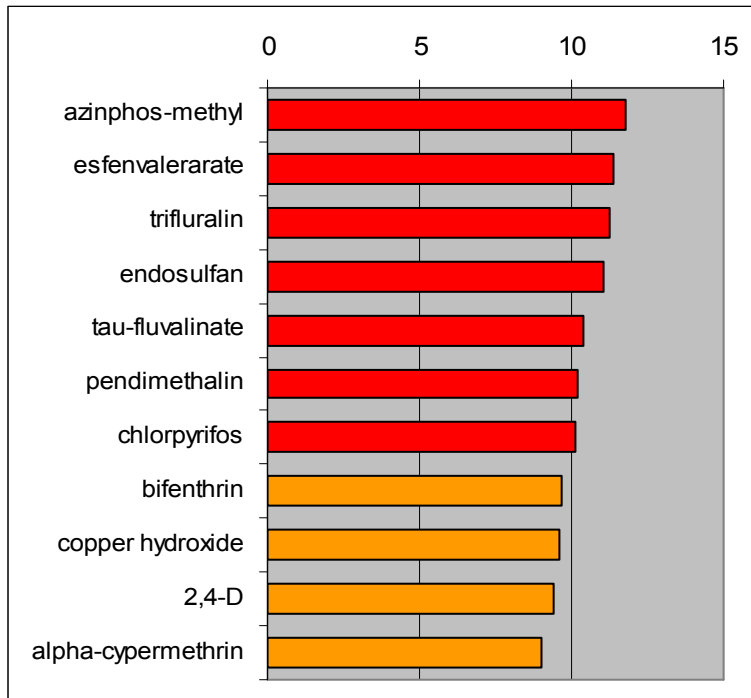


Figure 5-13 Spills Highest Pesticide Risk Rating for Aquaculture (Rainbow trout)

>11=very high; 9.5-11=high; 6-9.5=moderate; 5-6=low and <5=very low

From Figure 5-13, **azinphos-methyl** appears to have the **highest risk of spilling** into waterways and affecting **aquaculture**. Azinphos-methyl also had **high risk for drifting** into waterways and affecting **mammals**, and the **2nd highest risk for drift for aquaculture**.

Table 5-13 Spills Highest Pesticide Risk Rating for Aquaculture with Landuse

Pesticide	Rating	Land Use	Areas
azinphos-methyl	Very High	Stone fruits, pome fruits	GMV
esfenvalerate	Very High	Vegetables	R
trifluralin	Very High	Irrigated pasture, irrigated cereals (wheat, oats, canola, faba beans)	P-B, T
endosulfan	Very High	Irrigated pasture, vegetables, crops (canola, wheat, lucerne, barley, clover), cereals (wheat, oats, canola, faba beans)	P-B, P-B, R, T
tau-fluvalinate	Very High	Stone fruits, pome fruits	
Pendimethalin	Very High	Irrigated pasture, stone fruits, viticulture,	P-B, GMV, R, T
chlorpyrifos	Very High	Stone fruits, pome fruits, viticulture, crops (rice & millet, canola, wheat, lucerne, barley, clover), vegetables, viticulture, pasture	GMV, T, P-B,R, T
bifenthrin	High	Irrigated cereals (wheat, oats, canola, faba beans), irrigated cropping (canola, wheat, lucerne, barley, clover), vegetables, irrigated pasture	T, R, T
copper hydroxide	High	Vegetables, viticulture	R,
2,4-D	High	Irrigated pasture	GMV, P-B
alpha-cypermethrin	High	Irrigated pasture, vegetables	GMV, Pyramid Hill (T)

GMV -Central Goulburn and Murray Valley, R- Rochester Campaspe, P-B -Pyramid-Boort and T- Torrumbary

Of the large number of pesticides assessed for risk to aquaculture throughout the G-MW area, organophosphate pesticides (chlorpyrifos, azinphos methyl) and pyrethroids (esfenvalerate, bifenthrin, taufluvinate) were rated to be of high risk, together with copper fungicides. The majority of these pesticides are used mainly in the fruit, viticulture and vegetable growing areas, although some pesticides such as endosulfan and trifluralin which are used more widely.

5.2.3 UNLAWFUL ACTS

The results of the risk scoring for unlawful acts are shown in Appendix 13 and Appendix 14.

Recall that the risk score for Unlawful acts was defined via the following formula.

$$\text{Unlawful Acts Risk Score for Mammals} = \log(\text{volume}) + 2 + \log(\% \text{ active}) + 5 - \log \text{LD50(Rat)}$$

Recall also that this unlawful acts risk scoring is very rough. Additional information on cost and disposal cost of pesticides will improve this risk score.

From Figure 5-14, chlorpyrifos appears to have the highest risk via unlawful acts of getting into waterways and affecting aquaculture (Rainbow Trout). Chlorpyrifos also had very high risk for drift and spills into waterways and affecting aquaculture (Rainbow Trout).

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

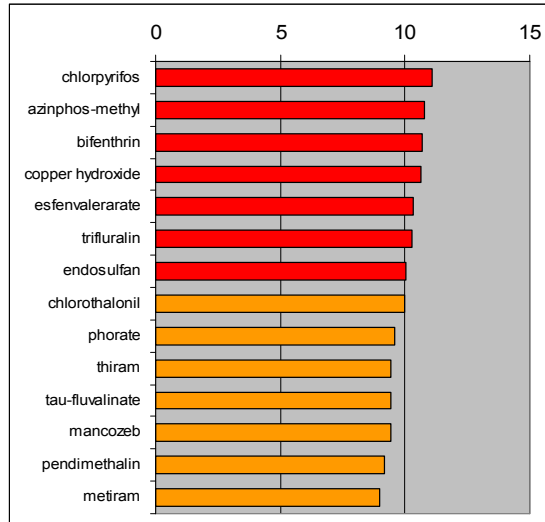


Figure 5-14 Unlawful Acts-Highest Aquaculture (Rainbow Trout) Pesticide Risk Ratings

Pesticides with “High” or “Very High” unlawful acts risk ratings are displayed in table format alongside landuse and the areas applied in Table 5-14.

Table 5-14 Unlawful Acts Highest Aquaculture (Rainbow Trout) Pesticide Risk Ratings with Landuse

Pesticide	Rating	Land Use	Areas
chlorpyrifos	Very High	Stone fruits, pome fruits, viticulture, irrigated cropping (canola, wheat, lucerne, barley, clover, rice & millet), vegetables, irrigated pasture	GMV, T, P-B, R, T
azinphos-methyl	Very High	Stone fruits, pome fruits	GMV
bifenthrin	Very High	Irrigated cropping (canola, wheat, lucerne, barley, clover, oats, faba beans), vegetables, irrigated pasture	T, R, T
Copper hydroxide	Very High	Vegetables, viticulture	R,
esfenvalerate	Very High	Vegetables	R
trifluralin	Very High	Irrigated pasture, irrigated cereals (wheat, oats, canola, faba beans)	P-B, T
endosulfan	Very High	Irrigated pasture, vegetables, irrigated cropping (canola, wheat, lucerne, barley, clover, oats, faba beans)	P-B, P-B, R, T
chlorothalonil	High	Irrigated cereals (wheat, oats, canola, faba beans), vegetables	R, T
phorate	High	Vegetables	R
thiram	High	Stone fruits, pome fruits	GMV
tau-fluvalinate	High	Stone fruits, pome fruits	
mancozeb	High	Stone fruits, pome fruits, viticulture, irrigated cereals (wheat, oats, canola, faba beans), vegetables, irrigated pasture	T, R, T,P-B
pendimethalin	High	Irrigated pasture, stone fruits, viticulture	P-B, GMV, R, T
metiram	High	Stone fruits, pome fruits	GMV

GMV -Central Goulburn and Murray Valley, R- Rochester Campaspe, P-B -Pyramid-Boort and T- Torrumbarry

5.3 Aquatic ecosystem (environment)

The results of risk assessment for this group of receptor environment from various pathways such as accidental spill, drift, discharge of drainage water to supply channel and illegal acts has been provided below. Aquatic ecosystem (environment) risk assessment was based on Daphnia and Algae, because toxicity (LC50 and EC50 respectively) was available for these species and they were considered representative of the aquatic ecosystem.

5.3.1 DRIFT

The results of the risk scoring for drift are shown in Appendix 9 and Appendix 10, which includes three different receptor groupings (mammalian, aquaculture and aquatic ecosystem). Figure 5-15, Figure 5-16, Table 5-15 and Table 5-16 show the highest risk scorings of drifting into water ways and affecting the Aquatic ecosystem (environment, namely Daphnia and Algae).

From Figure 5-15, **metiram (a fungicide)** appears to have the **highest risk via drifting** into water ways and affecting **Aquatic ecosystem (Algae)**. Metiram was **not** identified in high risk scores **previously** for any other receptors for either drift and spills or unlawful acts.

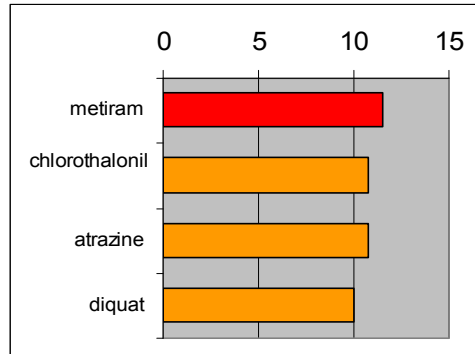


Figure 5-15 Drift -Highest Aquatic ecosystem (Algae) Pesticide Risk Ratings

Table 5-15 Drift Highest Risk Ratings for Aquatic Ecosystem (Algae) with Landuse

Pesticide	Algae Rating	Land Use	Areas
metiram	Very High	Stone fruits, pome fruits	GMV
chlorothalonil	High	Irrigated cereals (wheat, oats, canola, faba beans), vegetables	R, T
atrazine	High	Irrigated pasture,	P-B
diquat	High	Irrigated pasture, viticulture, Lucerne	P-B, GMV, R

GMV -Central Goulburn and Murray Valley, R- Rochester Campaspe, P-B -Pyramid-Boort and T- Torrumbary

From Figure 5-16, azinphos-methyl appears to have the **highest risk of drifting** into waterways and affecting **aquatic ecosystem (represented by Daphnia)**. Azinphos-methyl also had the **highest risk for spills and drift** into waterways and affecting **mammals**, and the very **high risk for drift and spills for aquaculture**.

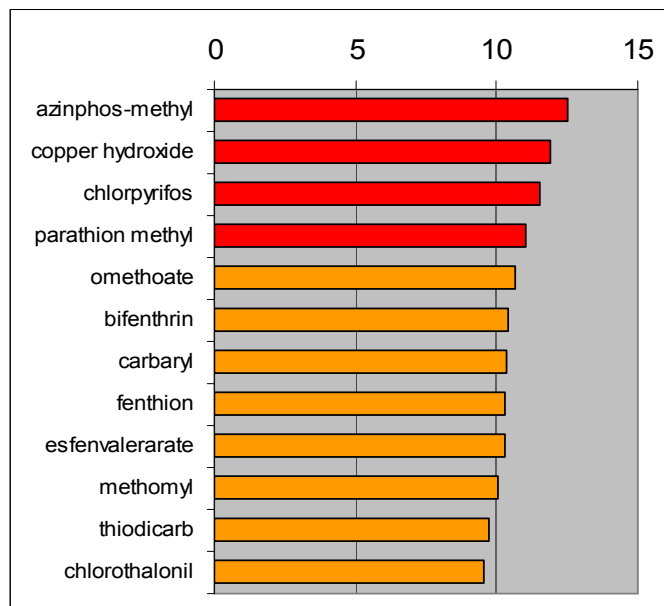


Figure 5-16 Drift-Highest Aquatic ecosystem (Daphnia) Risk Ratings

Table 5-16 Drift-Highest Aquatic ecosystem (Daphnia) Pesticide Risk Ratings with Landuse

Pesticide	Daphnia Rating	Land Use	Areas
azinphos-methyl	Very High	Stone fruits, pome fruits	GMV
copper hydroxide	Very High	Vegetables, viticulture	R
chlorpyrifos	Very High	Stone fruits, pome fruits, viticulture, irrigated cropping (canola, wheat, lucerne, barley, clover, rice & millet), vegetables, irrigated pasture	GMV, T, P-B, R, T
parathion methyl	Very High	Stone fruits, pome fruits	GMV
omethoate	High	Irrigated pasture, Lucerne	P-B, GMV, T, R, T
bifenthrin	High	Irrigated cropping (canola, wheat, lucerne, barley, clover, oats, faba beans), vegetables, irrigated pasture	T, R, T
carbaryl	High	Stone fruits, pome fruits	GMV
fenthion	High	Vegetables (tomatoes)	GMV
esfenvalerate	High	Vegetables	R
methomyl	High	Tomatoes, vegetables, viticulture	GMV, T
thiodicarb	High	Vegetables (tomatoes), vegetables	GMV, R
chlorothalonil	High	Irrigated cereals (wheat, oats, canola, faba beans), vegetables	R, T

GMV -Central Goulburn and Murray Valley, R- Rochester Campaspe, P-B -Pyramid-Boort and T- Torrumbarry

Once again from Table 5-15 and Table 5-16, it is noted that the highest ranked pesticides are often used in fruit, vegetable or viticulture areas.

5.3.2 SPILLS

The results of the risk scoring for spills are shown in Appendix 11 and Appendix 12 which includes three different receptor groupings (mammalian, aquaculture and aquatic ecosystem). Table 5-17, Table 5-18, Figure 5-18 and Figure 5-17 show the highest risk scorings of spilling into waterways and affecting the environment (aquatic ecosystems, represented by Daphnia and Algae).

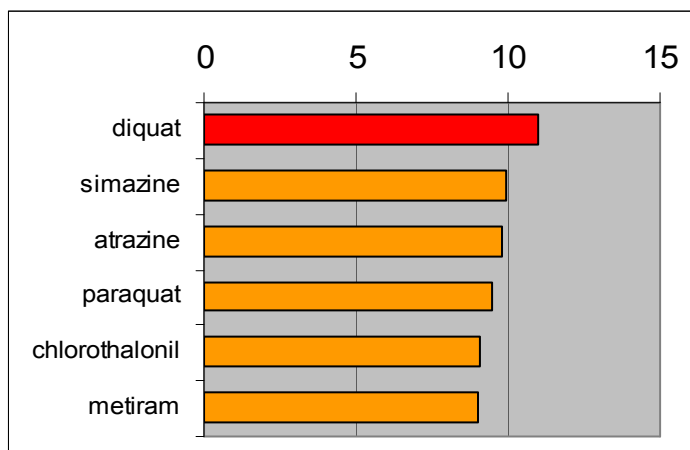


Figure 5-17 Spills Highest Aquatic ecosystem (Algae) Pesticide Risk Ratings

From Figure 5-17, **diquat** appears to have the **highest risk via spilling** into waterways and affecting **aquatic ecosystem (Algae)**. Diquat also had **high drift** risk score affecting **aquatic ecosystem (Algae)**. Diquat was **not** identified in high-risk scores **previously** for any other receptors for either drift, spills or unlawful acts.

Table 5-17 Spills Highest Aquatic ecosystem (Algae) Pesticide Risk Ratings with Landuse

Pesticide	Algae Rating	Land Use	Areas
diquat	Very High	Irrigated pasture, viticulture , lucerne	P-B, GMV, R
simazine	High	Irrigated pasture, viticulture	P-B, R
atrazine	High	Irrigated pasture,	P-B
paraquat	High	Stone fruits, pome fruits	T
chlorothalonil	High	Irrigated cereals (wheat, oats, canola, faba beans), vegetables	R, T
metiram	High	Stone fruits, pome fruits	GMV

GMV -Central Goulburn and Murray Valley, R- Rochester Campaspe, P-B -Pyramid-Boort and T- Torrumbary

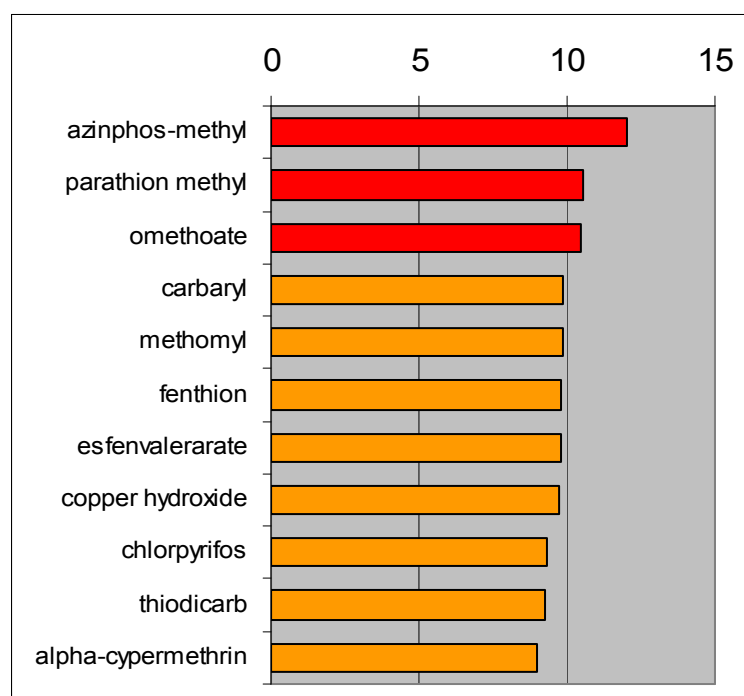


Figure 5-18 Spills Highest Pesticide Risk Ratings for Aquatic ecosystem (Daphnia)

From Figure 5-18, **azinphos-methyl** appears to have the **highest risk of spilling** into waterways and affecting **aquatic ecosystem (Daphnia)**. Azinphos-methyl also had the **highest risk for spills and**

drift into waterways and affecting mammals and aquatic ecosystem (Daphnia), and the very high risk for drift and spills for aquaculture.

Table 5-18 Spills Highest Risk Ratings for Aquatic ecosystem (Daphnia) with Landuse

Pesticide	Daphnia Rating	Land Use	Areas
azinphos-methyl	Very High	Stone fruits, pome fruits	GMV
parathion methyl	Very High	Stone fruits, pome fruits	GMV
omethoate	Very High	Irrigated pasture, irrigated pasture (fat lambs, cattle, dairy), Lucerne	P-B, GMV, T, R, T
carbaryl	High	Stone fruits, pome fruits	GMV
methomyl	High	Tomatoes, vegetables, viticulture	GMV, T
fenthion	High	Vegetables (tomatoes)	GMV
esfenvalerate	High	Vegetables	R
copper hydroxide	High	Vegetables, viticulture,	R,
chlorpyrifos	High	Stone fruits, pome fruits, viticulture, lcrops (rice & millet, canola, wheat, lucerne, barley, clover), vegetables, viticulture, irrigated pasture	GMV, T, P-B,R, T
thiodicarb	High	Vegetables (tomatoes), vegetables	GMV, R
alpha-cypermethrin	High	Irrigated pasture, vegetables,	GMV, Pyramid Hill (T)

GMV -Central Goulburn and Murray Valley, R- Rochester Campaspe, P-B -Pyramid-Boort and T- Torrumbary

Once again from Table 5-17 and Table 5-18, the highest ranked pesticides are often used in fruit, vegetable or viticulture areas.

5.3.3 UNLAWFUL ACTS

The results of the risk scoring for unlawful acts are shown in shown in Appendix 13 and Appendix 14.

Recall that the risk score for Unlawful acts was defined via the following formula.

$$\text{Unlawful Acts Risk Score for Mammals} = \log(\text{volume}) + 2 + \log(\% \text{ active}) + 5 - \log \text{LD50(Rat)}$$

Recall also that this unlawful acts risk scoring is very rough. Additional information on cost and disposal cost of pesticides will improve this risk score.

Table 5-19, Table 5-20, Figure 5-19 and Figure 5-20 show the highest risk scorings via unlawful acts of getting into water ways and affecting the environment (aquatic ecosystems, namely Daphnia and Algae).

From Figure 5-19, atrazine appears to have the highest risk via unlawful acts of getting into waterways and affecting aquatic ecosystem (Algae). Atrazine also had high drift and spills risk

score affecting **aquatic ecosystem (Algae)**. Atrazine was **not** identified in high-risk scores **previously** for any other receptors for either drift and spills or unlawful acts.

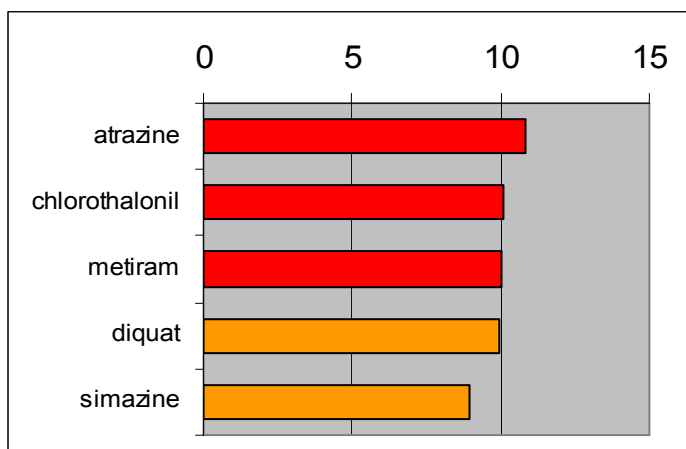


Figure 5-19 Unlawful Acts Highest Risk Ratings for Aquatic ecosystem (Algae)

Table 5-19 Unlawful Acts Highest Risk Ratings for Aquatic ecosystem (Algae) with Landuse

Pesticide	Algae Rating	Land Use	Areas
atrazine	Very High	Irrigated pasture	P-B
chlorothalonil	Very High	Irrigated cereals (wheat, oats, canola, faba beans), vegetables	R, T
metiram	Very High	Stone fruits, pome fruits	GMV
diquat	High	Irrigated pasture, viticulture, Lucerne	P-B, GMV, R
simazine	High	Irrigated pasture, viticulture	P-B, R

GMV -Central Goulburn and Murray Valley, R- Rochester Campaspe, P-B -Pyramid-Boort and T- Torrumbary

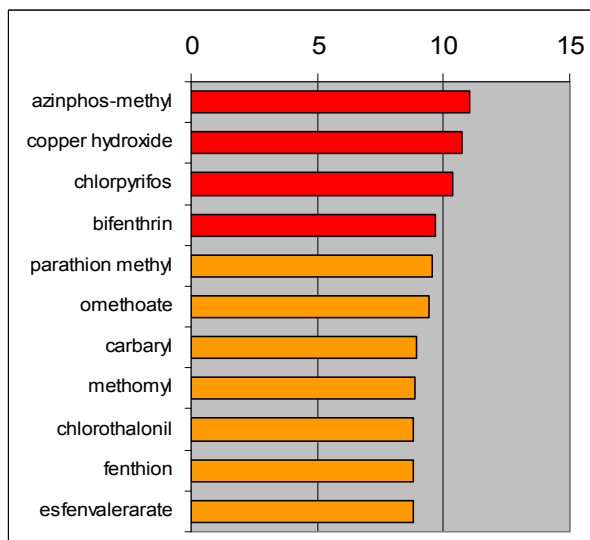


Figure 5-20 Unlawful Acts Highest Risk Ratings for Aquatic ecosystem (Daphnia)

From Figure 5-20, **azinphos-methyl** appears to have the **highest risk via unlawful acts** of getting into waterways and affecting **aquatic ecosystem (Daphnia)**. Azinphos-methyl also had the **highest risk for spills and drift** into waterways and affecting **mammals and aquatic ecosystem (Daphnia)**, and the very **high risk for drift and spills for aquaculture**.

Table 5-20 Unlawful Acts Highest Risk Ratings for Aquatic ecosystem (Daphnia) with Landuse

Pesticide	Daphnia Rating	Land Use	Areas
azinphos-methyl	Very High	Stone fruits, pome fruits	GMV
copper hydroxide	Very High	Vegetables, viticulture	R,
chlorpyrifos	Very High	Stone fruits, pome fruits, viticulture, crops (canola, wheat, lucerne, barley, clover, rice & millet), vegetables, irrigated pasture	GMV, T, P-B,R, T
bifenthrin	High	Irrigated cropping (canola, wheat, lucerne, barley, clover, oats, faba beans), vegetables, irrigated pasture	T, R, T
parathion methyl	High	Stone fruits, pome fruits	GMV
omethoate	High	Irrigated pasture, Lucerne	P-B, GMV, T, R, T
carbaryl	High	Stone fruits, pome fruits	GMV
methomyl	High	Tomatoes, vegetables, viticulture	GMV, T
chlorothalonil	High	Irrigated cereals (wheat, oats, canola, faba beans), vegetables	R, T
fenthion	High	Vegetables (tomatoes)	GMV
esfenvalerate	High	Vegetables	R

GMV -Central Goulburn and Murray Valley, R- Rochester Campaspe, P-B -Pyramid-Boort and T- Torrumbary

5.4 Pastures

The results of risk assessment for this group of receptor environment from two pathways namely: drift and discharge of drainage water to supply channel has been provided below.

5.4.1 DRIFT and DRAINAGE DISCHARGE into water supply channels

A combined list of all herbicides (see Appendix 5 Appendix 5 for herbicides) used in all irrigations areas in Goulburn Murray were assessed for potential mobility through drainage water and therefore potential risk to pastures. In total, 33 herbicides were identified to be commonly used in the G-MW area. The mobility rating for various herbicides is provided in the following figure (Figure 5-21). Fifteen herbicides were rated to have medium or higher risk, whereas the remaining 18 herbicides fell into low risk category.

The herbicides with medium to high risk were assessed further for their potential phytotoxic impact on the pasture crops. In addition, due to the high potency of sulfonylurea group of herbicides, these have also been included in this assessment. The overall risk rating for these herbicides is given in Table 5-21.

Several herbicides, although rated to have medium or high risk of movement off-site, were found to be commonly used in irrigated pastures and therefore small contamination with these herbicides is not expected to pose any risk to the growth of pastures. However, only two herbicides (molinate, glufosinate ammonium) were rated to be a significant potential risk (medium) to pastures in the irrigation areas. Molinate is used in rice production, whereas glufosinate ammonium herbicide is used in fruits.

Leguminous pastures (medics, lucerne, clover) as well as crops such as canola, peas and faba beans are known to be highly sensitive to the sulfonylurea group of herbicides (chlorsulfuron, metsulfuron methyl, triasulfuron etc.). These herbicides are also highly mobile in water. Their current use in the G-MW is small and therefore their risk rating is low. However, with time if their use increases or if they are used more intensively in a given area, they may present significant risk to pasture production if the irrigation water is contaminated with these herbicides.

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

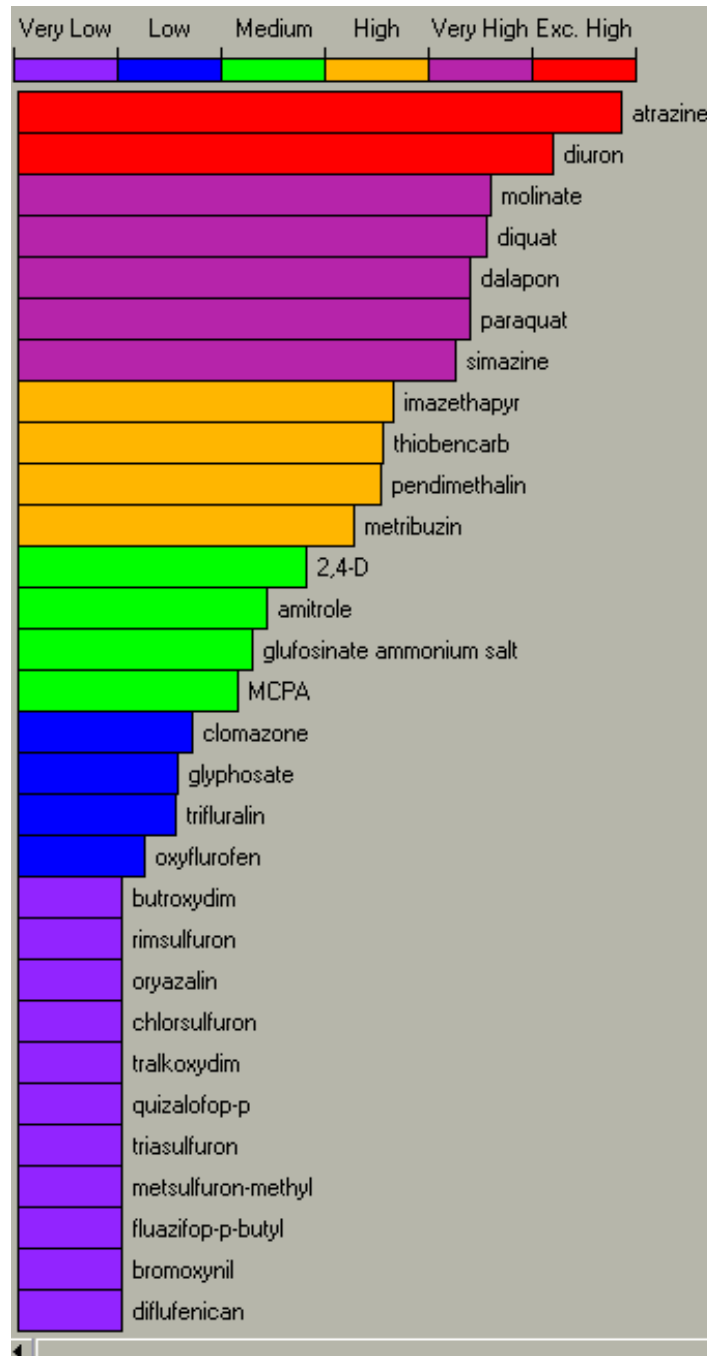


Figure 5-21 Potential mobility rating for herbicides used in all six irrigation areas in the Goulburn Murray

Table 5-21 Overall risk rating for various herbicides for their potential impact on pasture growth, if contaminated water is used for irrigation

Pesticide	Mobility rating	Where used crop (area)*	Risk rating for pastures
atrazine	High	Irrigated Pasture (MV, PB)	Low
diuron	High	Irrigated Pasture (RC, T)	Low
molinate	High	Rice (GMV)	Medium
diquat	High	Irrigated Pasture, Viticulture, Lucerne (PB, GMV, RC)	Low
paraquat	High	Fruits (T)	Low
simazine	High	Irrigated Pasture, viticulture (PB, RC)	Low
imazethapyr	High	Lucerne (T)	Low
thiobencarb	High	Rice, irrigated cropping (GMV, T)	Low
pendimethalin	High	Irrigated pasture (PB, GMV, RC, T)	Low
metribuzin	High	Vegetables (CG, MV, RC)	Low
2,4-D	Medium	Irrigated pasture (GMV, PB)	Low
amitrole	Medium	Irrigated pasture (PB)	Low
glufosinate	Medium	Fruits (CG,T)	Medium
ammonium salt			
MCPA	Medium	Irrigated pastures and cropping (PB, GMV, T)	Low
Chlorsulfuron	Low	Irrigated pastures**, irrigated cereals (PB, T)	Low#
metsulfuron methyl	Low	Irrigated pastures**, irrigated cereals (PB, T)	Low#
Triasulfuron	Low	Irrigated cereals (T)	Low#
Bensulfuron	Low	Rice and Millet (GMV, T)	Low#
Rimsulfuron	Low	Vegetables (RC)	Low#

* CG= Central Goulburn; MV=Murray Valley, PB= Pyramid-Boort, RC= Rochester Campaspe; T=Torrumbarry

** The information was taken from the pesticide survey report, but authors suggest that this should be checked again, as the herbicide is known to adversely impact leguminous pastures.

Leguminous pastures are particularly sensitive to sulfonylureas. The rating is low due to currently low use in the area. However, the risk may be higher where these herbicides are used more intensively or if their use increases in the irrigation area.

5.5 Combined Risk

Complete table of the combined risk for each receptor is shown in Appendix 15, calculated across drift, spills and unlawful acts. As mentioned previously in the next phase of work, drainage discharge (runoffs) could also be incorporate into this combined risk score.

Recall **combined risk (4.3.5.1) across pathways** was calculated as shown in the formula below.

Combined (Drift, Spills and Unlawful Acts) Risk Score =

$$(\text{Drift Score} + 0.25 * \text{Spills Score} + 0.125 * \text{Unlawful Acts Score}) / 1.375$$

for each of the four receptor species (rat, Rainbow trout, Daphnia Score and algae).

Also recall **combined risk (4.3.5.2) across receptors** was calculated as shown in the formula below.

$$\text{Overall Sum}^* = (\text{Rat Score} + \text{Rainbow trout Score} + 0.82 * \text{Daphnia Score} + 0.38 \text{ Algae Score}) / 3.2$$

for each pesticide.

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

Pesticides with “**Very High**” combined risk ratings are shown in Table 5-22. **83%** (15 out of 18) of these pesticides were used where **fruit or vegetables** were grown.

In contrast, Table 5-23 lists pesticides with the lowest combined risk ratings (i.e. Overall Sum*). Of the 21 pesticides with the lowest combined risk (Overall Sum*), only **14%** were applied in areas where **fruit or vegetables** were grown.

Table 5-22 Very High - Combined Pesticide Risk Rating with Land Use

Pesticide	Receptors:				Over all	Land Use						Districts where used					
	Humans Animals	Aqua-culture	Aquatic ecosystems			Fruit	Vegies	Vines	Pasture	Crops	Rice	CG	MV	Boort	Kerang	Rochester	Swan Hill
azinphos-methyl	Very High	Very High		Very High	12.08												
copper hydroxide	High	Very High		Very High	10.76												
parathion methyl	Very High	High		Very High	10.47												
chlorpyrifos	Moderate	Very High		Very High	10.32												
omethoate	Very High	Moderate		Very High	10.08												
esfenvalerate	Moderate	Very High		Very High	9.91												
methomyl	Very High	Moderate		High	9.77												
thiram	High	Very High			9.74												
bifenthrin	Moderate	Very High		Very High	9.67												
mancozeb	High	Very High			9.67												
metiram	Moderate	High	Very High	Moderate	9.18												
chlorothalonil	Moderate	Very High	Very High	High	9.18												
fenthion	Moderate	Moderate		Very High	9.23												
carbaryl	Moderate	Moderate		Very High	9.18												
tau-fluvalinate	Moderate	Very High		High	9.00												
atrazine	Moderate	Moderate	Very High	Low	8.05												
diquat	Moderate	Low	Very High		7.81												
endosulfan	Moderate	Very High		Very Low	7.86												

Note: In some cases 'areas where used' was missing.

Table 5-23 Very Low – Combined Pesticide Risk Rating with Land use

Pesticide	Rat Rating	R Trout Rating	Algae Rating	Daphnia Rating	Sum*	Fruit	Vegies	Vines	Pasture	Crops	Rice	CG	MV	Boort	Kerang	Rochester	Swan Hill	Pyramid Hill
metalaxyl	Very Low	Very Low		Very Low	2.39													
butoxydim	Very Low	Very Low		Very Low	2.49													
metsulfuron-methyl	Very Low	Very Low			2.63													
diuron	Very Low	Very Low		Very Low	3.58													
ammonium glufosina	Very Low	Very Low		Very Low	3.69													
propaquizafop	Very Low	Very Low	Very Low	Very Low	4.05													
fluazifop-p-butyl	Very Low	Very Low	Moderate	Very Low	4.12													
bensulfuron	Very Low	Very Low	Very Low	Very Low	4.15													
quizalofop-p	Very Low	Very Low		Very Low	4.71													
trifluralin	Very Low	Low	Very Low	Very Low	4.80													
diflufenican	Very Low	Very Low	Low	Very Low	5.19													
imazethapyr	Very Low	Very Low		Very Low	5.25													
thiobencarb	Very Low	Low	Very Low	Very Low	5.47													
fluroxypyr	Low	Very Low	Very Low	Very Low	5.53													
triasulfuron	Very Low	Low	Low	Very Low	5.59													
oryzalin	Very Low	Low	Low	Very Low	5.67													
clomazone	Very Low	Very Low	Low	Very Low	5.74													
fenoxaprop-p	Moderate	Very Low		Very Low	5.74													
penconazole	Very Low	Low		Very Low	5.85													
phorate	Low	Very Low			5.98													
chlorsulfuron	Low	Low	Moderate	Very Low	6.03													

6. Discussion and Recommendations

Only a fraction of the pesticides that are used in the G-M study area are likely to reach the waterways. A diagrammatic representation is given in Figure 6-1. Much of this study is concerned with quantifying the movements that are described in that diagram, and hence obtaining an indication of their likely harm on the various receptors.

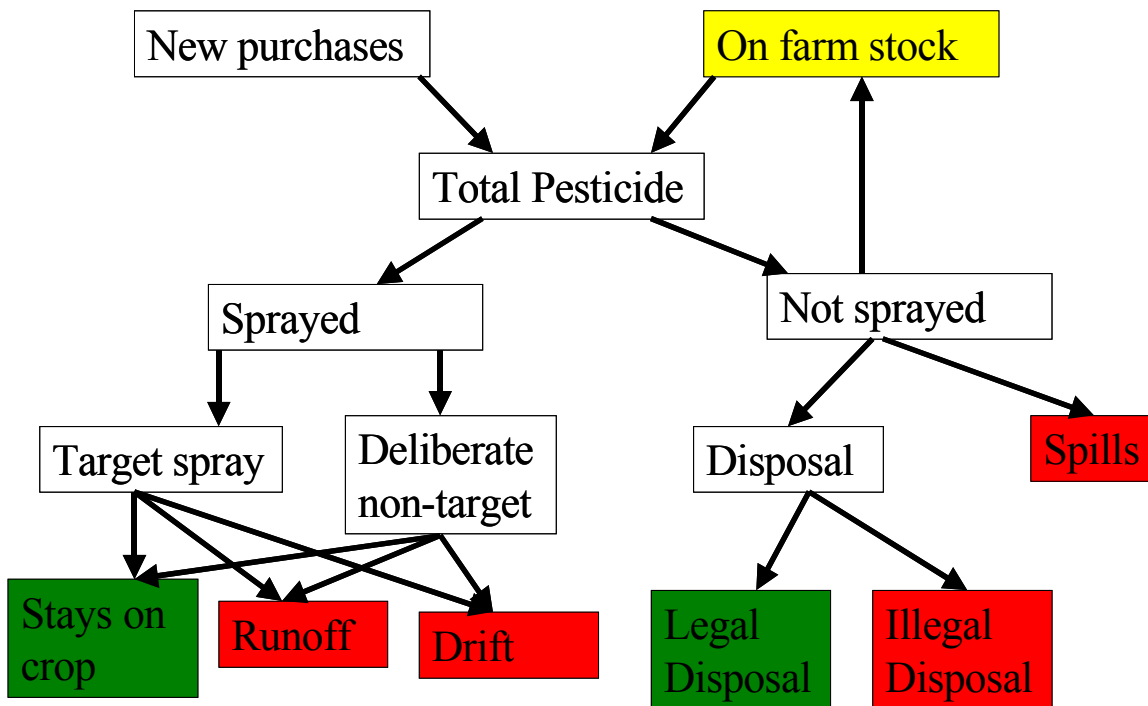


Figure 6-1 Diagrammatic fate of pesticides in the study area

It may be feasible to quantify various components of that diagram. For example, the amount of pesticides purchased is known and those data were a major input to this study. Other components could be obtained by a non-threatening survey. Such components could include

- Details of the stock of pesticides on a farm, and whether they contributed to that years spray program;
- The spray diaries could be used to estimate the amount of pesticide sprayed;
- Excess diluted pesticide may be disposed of by spraying on some other crop as a form of disposal;
- The amount of pesticide that is legally disposed of through registered waste removers could be obtained either from growers or from those registered to dispose of pesticides.

Estimates of run off and drift can be obtained using methods outlined in this report in sections 4.3.1 and 4.3.2.

The benefits of such modelling would be

- a. to quantify the amount of pesticide that is stored on farms;
- b. quantify the amount being disposed of legally;
- c. Provide an estimate of other losses of pesticide.

Such information could be obtained through an audit process. Such a process would require careful planning and sensitive management. We therefore recommend the following

Recommendation 1. That Goulburn-Murray Water consider an audit of pesticides use patterns across the different farming sectors in the six Irrigation Areas.

The risk assessment results presented in this report are valid for comparisons between pesticides, but they, at least at this stage, have no absolute basis (the risks are relative to each other). Data are available on the length and width of the irrigation channels (refer to Appendix 17 and Appendix 1), so an approximation could be made as to how much pesticide drifts into these channels. This could be compared with the amounts that could run-off paddocks and also with projected amounts that could be expected from spills.

There is a clear distinction between the risk from spills (acute) and the risk from drift (chronic). In the case of spills, there is a low probability of a major accident, but the consequences would be high. By contrast, there is a high probability of drift occurring, but the consequences would not be as severe as would be those of say, an overturned truck carrying pesticide.

Even though risks have been assessed on a relative scale, risks can be markedly different. Let us consider the risk of pesticides drifting into irrigation channels and affecting mammals. The risk for azinphos-methyl (Very High) was about 30 times that of methomyl (High), and about 500 times that of sulphur (moderate). Certainly in this case the **risk from different pesticides are markedly different**.

Results presented are **relative risks**. These risks are very dependent upon the **quantity used** for each pesticide. This may cause some confusion. For example if a new pesticide which is very similar to an existing pesticide only gets a **low usage**, then the **relative risk for drift, spills and unlawful acts** calculated will be **low**, because these three risk estimates take the total amount of pesticide used into account. Increasing the quantity used of this new pesticide will increase the relative risk from this pesticide, and may not necessarily reduce the overall pesticide risk.

The risk from the run-off pathway was assessed using PIRI – that does take into account the half-life of the pesticide. This study has not considered the persistence of all the pesticides for drift, spills and illegal acts pathways. This could be important, as some pesticides, particularly copper hydroxide, are persistent and could accumulate. The risk from persistent, accumulating pesticides such as copper hydroxide, may well increase with time, whereas the risk from a non-persistent pesticide would not accumulate. This limitation should be addressed with further study. Hence we make the following recommendation.

Recommendation 2. Persistence of pesticides should be considered in future 2nd tier risk assessments.

Recommendation 3. Cumulative risks of persistent pesticides need further investigation.

A further limitation is that despite the current effort that has been expended on obtaining pesticide use data, there are still some gaps. In some cases (e.g. the use of pesticides in olive plantations) this is due to a recent change in land use in the Pyramid-Boort Irrigation Area. A complete picture of the pesticide use is necessary to undertake a thorough risk assessment. Some of the gaps identified are given below.

For Kerang there are no pesticide data available for irrigated crops (including rice and millet), vegetables (including onion seed) and citrus. Similarly for the Pyramid–Boort area, there are no data for irrigated crops, tomatoes and viticulture. There is also no data on the expanding olive industry. No data are available of the emerging kiwifruit industry in the Shepparton area. We therefore make the following recommendation.

Recommendation 4. The collection of pesticide use data should continue, with emphasis on usage by new crops (including onion seed and olives).

6.1 Mammals (humans, stock, domestic use and food processing industry)

The pesticides identified to be of potential risk to mammal via different exposure pathways (drift, runoff, accidental spills and unlawful acts), were generally found to be the same. These are shown in Table 6-1.¹ The main drivers of these risks were

- (i) their toxicity to mammals and
- (ii) the quantity used in G-MW.

The majority of the pesticides identified to be of potential risk via the above four pathways are used in fruit and vegetable production systems, located mainly in the Goulburn-Murray Valley. This provides the focus for future actions, especially to carry out the 2nd Tier Risk Assessment. This leads to the following recommendation

Recommendation 5. The pesticides listed in Table 6-1 be monitored to validate the findings of the current 1st tier risk assessment.

Table 6-1 Pesticides presenting largest risk to mammals (rats)

Pesticide	Exposure pathways with High Risk	Land Use
azinphos-methyl	Drift Spills Unlawful	Stone fruits, pome fruits
parathion methyl	Drift Spills Unlawful	Stone fruits, pome fruits
omethoate	Drift Runoff Spills	pasture, Lucerne
Phorate	Runoff Unlawful	vegetables
methomyl	Runoff Spills	vegetables, viticulture

An examination of Table 6-1 and Table 5-22 indicates that the majority of the pesticides considered as high risk are associated with vegetables or fruit. Resources should be concentrated on monitoring pesticide use, drift and runoff where vegetables and fruit are grown. This leads to the recommendation

¹ Only pesticides with high risk in at least two pathways were included in Table. For example via drift and runoff

Recommendation 6. Pesticide monitoring should be concentrated where fruit and vegetable are grown.

The tier 1 analysis indicates that fruit and vegetable landuses present the greatest risk from pesticides. A more details study of these areas should be undertaken, involving concentrations of pesticides and specific ecotox data, thus performing a 2nd tier risk assessment. If that risk proves to be minimal, then it can be inferred that the other risks are also low. We therefore make the following recommendation.

Recommendation 7. A 2nd tier risk assessment be carried out for fruit and vegetable landuses.

Currently pesticide use in citrus is not known, this should be obtained. Similarly, the onion seed crop industry is expanding and pesticide use in this landuse should be assessed. Also there is no information on pesticide use on tomatoes in the Pyramid-Boort irrigation area. We therefore make the following recommendation

Recommendation 8. Pesticide information for citrus and onion seed, and on tomatoes in the Pyramid-Boort irrigation area be obtained.

Spray drift is considered a potential problem for contamination of waterways. This threat could be minimised by adopting best practice in the use of spray applications. This may require an education program. Similarly efforts need to be made to minimise the risk from accidental spills. We therefore make the following recommendation

Recommendation 9. The G-MW water authority encourage best-practice to reduce spray drift and accidental spills.

6.2 Aquaculture

For aquaculture, a number of pesticides were noted to present a potentially high risk via drift, accidental spill and unlawful acts. Generally, those pesticides affecting mammals (rats) also had high pesticide risk for aquaculture (using rainbow trout as a surrogate target species).

Several insecticides identified in the high-risk category belong to organophosphate (chlorpyrifos, azinphos-methyl) and pyrethroid (esfenvalerate, bifenthrin) classes.

In addition, some fungicides (including copper hydroxide) and herbicides were also rated to be of potential risk to aquaculture. The following pesticides in Table 6-2 were identified as priority compounds for further investigations from Table 5-12, Table 5-13 and Table 5-14. Table 6-2 only lists pesticides with more than one exposure pathway with very high risk.

Table 6-2 Pesticides presenting largest risk to Aquaculture (Rainbow Trout)

Pesticide	Exposure pathways with Very High Risk	Land Use
chlorpyrifos	Drift Spills Unlawful	Fruits, viticulture, crops vegetables, pasture
azinphos-methyl	Drift Spills Unlawful	Fruits
esfenvalerate	Drift Spills Unlawful	Vegetables
copper hydroxide	Drift Unlawful	Vegetables, viticulture
bifenthrin	Drift Unlawful	Crops, vegetable, pasture
trifluralin	Spills Unlawful	pasture, cereals
endosulfan	Spills Unlawful	pasture, vegetables, crops cereals

Several of these pesticides (especially the insecticides) are used in fruits and vegetables and some (e.g. endosulfan) are used more widely. Azinphos methyl was also found to be of high risk to mammalian group of receptors.

The first step to quantify the risk to aquaculture would be to identify what is threatened. This involves identifying the location and size of the aquaculture establishments. We therefore recommend the following.

Recommendation 10. Identify key areas used for aquaculture and the dominant landuse in proximity to those areas.

This 1st tier risk assessment has identified the pesticides in Table 6-2 and Table 5-22 as presenting the greatest risk to aquaculture. Confirmation of the threat should be obtained by monitoring the aquaculture establishments for those pesticides. Thus we recommend the following

Recommendation 11. Aquaculture establishments should be monitored for those pesticides identified as posing a high risk (as define in Table 6-2).

Note: if it happens to be fruit and vegetable production area in the Goulburn Murray Valley – then the single monitoring study would cover the two receptor groups, mammals and aquaculture.

If pesticide is detected in the aquaculture establishments, a 2nd tier risk assessment should be undertaken. This would take into account not only mortality, but also chronic toxicity and decreased production levels. We therefore make the following recommendation.

Recommendation 12. If pesticide is detected in an aquaculture establishment, a 2nd tier risk assessment that includes chronic effects should be undertaken.

Some reduction in the risk to aquaculture could be achieved by using best industry practice. This is covered in Recommendation 9.

6.3 Aquatic Ecosystem (Environment)

The pesticides identified to be of potential high risk to aquatic ecosystems via different exposure pathways (drift, accidental spills and unlawful acts) are shown in Table 6-1. The main drivers of these risks were

- (i) their toxicity² to aquatic ecosystem organisms and
- (ii) the quantity used in G-MW.

Metiram, diquat and atrazine were found to be high risk to algae, but were not identified as very high pesticide risk for any other receptors (namely mammals, rainbow fish or daphnia).

The majority of the pesticides identified to be of potential risk via the above three pathways are used in fruit and vegetable production systems, located mainly in the Goulburn-Murray Valley. This provides the focus for future actions, especially to carry out the 2nd Tier Risk Assessment. This leads to the following recommendation

Table 6-3 Pesticides presenting largest risk to aquatic ecosystems (algae & Daphnia)

Pesticide	Exposure pathways with Very High Risk	Land Use
azinphos-methyl	Drift Spills Unlawful	Fruits
copper hydroxide	Drift Unlawful	Vegetables, viticulture
chlorpyrifos	Drift Unlawful	Fruits, viticulture, crops vegetables, pasture
metiram	Drift Unlawful	Fruits
diquat	Spills	pasture, viticulture, Lucerne
parathion methyl	Spills	Fruits
omethoate	Spills	pasture, Lucerne
atrazine	Unlawful	Irrigated pasture,
chlorothalonil	Unlawful	Cereals, vegetables

Recommendation 13. Aquatic ecosystems should be monitored for those pesticides identified as posing a high risk (those shaded red in Table 6-1).

62% of algae eco-toxic acute studies for pesticides were **missing**. Similarly, toxicities for **18%** of pesticides for **Daphnia** were **unavailable**. This is shown as blank cells in Appendix 10, Appendix 11 and Appendix 14. Even less chronic studies have been undertaken on Daphnia and algae. These **gaps** in eco-toxic studies make it extremely difficult to assess risk to the aquatic ecosystem receptor group. Only comparisons of the risk of pesticides with available toxicities are valid.

² Only the effects of the products per se are considered in this report. The authors are aware that in some cases daughter products can be more toxic than the original compounds.

The monitoring cost may be reduced by focusing on pesticides that pose high risk to mammals, aquaculture and aquatic ecosystems. This is summarised in the recommendation below.

Recommendation 14. Where possible, monitoring should be combined to assess the risks to mammals and aquaculture, to reduce cost and increase efficiency.

6.4 Pastures

Risk of supply water contaminated with herbicides to pasture production system was assessed. The risk did not include any impact on grazing animals, say via contaminated fodder or ingestion of soil or dust particles during grazing. The main mechanism of risk was assumed to be the phytotoxic effect of herbicides on the pasture production.

The majority of herbicides used in the G-MW region were noted to be registered for use in pastures and therefore fell into the category of low risk.

Only two herbicides were rated to be **high risk**. These were **molinate** -a rice herbicide and **glufosinate ammonium** – a herbicide used in fruit production. Note that these results are valid only for pastures and not for other important crops, such as tomatoes, canola or beans.

Preliminary calculations indicate that the risk from spray drift via irrigation channels will be reduced significantly by dilution in the irrigation channel. Such a calculation is given below. The amount of spray drift that is likely to fall into an irrigation channel is likely to be quite small when compared to the volume of water in that channel. For example, with a channel that is 5.8 m wide and 1 m deep, it is unlikely that 0.1 mm depth of spray would fall into the channel. If we assume that a small field (100 m by 100 m) is sprayed, almost 60 L would be required to achieve this 0.1 mm depth. Even such extreme conditions would result in a 10,000-fold dilution of the pesticide. The risk of harm to pastures from this source of pesticide is therefore considered extremely low.

There may be pathways other than drift that may pose a more serious to pastures. For example illegal acts or accidental spills may cause harmful concentrations.

The effect of direct drift from one field to another would not be subject to dilution – in fact it could be concentrated by evaporation from the droplets. This pathway is beyond the scope of this study.

The following recommendations are made concerning pastures, crops and other plants.

Recommendation 15. Pesticide risks to pasture are generally low and should be given a relatively low priority.

However, the sulfonylureas herbicides are a potentially “high-risk” group for pastures and other sensitive crops, such as canola, chickpeas, faba beans, etc.

Recommendation 16. Sulfonylureas herbicide use should be carefully assessed, especially upstream or in proximity of leguminous pastures.

Recommendation 17. For high value crops such as tomatoes, viticulture and other horticultural crops, separate risk assessment needs to be made for herbicides used on these crops.

Recommendation 9, which encourages best-practice to reduce spray drift and accidental spills, will help in minimise any risk to crops and other plants also.

Five pesticides used in Pyramid Boort, irrigated pastures (atrazine, diquat, mancozeb, simazine and pendimethalin) were rated to have high or very high risk of off-site migration through drainage water. Four pesticides (2,4-D, omethoate, endosulfan and MCPA) were rated to have medium potential risk of off-site migration. The remaining fourteen pesticides were assessed to be of low migration risk.

Many of these pesticides are commonly used in pasture production in other areas also.

6.5 Combined Risk

It was thought that drift would be more likely than spills which in turn would be more likely than unlawful acts, therefore to get a picture of what is the risk across all three pathways a weighted sum of their risk score was calculated. At this stage we cannot readily include Drainage Discharge (runoff) into this combined risk score. However we propose to do this in tier 2.

The manner in which run-off should be incorporated into the combined risk score will depend on the fate of the drainage water. In many cases, the irrigation channels are higher than the surrounding irrigated areas, so there is little possibility of the drainage water entering the irrigation channels and affecting plants and other receptors via contaminated irrigation water. However, there is the possibility of pesticide residues in the drainage water affecting aquatic system health. Knowledge of the fate of the drainage water is therefore critical in assessing the contribution of this pathway to the overall risk.

We therefore make the following recommendation.

Recommendation 18. Data should be obtained on the fate of the Drainage Discharge (run-off). If adequate data are not available, a study should be commissioned to obtain those data.

Once data are available on the fate of the run-off, some risk score that combines all four pathways should be formed. Currently a combined risk score is used that omits run-off. This is implicitly giving zero weight to run-off. Clearly some improvement is required. We therefore make the following recommendation.

Recommendation 19. Incorporation of drainage discharge into combined risk score.

The current weightings used in the risk score are based on the rankings indicated for each of the four pathways. The weightings are therefore subjective. Further study is required to devise a new combined index that uses objective weightings for the pathways.³

Recommendation 20. Objectively determine weightings for combined risk score.

A summary of priorities is listed in the following Table 6-4.

³ We note in passing that the combined risk indices suggested in this report are in effect weighted geometric means

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

Table 6-4 Priority Recommendations for Management Decisions

ASPECTS	TASKS	TARGETS	REMARKS	MANAGEMENT PRIORITY
1. PESTICIDE TO BE MONITORED	1a. Pesticides (listed in the next column) should be monitored in channels passing through the intensive fruits and vegetables (tomatoes) production areas , in particular in Central Goulburn, Shepparton and Murray Valley Irrigation areas (Goulburn-Murray Valley)	Organophosphate 1. Azinphos methyl 2. Parathion methyl 3. Omethoate	a. Very likely chance of contaminating channel water via spray drift and affecting human, stock, domestic use and food processing b. Spray drift/over-spray is suspected to cause about 90% exposure pathway to G-MW water supply channels	High
		Carbamate 1. Methomyl 4. Thiodicarb Fungicides 2. Ziram 3. Copper hydroxides 4. Mancozeb 4. Thiram	Likely chance of contaminating channel water via spray drift and affecting human, stock, domestic use and food processing	Medium
	1b. Pesticides (listed in the next column) should be monitored in channels passing through intensive aquaculture farming areas covering all G-MW Irrigation Areas	Organophosphate 1. Chlorpyrifos 2. Azinphos methyl Synthetic Pyrethroids 3. Esfenvalerate 5. Bifenthrin Fungicides 4. Copper hydroxides	Very likely chance of contaminating channel water via spray drift and affecting aquaculture	High
		Organochlorine 6. Endosulfan Synthetic Pyrethroids 2. Taufluvinate Herbicides 3. Chlorothalonil Fungicides 1. Thiram 4. Mancozeb 7. Ziram 5. Metiram	Likely chance of contaminating channel water via spray drift and affecting aquaculture	Medium
	1c. Pesticides (listed in the next column) should be monitored in channels passing through the intensive leguminous pastures and crops (canola, chickpeas, fababeans) production areas covering all G-MW Irrigation Areas	Herbicides 1. Molinate 2. Glufosinate Ammonium 3. Various Sulfonyl ureas	Likely chance of contaminating channel water via spray drift & drainage discharge and affecting pastures and crops	Medium
		Herbicides 1. Atrazine 2. Diuron 3. Diquat 4. Paraquat 5. Simazine 6. Imazethapyr 7. Thiobencarb 8. Pendimethalin 9. Metribuzin	Some chance of contaminating channel water via spray drift & drainage discharge and affecting pastures and crops	Low
	1d. Pesticides (listed in the next column) should be monitored in channels passing	Organophosphate 1. Azinphos methyl	Very likely chance of contaminating channel water via spray drift & drainage discharge	High

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

ASPECTS	TASKS	TARGETS	REMARKS	MANAGEMENT PRIORITY
	through fruits and vegetables production areas , and in channel outfalls (outfalls to ecologically sensitive areas) covering all G-MW Irrigation Areas	2. Chlorpyrifos 3. Parathion methyl <i>Fungicides</i> 4. Copper hydroxides 5. Metiram	and affecting aquatic environment (algae & Daphnia)	
		<i>Organophosphate</i> 8.Chlorothalonil 1.Omethoate 4.Fenthion <i>Herbicides</i> 9.Atrazine 10.Diquat <i>Pyrethroids</i> 2.Bifenthrin 5.Esfenvalerate <i>Carbamate</i> 3.Carbaryl 6.Methomyl 7.Thiodicarb	Likely chance of contaminating channel water via spray drift & drainage discharge and affecting aquatic environment (algae & Daphnia)	Medium
	1e. Pesticides (listed in the next column) should assess the impacts of all exposure pathways (drift, spills, unlawful acts) and to all receptors organisms (human, aquaculture, aquatic environment) in fruits and vegetables production areas	<i>Organophosphate</i> 1.Azinphos methyl 3. Parathion methyl 4.Chlorpyrifos <i>Fungicides</i> 2.Copper hydroxides	Very likely chance of contaminating channel water via all pathways (spray drift, spills, unlawful acts) and affecting all receptors (human, aquaculture, aquatic environment)	High
		<i>Organophosphate</i> 1.Omethoate <i>Pyrethroids</i> 2. Esfenvalerate 5.Bifenthrin <i>Carbamate</i> 3.Methomyl <i>Fungicides</i> 4.Thiram 6.Mancozeb	Likely chance of contaminating channel water via all pathways (spray drift, spills, unlawful acts) and affecting all receptors (human, aquaculture, aquatic environment)	Medium
ASPECTS	TARGETS			MANAGEMENT PRIORITY
2. PESTICIDE MONITORING SITES	2a. Intensive fruits and vegetables production areas	-	-	High
	2b. Leguminous pastures (lucerne) & canola, chickpeas, faba beans production areas	-	-	Medium
	2c. Channel outfall, water offtake point, tile drain pumping out water into channels (am I right here??)			Low

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

ASPECTS	TASKS	TARGETS	REMARKS	MANAGEMENT PRIORITY
3. PESTICIDES USE SURVEY	3a. Obtain pesticide use data in Pyramid Boort (for tomatoes, olives) Torrumbarry (Kerang) (for Onion) and other new horticulture within G-MW Irrigation Areas			High
	3b. Obtain pesticide use data in all G-MW Irrigation Areas			Medium
ASPECTS	TARGETS			MANAGEMENT PRIORITY
4. TOXICITY DATA ON HIGH RISK PESTICIDES	4a. Obtain ecotoxicological data on acute and chronic toxicity of high risk pesticides identified (either through lab based experiments or through literature review)			High
	4b. Obtain endocrine disrupting information of high risk pesticides to human, stock, fish and wildlife			Medium

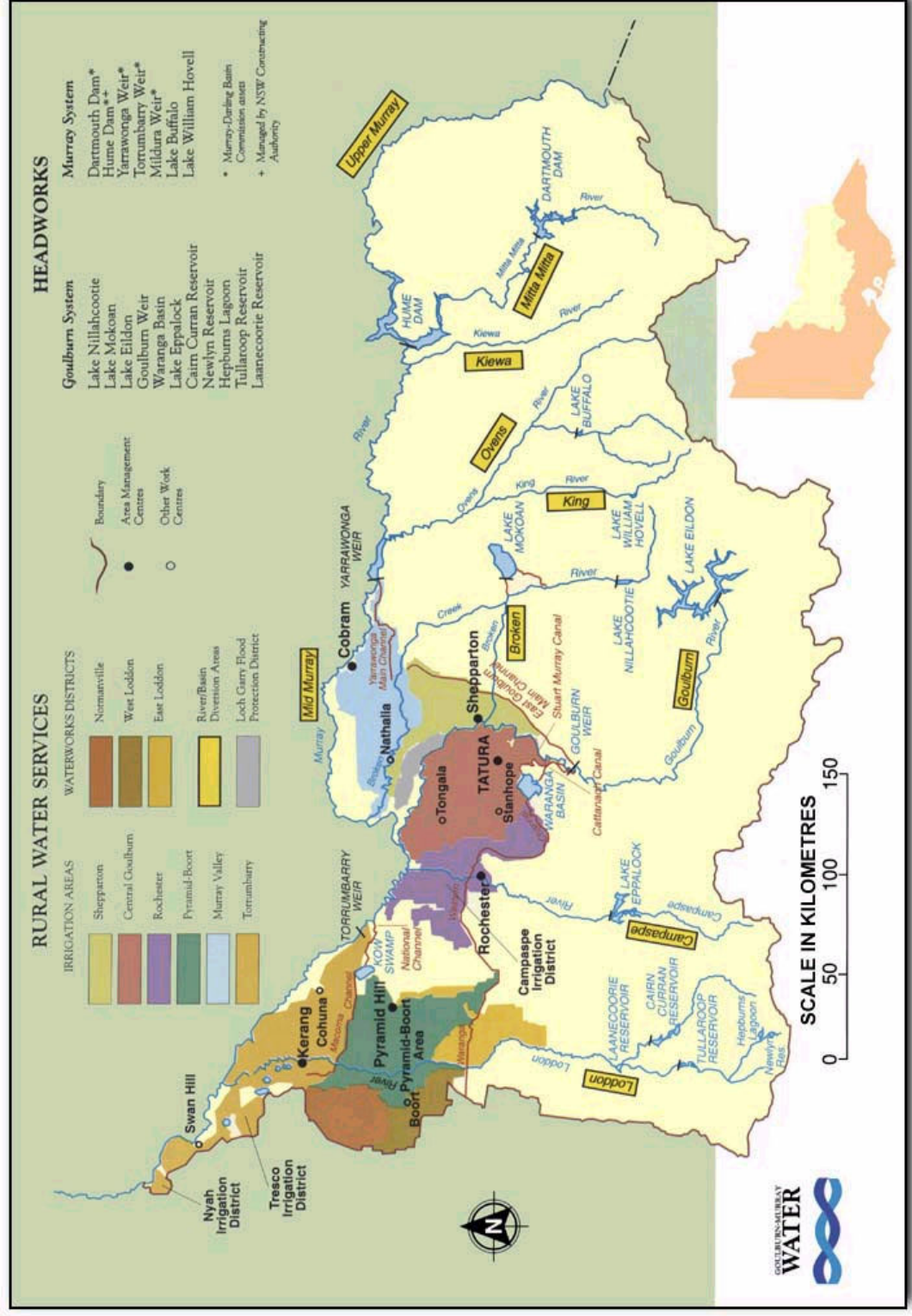
7. References

Krake, Kevin, Brewel, Louise and Kibria, Golam. (2001). *Pesticide and Channel Contamination Pesticides Used in G-MW Irrigation Areas*. 25p. (GM-W-Aquatic Plant Services)

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<http://www.cmis.csiro.au/envir/Research/PesticideRisk/index.htm>

8. Appendices

Appendix 1. Goulburn-Murray Water Services, Systems and Irrigation Areas



Appendix 2. Scenarios assessed and where to find them

Scenario	Location	Land use	Pathway	Receptor	Covered in Section	Page
1-6	6 main irrigation areas	Fruits (Grape vine, stone fruits, Pome fruits)	Drift Drainage water Discharge into channels	Food Industry Human Consumption Domestic and stock	Section 4.1 Subsection 4.1.1; 4.1.2.3; 4.1.2.5 Table 4-1; 4-2; 4-4; 4-6; Figure 4-1; 4-2; 4-5;4-7	
7-12	6 main irrigation areas	Vegetables	Drift Drainage water Discharge into channels	Food Industry Human Consumption Domestic and stock	Section 4.1 Subsection 4.1.1; 4.1.2.4; Table 4-1; 4-2; 4-5 Figure 4-1; 4-2; 4-6	
13-18	6 main irrigation areas	Pastures and Crops	Drift Drainage water Discharge into channels	Food Industry Human Consumption Domestic and stock	Section 4.1 Subsection: 4.1.1; 4.1.2.1; 4.1.2.2; 4.1.2.6 Table 4-1; 4-2; 4-3; 4-7; Figure 4-1; 4-2; 4-3; 4-4;4-8	
19	G-MW	All pesticides	Accidental spill in water, (need to be based on realistic scenario otherwise risk can be very high and no need to assess this)	Food Industry Human Consumption Domestic and stock	Section 4.1 Subsection 4.1.3 Table 4-8; 4-9; Figure 4-9;4-10 Appendix 9,10	
20-21	G-MW	All pesticides	Drift	Aquaculture Other aquatic flora & fauna	Section 4.2, 4.3; 5.2, 5.3 Subsections 4.2.1; 4.3.1 Table 4-12; 4-15; 4-16	

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

Scenario	Location	Land use	Pathway	Receptor	Covered in Section	Page
			Spills (additional)	Aquaculture Other aquatic flora & fauna	Figure 4-12; 4-15, 4-16 Section 4.2 Subsections 4.2.2; 4.3.2 Table 4-13; 4-17; 4-18; Figure 4-13, 4-17; 4-18;	
22	G-MW	Herbicides only	Drift Drainage water Discharge into channels	Pastures & crops	Section 4-4 Subsection 4.4.1 Figure 4-21 Table 4-21	
23-24	G-MW	All pesticides	Illegal acts (to be defined specifically, as there can be all types of illegal acts) e.g. Washing of spraying equipment in channel)	Food Industry Human Consumption Domestic and stock Aquaculture Aquatic ecosystem	Section 4.1, Subsection 4.1.4 (Food, Human, domestic and stock consumption) Subsection 4.2.1; 4.2.3 (aquaculture); 4.3.3 (aquatic ecosystems) Table 4-10; 4-11; 4-14; 4-19; 4-20 Figure 4-11, 4-14; 4-19; 4-20; Appendix 6,11, 12	

Appendix 3. Framing Practices and Locations in Six Irrigation Areas

Irrigation Areas	Major Towns/District	Farming (Based on 1996/97 census) and recent information	Farm Locations	Identify Major Farming Practices
1. Shepparton	Congupna; Tallygaroopna; Katandra West; Bunbartha; Shepparton East; Kialla; Shepparton, Arcadia, Nathalia, Invergordon, Pine Lodge, Lemnos.	<p><u>Horticulture</u></p> <ul style="list-style-type: none"> • Tomato (143ha) • Other vegetables (181 ha) • Grapevines (71 ha) • Citrus (1 ha) • Stone fruit (1311 ha) • Pome fruit (2827 ha) <p><u>Irrigated crops</u></p> <ul style="list-style-type: none"> • Winter grain (1389 ha) • Summer grain (1077 ha) <p><u>Pastures</u></p> <ul style="list-style-type: none"> • Perennial (27,535 ha) • Annual (18,819 ha) • Lucerne (709 ha) <p><u>Other (please specify)</u></p>	<p>Tomato: Kialla</p> <p>Other Vegetables: Kialla, Shepp East, Lemnos</p> <p>Grapevines: Kialla, Shepp East, Shepparton, Lemnos.</p> <p>Citrus:</p> <p>Stone Fruit: Kialla, Shepp East, Lemnos, Shepparton, Bunbartha, Invergordon</p> <p>Pome Fruit: Shepp East, Shepparton, Lemnos, Bunbartha, Invergordon</p> <p>Winter Grain:</p> <p>Summer Grain: Arcadia, Pine Lodge, Nathalia</p> <p>Perennial Pasture: Arcadia, Kialla, Bunbartha, Nathalia, Pine Lodge, Shepp East, Congupna, Tallygaroopna, Katandra west, Invergordon, Lemnos.</p> <p>Annual Pasture: Arcadia, Kialla, Pine Lodge, Katandra west, Invergordon, Nathalia, Bunbartha, Tallygaroopna, Congupna.</p> <p>Other:</p> <p>Kiwifruit: Bunbartha</p> <p>Agroforestry: Kialla, Shepp East, Bunbartha</p> <p>Rice: Tallygaroopna, Nathalia</p> <p>Olives: Bunbartha, Kialla</p>	<ul style="list-style-type: none"> • Dairy • Stone fruit • Mixed cropping
2. Central Goulburn	Echuca; Tatura, Mooroopna, Ardmona, Undera, Merrigum, Lancaster, Wyuna, Kyabram, Tongala, Girgarre, Stanhope, Murchison,	<p><u>Horticulture</u></p> <ul style="list-style-type: none"> • Tomato (734 ha) • Other vegetables (108 ha) • Grapevines (73 ha) • Citrus (47 ha) • Stone fruit (972 ha) 	<p>Tomato: Tatura, Mooroopna, Murchison.</p> <p>Other vegetables: Tatura, Mooroopna.</p> <p>Citrus: Kyabram</p> <p>Stone fruit: Tatura, Mooroopna, Ardmona, Murchison, Merrigum and Lancaster</p>	<ul style="list-style-type: none"> • Dairy (46%) • Pome fruit (10%) • Cropping & grazing (44%) • Stone fruit

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

Irrigation Areas	Major Towns/District	Farming (Based on 1996/97 census) and recent information	Farm Locations	Identify Major Farming Practices
		<ul style="list-style-type: none"> • Pome fruit (2361 ha) <p><u>Irrigated crops</u></p> <ul style="list-style-type: none"> • Winter grain (2176 ha) • Summer grain (976 ha) <p><u>Pastures</u></p> <ul style="list-style-type: none"> • Perennial (71,552 ha) • Annual (39,104 ha) • Lucerne (1257 ha) <p><u>Other (please specify)</u></p>	<p>Pome: Tatura, Mooroopna, Ardmona, Murchison, Merrigum and Lancaster.</p> <p>Winter grain:</p> <p>Summer grain; Echuca; Tatura, Mooroopna, Ardmona, Undera, Merrigum, Lancaster, Wyuna, Kyabram, Tongala, Girgarre, Stanhope, Murchison,</p> <p>Perennial: Echuca; Tatura, Mooroopna, Ardmona, Undera, Merrigum, Lancaster, Wyuna, Kyabram, Tongala, Girgarre, Stanhope, Murchison,</p> <p>Annual: Echuca; Tatura, Mooroopna, Ardmona, Undera, Merrigum, Lancaster, Wyuna, Kyabram, Tongala, Girgarre, Stanhope, Murchison,</p> <p><u>Other:</u> Cut flowers: Murchison</p>	
3. Murray Valley	Nathalia, Numurkah, Cobram, Katunga, Picola, Yalca, Waaia, Wunghnu; Yarrowongah; Yarrowongah; Strathmerton, Koonoomoo, Katamatite, Yielima, Picola, Barmah, Boosey, Sandmount, Naringaningalook	<p><u>Horticulture</u></p> <ul style="list-style-type: none"> • Tomato (10 ha) • Other vegetables (228 ha) • Grapevines (140 ha) • Citrus (354 ha) • Stone fruit (1597 ha) • Pome fruit (608 ha) <p><u>Irrigated crops</u></p> <ul style="list-style-type: none"> • Winter grain (2725 ha) 	<p><u>Horticulture:</u></p> <ul style="list-style-type: none"> • <u>Stone & pome fruits:</u> Cobram, Katunga • <u>Citrus:</u> Cobram, Katunga (Routleys), • <u>Grapevines:</u> Katunga (Monichinos), Picola (Tisdalls). Cobram, Yarrowongah. <p><u>Irrigated Crops:</u></p> <p><u>Winter:</u></p> <p><u>Summer:</u></p> <ul style="list-style-type: none"> • Rice: Strathmerton, Koonoomoo • Wheat: Yalca, Yielima, Katamatite, Picola 	<ul style="list-style-type: none"> • Dairy (47%) • Stone fruit (8%) • Cropping & grazing (45%)

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

Irrigation Areas	Major Towns/District	Farming (Based on 1996/97 census) and recent information	Farm Locations	Identify Major Farming Practices
		<ul style="list-style-type: none"> • Summer grain (1651 ha) <p><u>Pastures</u></p> <ul style="list-style-type: none"> • Perennial (38,425 ha) • Annual (33,193 ha) • Lucerne (2,215 ha) 	<p>Pastures:</p> <p>Annual: Burramine, Katamatite, Yalca, Yielima, Picola, Barmah, Sandmount, Naringaningalook</p> <p>Perennial: Katunga, Nathalia, Yarroweyah, Strathmerton, Waaia, Numurkah)</p> <p>Other:</p> <p>Cut Native Decorative Displays: Sandmount</p>	
4. Rochester-Campaspe	Rochester, Echuca, Lockington, Colbinabbin	<p><u>Horticulture</u></p> <ul style="list-style-type: none"> • Tomato (1450 +162 ha) • Other vegetables (69 + 33 ha) • Grapevines (8 +0 ha) • Citrus (0+0ha) • Stone fruit (5+5 ha) • Pome fruit (5+0 ha) <p><u>Irrigated crops</u></p> <ul style="list-style-type: none"> • Winter grain (1955 +258 ha) • Summer grain (538 + 28 ha) <p><u>Pastures</u></p> <ul style="list-style-type: none"> • Perennial (30,662 + 3364 ha) • Annual (25,141+677 ha) • Lucerne (1772+475 ha) 	<p>Colbinabbin, Rochester, Echuca</p> <p>Colbinabbin (minimal)</p> <p>Colbinabbin</p> <p>No Commercial growing</p> <p>Colbinabbin</p> <p>Rochester, Echuca, Lockington, Colbinabbin (BOTH)</p>	
5. Pyramid-Boort	Tandara, Dingee; Durham Ox; Bears Lagoon; Boort; Pyramid Hill; Macorna; Calivil; Lake Meran	<p><u>Horticulture</u></p> <ul style="list-style-type: none"> • Tomato (536 ha) • Other vegetables (7 ha) • Grapevines (300 ha) • Citrus (0 ha) • Stone fruit (0 ha) • Pome fruit (0 ha) <p><u>Irrigated crops</u></p> <ul style="list-style-type: none"> • Winter grain (12,128 ha) 	<p>Tomato : Leaghur</p> <p>Vegetables : Durham Ox; Pyramid; Leaghur</p> <p>Grapevines : Lake Maramal</p> <p>Yarrowalla</p> <p>Winter grains (canola, wheat, barley & oats) : Marcorna; Pyramid; Boort; Lake Meran;</p>	<ul style="list-style-type: none"> • Wool & fat lamb (71% in Pyramid Hill) • Pastures (31% in Boort)

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

Irrigation Areas	Major Towns/District	Farming (Based on 1996/97 census) and recent information	Farm Locations	Identify Major Farming Practices
		<ul style="list-style-type: none"> • Summer grain (2257 ha) <p><u>Pastures</u></p> <ul style="list-style-type: none"> • Perennial (18,916 ha) • Annual (66,348 ha) • Lucerne (8026 ha) <p><u>Other (please specify)</u></p> <ul style="list-style-type: none"> • Olives (2500 ha) 	<p>Appin; West Boort.</p> <p>Summer grains (Lucernes Maze & corn) : As Above</p> <p>Dingee; Calivil; Mincha; Appin</p> <p>Marcorna; Pyramid; Boort; Lake Meran; Appin; Leaghur; West Boort.</p> <p>West Boort; Boort.</p>	
<p>6. Torrumbarry, Tresco, Nyah</p>	<p>Nyah, Woorinen, Swan Hill, Kerang, Cohuna, Tresco, Gunbower, Leitchville, Koondrook, Murrabit, Lake Boga.</p>	<p><u>Horticulture</u></p> <ul style="list-style-type: none"> • Tomato (39+3+3 ha) • Other vegetables (225 +57+56ha) • Grapevines (478+326+505 ha) • Citrus (160+14+12 ha) • Stone fruit (989+385+64 ha) • Pome fruit (8+4+0 ha) <p><u>Irrigated crops</u></p> <ul style="list-style-type: none"> • Winter grain (3328+0+7 ha) • Summer grain (1641+2+5 ha) <p>Including Rice</p> <p><u>Pastures</u></p> <ul style="list-style-type: none"> • Perennial (48,181+46+08 ha) • Annual (71,418+36+82 ha) • Lucerne (3419+6+24 ha) 	<p>Dingwall</p> <p>Nyah, Woorinen, Tresco, Kerang</p> <p>Kangaroo Lake, Tresco, Lake Boga, Swan Hill, Woorinen, Nyah</p> <p>Murrabit, Lake Boga, Woorinen, Nyah</p> <p>Kangaroo Lake, Tresco, Lake Boga, Swan Hill, Woorinen, Nyah</p> <p>Tresco, Woorinen</p> <p>Dingwall, Wandella, Murrabit, Lake Charm, Winlaton, Mystic Park</p> <p>Gunbower, Leitchville, Murrabit, Benjeroop, Macorna, Kerang, Dingwall, Wandella, Lake Charm, Winlayton, Fish Point, Mystic Park.</p> <p>All areas except for Kangaroo Lake, Nyah & Tresco</p> <p>All areas except for Nyah, Tresco & Woorinen</p> <p>Woorinen</p>	<ul style="list-style-type: none"> • Fruit (vine, stone) & vegetables (Swan Hill, Nyah) • Dairy (Cohuna) • Mixed farming - Fat lamb & Beef (Kerang)

RISK ASSESSMENT -PESTICIDES USED IN GOULBURN-MURRAY

Irrigation Areas	Major Towns/District	Farming (Based on 1996/97 census) and recent information	Farm Locations	Identify Major Farming Practices
		<p><i><u>Other (please specify)</u></i></p> <p>Olives, Nuts</p>		

Information based on : Waternotes- Irrigated Farm Census 1997 Culture Statistics, G-MW, March 1998 (#701340 & #701363); and David Hellesten (Pyramid-Hill); Glen Stanmore (Torrumbarry); Ross Gledhill (Shepparton); Geoff Enever (Rochester-Campaspe); Tony Caia (Central Goulburn); Glen Robertson (Murray Valley)

Appendix 4. Farming Census Data

Name of District, Area etc.	Total Property Area Irrigation areas (ha)*	Total Property Area for Properties Included In Table (ha)**	Pastures (ha)		Irrigated Crops (ha)	Horticulture (ha)									
			Grazing Only	Perennial Annual Lucerne		Winter Grain or Fodder Crop	Summer Grain or Fodder Crop	Tomatoes	Other Vegetables & Annual Fruit Crops	Grape vines	Citrus Fruits of all types	Stone Fruit	Pome Fruit	Other Permanent Orchard Crops	
Goulburn System Shepparton	82,460	76,090	771	27,535	18,819	709	1,389	1,077	143	181	71	1	1,311	2,827	10
Central Goulburn	172,131	152,633	1,329	71,552	39,104	1,257	2,176	976	734	108	73	47	972	2,361	31
Rochester***	107,758	95,220	511	30,662	25,141	1,772	1,955	538	1,450	69	8	-	5	5	32
Campaspe District	9,308	8,197	33	3,364	677	475	258	28	162	33	-	-	5	-	-
Pyramid-Boort	186,481	177,158	344	18,916	66,348	8,026	12,128	2,257	536	7	-	-	-	-	4
Murray System Murray Valley	128,268	122,457	565	38,425	33,193	2,215	2,725	1,651	10	228	140	354	1,597	608	147
Torrumbarry****	176,170	170,303	1,180	48,181	71,448	3,419	3,328	1,641	39	225	478	160	989	8	24
Tresco District	1,902	1,710	4	46	36	6	-	2	3	57	326	14	385	4	4
Nyah District	1,616	1,544	70	208	82	24	7	5	3	56	505	12	64	0	14
GRAND TOTAL	866,094	843,053	5,725	251,622	265,449	21,472	25,303	9,670	3,279	2,036	3,141	749	5,426	5,958	715

*** Excluding Campaspe Irrigation area.

**** Excluding Tresco and Nyah Irrigation areas.

Appendix 5. Pesticides used in 6 Irrigation Areas within Goulburn-Murray Water (G-MW) during 2001

Note : Pesticide usage information of Central Goulburn, Shepparton and Murray Valley Irrigation Areas were combined and reported as Goulburn-Murray Valley or GMV

HERBICIDES

	Herbicide group	Sold as L=Liquid; G=Granular; P=Powder C=Crystals	K_{ow} logP	Quantity used per annum (total of all G-MW areas)	Usage in farming sectors	Application method	Areas where used :
1	2,4-D	L	2.58-2.83	14853L	Irrigated pasture, irrigated pasture (fat lamb, cattle, dairy)	Boom spray	GMV=Goulburn Murray Valley includes Central Goulburn, Shepparton, Murray Valley; R=Rochester-Campaspe; P=Pyramid-Boort and T=Torrumbarry
2	Amitrole	L	-0.97	35000L	Irrigated pasture	Misting machine	GMV, P-B (Pyramid Hill), T (Swan Hill)
3	Glufosiate-ammonium salt	L	<0.1	30000L	Stone fruit, pome fruit,	Boom spray, Knapsack, Control droplet application (CDA)	GMV
4	Atrazine	L,G	2.5	3000L	Irrigated pasture	Low volume boom spray	P-B (Boort)
5	Bensulfuron-methyl	G	2.45	2,860 kg	Rice, irrigated cropping (rice & millet)	??	GMV, T (Kerang)
6	Bromoxynil	L	2.8	5162L	Lucerne, irrigated cereals (wheats, oats, canola, faba beans), irrigated pasture	Boom spray	T (Kerang), P-B (Pyramid Hill)
7	Butroxydim	G	1.9	1343L	Irrigated pasture, irrigated cereals (wheat, oats, canola, faba beans)	Boom spray	P-B (Boort), T (Kerang)
8	Clomazone	L	2.5	143L	Irrigated cropping (rice & millet)		T (Kerang)
9	Chlorosulfuron	G	-0.99	52kg	Irrigated pasture, irrigated cereals (wheat, oats, canola, faba beans)	Boom spray	P-B (Boort), T (Kerang)

		Herbicide group	Sold as L=Liquid; G=Granular; P=Powder C=Crystals	K_{ow} logP	Quantity used per annum (total of all G-MW areas)	Usage in farming sectors	Application method	Areas where used : GMV=Goulburn Murray Valley includes Central Goulburn, Shepparton, Murray Valley; R=Rochester-Campaspe; P-Pyramid-Boort and T=Torrumbarry
10	Dalapon	2,2-dichloro-propionic acid	L	0.778	9000L	Stone fruit, pome fruit	Dip	G-MV
11	Diclofop-methyl	Aryloxyphenoxypropionate	L	4.58	1600L	Irrigated pasture	Boom spray	P-B (Boort)
12	2,4-DB	Aryloxyalkanoic acid/phenoxy compound	L		1280L,	Irrigated pasture	Boom spray	P-B, T
13	Diflufenican	pyridinecarboxamide	L, G	4.9	3015kg	Irrigated pasture, irrigated pasture (fat lambs, cattle, dairy),	Boom spray	P-B (Boort), P-B (Pyramid Hill), T (Kerang)
14	Diquat or diquat dibromide	bipyridylum	L	-4.60	16430L	Irrigated pasture, viticulture, Lucerne	Boom Spray	P-B (Boort), GMV, T (Kerang), R
15	Diuron	urea	L, G	2.85	5515L	Lucerne, irrigated pasture	Boom spray	T (Kerang, Swan Hill), R,
16	Fenoxaprop-p-ethyl	2-(4-aryloxyphenoxy)propionate	L	4.58	1600L	Irrigated pasture	Boom spray	P-B (Boort)
17	Fluazifop-P butyl	aryloxyphenoxypropionate	L	4.5	2,500L	Vegetables (tomatoes), irrigated pasture, vegetables	?, Boom spray, Knapsack	GMV, T
18	Fluroxypyr	pyridinecarboxylic acid	L	-1.24	500L	Rice		GMV
19	Glyphosate	glycine derivative	L, G	<-3.2	121,110L	Irrigated pasture, stone fruit, pome fruit, viticulture, irrigated cereals (wheat, oats, canola, faba beans)	Boom spray, Wiper equipment, Hand gun, Knapsack, CDA	P-B (Boort), GMV, T (Kerang, Swan Hill), R,
20	Imazethapyr	imidazolinone	G	1.04	72kg	Lucerne	Boom spray	T (Kerang)

		Herbicide group	Sold as L=Liquid; G=Granular; P=Powder C=Crystals	K_{ow} logP	Quantity used per annum (total of all G-MW areas)	Usage in farming sectors	Application method	Areas where used : GMV=Goulburn Murray Valley includes Central Goulburn, Shepparton, Murray Valley; R=Rochester-Campaspe; P-Pyramid-Boort and T=Torrumbarry
21	MCPA	Phenoxyacetic acid/Aryloxyalkanoic acid	L	2.75	29,784L	Irrigated pasture, irrigated pasture (fat lamb, cattle, dairy), Irrigated cropping (rice & millet),	Boom spray	P-B, GMV, T (Kerang),
22	Metribuzin	1,2,4 triazone	L	1.6	4000 L	Vegetables (tomatoes), other vegetables	Boom spray	GMV
23	Metsulfuron-methyl	sulfonylurea	G	-1.74	126kg	Irrigated pasture, Irrigated cereals (wheat, oats, canola, Faba beans),	Boom spray	P-B (Boort), T (Kerang)
24	Molinate	thiocarbamate	L	2.88	?	Rice	Boom spray	GMV
25	Oryzalin	dinitroaniline	G	3.73	600kg	Viticulture	Low pressure sprayer	GMV
26	Oxyfluorfen	diphenyl ether	L	4.47	1,143L	Irrigated cereals (wheat, oats, canola, faba beans), Stone fruits, pome fruits	Boom spray	T (Kerang), GMV
27	Paraquat dichloride	bipyridylum	L	-4.5	1500L	Stone fruits, pome fruits	Boom spray	T (Swan Hill)
28	Pendimethalin	dinitroaniline	L	5.18	20,500L	Irrigated pasture, stone fruits, viticulture,	Boom spray	P-B (Boort), GMV, R, T (Swan Hill)
29	Propaquizafop	aryloxyphenoxypropionate	L	4.78	500L	Irrigated pasture	Boom spray	R
30	Quizalofop	aryloxyphenoxypropionate	L	4.28	500L	Irrigated pasture	Boom spray	P-B
31	Rimsulfuron	sulfonylurea	G	0.288	80kg	Vegetables	Boom spray	R
32	Simazine	1,3,5-triazine	L, G	2.1	4,500L	Irrigated pasture, viticulture	Boom spray, Knapsack sprayer	P-B (Boort), R

		Herbicide group	Sold as L=Liquid; G=Granular; P=Powder C=Crystals	K_{ow} logP	Quantity used per annum (total of all G-MW areas)	Usage in farming sectors	Application method	Areas where used :
33	Thiobencarb	thiocarbamate	L	3.42	429L	Rice, irrigated cropping (rice & millet)	SCWIRT (soluble chemical injection in rice technique)	GMV, T (Kerang)
34	Tralkoxydim	Cyclohexanedione oxime	L	2.1	1629L	Irrigated pasture, Irrigated cereals (wheat, oats, canola, Faba beans)	Boom spray	P-B (Boort), T (Kerang)
35	Triasulfuron	sulfonylurea	G	1.1	29 kg	Irrigated cereals (wheat, oats, canola, faba beans)	Boom spray	T (Kerang)
36	Trifluralin	dinitroaniline	L	4.83	14,430L	Irrigated pasture, irrigated cereals (wheat, oats, canola, faba beans)	Soil incorporation	P-B (Boort), T (Kerang)

INSECTICIDES

	Insecticide group	Sold as L=Liquid; G=Granular; P=Powder C=Crystals	K_{ow} logP	Quantity used per annum	Usage in farming sectors	Application method	Areas where used :
1	Alpha-Cypermethrin	pyrethroid	L	6,000L	Irrigated pasture, vegetables,	Boom Spray	GMV= Goulburn Murray Valley includes Central Goulburn, Murray Valley an Shepparton ; R=C=Rochester-Campaspe; P-B=Pyramid-Boort and T=Torrumbarry
2	Azinphos methyl	organophosphorous	L	80,000L	Stone fruit, pome fruit	Air blast	GMV, P-B (Pyramid Hill)

		Insecticide group	Sold as L=Liquid; G=Granular; P=Powder C=Crystals	K_{ow} logP	Quantity used per annum	Usage in farming sectors	Application method	Areas where used : GMV=Goulburn Murray Valley includes Central Goulburn, Murray Valley an Shepparton ; R=C=Rochester-Campaspe; P=B=Pyramid-Boort and T=Torrumbarry
3	<i>Bacillus thuringiensis</i> delta endotoxins	bacterium	G		250kg	Viticulture	Air blast	T (Swan Hill)
4	Beta-Cypermethrin	pyrethroid	L	>4.7	4000L	Vegetables	Air blast	R
5	Bifenthrin	pyrethroid	L	>6	2943L	Irrigated cereals (wheat, oats, canola, faba beans), irrigated cropping (canola, wheat, lucerne, barley, clover), vegetables, irrigated pasture	Boom spray, Misting machine	T, R,
6	Carbaryl	carbamate	L,P	1.59	3000kg	Stone fruit, pome fruit	Air blast	GMV
7	Chlorpyrifos	organophosphorous	L,G	4.7	20,943kg	Stone fruit, pome fruit, viticulture, irrigated cropping (rice & millet), irrigated cropping (canola, wheat, lucerne, barley, clover), vegetables, viticulture, irrigated pasture	Air blast, Boom spray	GMV, T, P-B (Pyramid Hill),R,
8	Sodium sulfate		C		40,000Kg	Stone fruit, pome fruit	Dip	GMV
9	Dimethoate	organophosphorous	L	0.704	21,340L	Irrigated pastures, stone fruit, pome fruit	Boom spray	P-B (Boort), GMV, T
10	Endosulfan	organochlorine	L	4.74	2229L	Irrigated pasture, vegetables, irrigated cropping (canola, wheat, lucerne, barley, clover), irrigated cereals (wheat, oats, canola, faba beans)	Boom spray	P-B (Boort), P-B (Pyramid Hill), R, T
11	Esfenvalerate	pyrethroid	L	6.22	1000L	Vegetables	Air blast	R
12	Fenthion	organophosphorous	L	4.84	2000L	Vegetables (tomatoes)	Air blast	GMV
13	Fipronil	phenyl pyrazole	L	4	29L	Irrigated pasture (fat lambs, cattle, dairy)	?	T (Kerang)

	Insecticide group	Sold as L=Liquid; G=Granular; P=Powder C=Crystals	K_{ow} logP	Quantity used per annum	Usage in farming sectors	Application method	Areas where used : GMV=Goulburn Murray Valley includes Central Goulburn, Murray Valley an Shepparton ; R=C=Rochester-Campaspe; P=B=Pyramid-Boort and T=Torrumbarry
14	Imidacloprid	L	0.57	1000L	Stone fruit, pome fruit,	Air blast	GMV, T (Swan Hill)
15	Methomyl	L	0.093	6350L	Tomatoes, vegetables, viticulture	Air blast, Boom spray	GMV, T (Swan Hill)
16	Omethoate	L	-0.74	24,286L	Irrigated pasture, irrigated pasture (fat lambs, cattle, dairy), Lucerne	Boom spray, Air Blast	P-B (Boort), GMV, T, R,
17	Parathion Methyl	L	3.0	17,000L	Stone fruit, pome fruit	Air blast	GMV
18	Phorate	G	3.92	8,000kg	Vegetables	Soil applied granular form	R
19	Phosmet	G	2.95	1773kg	Irrigated pasture (fat lambs, cattle, dairy), irrigated cereals (wheat, oats, canola, faba beans)	Boom spray, Misting machine	T (Kerang),
20	Pirimicarb	G	1.7	1000kg	Stone fruit, pome fruit	Air blast	GMV
21	Tau Fluvalinate	L	4.26	?	Stone fruit, pome fruit	Air blast	T (Swan Hill)
22	Tebufozide	G	4.25	1400kg	Stone fruit, pome fruit	Air blast	GMV
23	Thiodicarb	L,G	-	4000L	Vegetables (tomatoes), vegetables	Air blast	GMV, R

FUNGICIDES

	Fungicides group	Form as sold	K_{ow} logP	Quantity	Usage in farming sectors	Application method	Area used
1	Azoxystrobin	G	2.5	?	Viticulture	Boom spray	
2	Carbendazim	L	1.38	2000L	Stone & pome fruit	Spray & dip	GMV

	<i>Fungicides group</i>	<i>Form as sold</i>	<i>K_{ow} logP</i>	<i>Quantity</i>	<i>Usage in farming sectors</i>	<i>Application method</i>	<i>Area used</i>
3	Chlorothalonil	L,G	2.92	30.86T	Irrigated cereals (wheat, oats, canola, faba beans), vegetables	Misting machine, Boom Sprayer	R, T (Kerang)
4	Copper hydroxides	G		55,000kg	Tomatoes; Stone fruit, pome fruit, viticulture	Boom Spray, Knapsack, Air Blast	GMV,R
5	Copper sulphate	C		32kg	Irrigated cropping (rice & Millet)		T (Kerang)
6	Imazalil	L,G	3.82	800kg	Stone fruit, pome fruit	?	GMV
7.	Iprodione		3.0	12000L	Pome fruit, stone fruit, viticulture	dips	GMV
8	Mancozeb (dithiocarbamate)	L,G		20,330L	Stone fruit, pome fruit, viticulture, irrigated cereals (wheat, oats, canola, faba beans), vegetables, irrigated pasture	Low volume Air blast, Boom sprayer, Knapsack	T, R, P-B (Boort)
9	Metalaxyl-M	L,G	1.75	5000L	Viticulture	Soil applied granular herbicide	GMV
10	Metiram	G	0.30	40,000Kg	Stone fruit, pome fruit	Air blast	GMV
11	Penconazole	L	3.72	300L	Viticulture	Air blast	T (Swan Hill)
12	Propiconazole	L	3.72	5000L	Stone fruit, pome fruit	Air blast	GMV
13	Procymidone	L	3.14	12000L	Pome fruit, stone fruit, viticulture	dips	GMV
14	Sulfur or wettable sulfur	L,G		30.50T	Vegetables, viticulture	Air blast	T (Swan Hill), R, GMV
15	Vinclozolin	L	3			Immersion	GMV
16	Thiram	L,G	1.73	14T	Stone fruit, pome fruit	Air blast	GMV
17	Ziram	G	1.23	50T	Stone fruit, pome fruit	Air blast	GMV

Appendix 6. Soil characteristics of six irrigation areas within G-MW

Irrigation Area	Main Soil Types (represented as 1,2,3,4,5,6)	Comments
Murray Valley	3 (31.58%), 2 (25.86%), 6 (14.04%)	1= sand to fine sandy loam to loamy fine sand; 2= loams; 3=sandy loams; 4=loams to clay loams to loams; 5=clay loams to clays; 6= clays to heavy clays
Shepparton	4 (39.86%), 5 (10.43%), 2 (8.58%)	1= sand to fine sandy loam to loamy fine; 2= loams; 3=sandy loams; 4=loams to clay loams to loams; 5=clay loams to clays; 6= clays to heavy clays
Rochester-Campaspe	Rochester : 4 (47.12%), 5 (25.71%), 2 (10.85%) Campaspe : 4 (32.62%), 1 (28.02%)	1= sand to fine sandy loam to loamy fine; 2= loams; 3=sandy loams; 4=loams to clay loams to loams; 5=clay loams to clays; 6= clays to heavy clays
Torrumbarr y	Kerang : 4 (22.36%), 5 (9.62%) Nyah : 3 (55.73%), 1 (14.84%), Tresco : 3 (34.43%), 4 (32.87%)	1= sands; 2= sands to sandy loams; 3=sandy loams to sandy clay loams; 4=clay loams to clays; 5=sandy loams to sandy clay loams to clay loams to clays; 6= brown loams overlaying heavy clays on lunettes; grey clays
Central Goulburn	Tongala : 3 (24.24%), 4 (22.64%) Rodney : 3 (40.32%), 2 (21.04%)	1= sand to fine sandy loam to loamy fine; 2= loams; 3=sandy loams; 4=loams to clay loams to loams; 5=clay loams to clays; 6= clays to heavy clays

Information based on : Skene, J.K. M. (1971); Skene & Poutsma (1962)

Appendix 7. Toxicities for receptors (PIRI input table)

Pesticide	LD ₅₀ Rat	LC ₅₀ Rainbow Trout	EC ₅₀ Algae	LC ₅₀ Daphnia
2,4-D	639	1.1	33.2	235
alpha-cypermethrin	250	0.0028		0.0003
amitrole	1100	1000	8.96 ⁴	10
ammonium glufosinate salt	1620	710	37	560
atrazine	1869	4.5	0.043	6.9 ⁵
azinphos-methyl	9	0.02		0.0011
Bensulfuron	5000	150		100
beta-cypermethrin	166	0.0028		0.00026
bifenthrin	54.5	0.00015		0.00016
bromoxynil	190	0.46	140	12.5
butoxydim	1635	6.9	0.71	3.7
carbaryl	500	1.3		0.006
carbendazim	15000	0.83		0.13
chlorothalonil	10000	0.049	0.13	0.07
chlorpyrifos	3000	0.003		0.0017
chlorsulfuron	5545	250		370
clomazone	1369	19	2.1	
copper hydroxide	1000	0.08		0.0065
dalapon	9330	100		
diflufenican	2000	56	10	10
dimethoate	290	6.2		4.7
diquat	231 ⁶	21	0.02	
diuron	3400	5.6		12
endosulfan	70	0.002		75
esfenvalerate	75	0.00007		0.00024
fenoxaprop-p	2500	0.48		3.18
fenthion	250	0.87		0.0052
fipronil	100	0.34	0.068	0.19
fluazifop-p-butyl	2451	1.37	2.1	2
fluroxypyr	2405	100	100	100
glyphosate	5600	86	485	780
imazalil	227	1.5		3.5
imazethapyr	5000	340	50	1000
imidacloprid	450	211		85
mancozeb	5000	2.2		
MCPA	900	232	392	100
metalaxyl	633	100		100
methomyl	17	3.4	0.1	0.0287
metiram	10000	1.1	0.3	2.55
metribuzin	2000	64		4.5
metsulfuron-methyl	5000	150	100	150
molinate	369	1.3		

⁴ NOEC value

⁵ some reference quote a value of 87

⁶ Other references have a value of 408

Pesticide	LD₅₀ Rat	LC₅₀ Rainbow Trout	EC₅₀ Algae	LC₅₀ Daphnia
omethoate	25	9.1		0.022
oryzalin	10000	3.26	51	1.7
oxyflurofen	5000	0.41		1.5
paraquat	157	32		
parathion methyl	6	2.7		0.0073
penconazole	2125	1.7		7
pendimethalin	1050	0.14		
phorate	1.6	0.013		
phosmet	113	0.23		0.0085
pirimicarb	147	29		0.08
propaquizafop	5000	1.2	2.1	2
propiconazole	1517	5.3		4.8
quizalofop-p	1182	0.51	3.2	2.1
rimsulfuron	5000	390		360
simazine	5000	100	0.26	100
sulfur	5000	100	180	
tau-fluvalinate	3000	0.0029	2.2	0.0089
tebufenozide	5000	5.7	0.64	3.8
thiobencarb	1300	3.6		
thiodicarb	66	2.55		0.053
thiram	620	0.13		
tralkoxydim	934	7.2	7.6	
triasulfuron	5000	100	0.035	100
trifluralin	5000	0.01	12.2	0.56
ziram	320	5		

The rat data are based on male rats. The algal data are based on available algal and this vary between pesticides.

Appendix 8. Unlawful Acts

(adapted from website <http://envirotext.eh.doe.gov/data/triblaw/10.html>)

1. It shall be unlawful for any person to:
2. Make false or fraudulent claims through any media, misrepresenting the effect of a pesticide or methods to be utilized;
3. Make pesticide recommendations or applications inconsistent with the labelling registered with Australian law for that pesticide;
4. Operate faulty or unsafe pesticide application equipment;
5. Operate pesticide application equipment in a faulty, careless or negligent manner;
6. Refuse or neglect to keep and maintain the records required by Australian law or to make reports when and as required;
7. Make false or fraudulent records, invoices, or reports;
8. Use, or supervise the use of a pesticide that is restricted to use by "certified applicators" without having qualified as a certified applicator; or without working under the direct supervision of a certified;
9. Distribute any pesticide labelled for restricted use to any person unless such person or his agent has a valid certification to use, supervise the use of, or distribute restricted use pesticides;
10. Apply pesticides onto any land without the consent of the owner or person in possession thereof; except, for governmental agencies, which must abate a public health problem; or apply pesticides known to be harmful to honeybees on blossoming on which bees are working during the period between two hours after sunrise and two hours before sunset; except on property owned operated by the applicator;
11. Withhold knowledge of the theft, loss, disappearance, spillage or unintentional but mistaken misuse of pesticides.

Appendix 9. Drift –Pesticide Risk Rating Calculation Sheet

Pesticide	Volume	Quantity	Active %	Product	Active %	Drift rating	Application Score	LD50 Rat	Rat Toxicity Score	Rat Total Score	LC50 Rainbow Trout			LC50 Algae			LC50 Daphnia		
											LC50 Rainbow Trout	R. Trout Tox. Score	R. Trout Total Score	LC50 Algae	Algae Toxicity Score	Algae Total Score	LC50 Daphnia	Daphnia Toxicity Score	Daphnia Total Score
thiobencarb	429	2.63	80%		1.90	0	-5.00	1300	1.89	1.42	3.6	1.94	1.48	0.56	1.75	2.51	0.56	1.75	2.51
trifluralin	14430	4.16	40%		1.60	0	-5.00	5000	1.30	2.06	0.01	4.50	5.26	100	-0.50	-0.10	100	-0.50	-0.10
metalaxyl	5,000	3.70	50%		1.70	0	-5.00	633	2.20	2.60	100	0.50	0.90	100	-0.50	1.74	100	-0.50	1.74
bensulfuron	2.9	0.46	60%		1.78	1	0.00	5000	1.30	3.54	150	0.32	2.56	100	-0.50	2.84	100	-0.50	2.84
triasulfuron	29	1.46	75%		1.88	1	0.00	5000	1.30	4.64	100	0.50	3.84	0.035	4.46	7.79	0.19	2.22	3.98
fipronil	29	1.46	2%		0.30	1	0.00	100	3.00	4.76	0.34	2.97	4.73	370	-1.07	2.52	370	-1.07	2.52
chlorsulfuron	52	1.72	75%		1.88	1	0.00	5545	1.26	4.85	250	0.10	3.69	51	1.29	5.17	1.7	1.27	5.14
oryzalin	600	2.78	13%		1.10	1	0.00	10000	1.00	4.88	3.26	1.99	5.86	2.1	2.68	6.38	2	1.20	4.90
propeaizaofop	500	2.70	10%		1.00	1	0.00	5000	1.30	5.00	1.2	2.42	6.12	50	1.30	5.00	1000	-1.50	2.20
phorate	8000	3.90	20%		1.30	0	-5.00	1.6	4.80	5.00	0.013	4.39	4.59	360	-1.06	2.69	360	-1.06	2.69
imazethapyr	72	1.86	70%		1.85	1	0.00	5000	1.30	5.05	390	-0.09	3.66	7	0.65	4.13	150	-0.68	3.20
rimsulfuron	80	1.90	70%		1.85	1	0.00	5000	1.30	5.15	1.7	2.27	5.75	100	1.00	4.88	3.18	1.00	4.81
penconazole	300	2.48	10%		1.00	1	0.00	2125	1.67	5.18	0.48	2.82	6.63	10	2.00	5.88	0.13	2.39	7.09
meetsulfuron-methyl	126	2.10	60%		1.78	1	0.00	5000	1.30	5.41	0.83	2.58	7.28	50	1.30	5.00	0.0003	5.02	8.01
fenoxaprop-p	5000	3.70	1%		0.11	1	0.00	2500	1.60	5.52	56	0.75	4.63	10	2.00	5.88	0.00026	5.09	7.89
carbendazim	2000	3.30	50%		1.70	0.5	-0.30	15000	0.82	5.58	0.0028	5.05	8.04	3.2	2.49	6.19	2.1	1.18	4.88
diflufenican	3015	3.48	3%		0.40	1	0.00	2000	1.70	5.58	0.41	2.89	7.33	0.71	3.15	7.67	1.5	1.32	5.76
alpha-cypermethrin	6000	3.78	0%		-0.80	1	0.00	250	2.60	5.58	6.9	1.66	6.19	100	1.00	5.70	3.7	0.93	5.46
beta-cypermethrin	4000	3.60	0%		-0.80	1	0.00	166	2.78	5.59	100	0.50	5.20	2.1	2.68	7.40	100	-0.50	4.20
quizalofop-p	500	2.70	10%		1.00	1	0.00	1182	1.93	6.32	1.37	2.36	7.09	0.26	3.59	8.94	2	1.20	5.92
clomazone	143	2.16	48%		1.68	1	0.00	1369	1.86	6.33	100	0.50	5.85	7.6	2.12	6.93	100	-0.50	4.85
oxyfluorfen	1143	3.06	24%		1.38	1	0.00	5000	1.30	5.74	0.41	2.89	7.33	485	0.31	5.95	780	-1.39	4.25
butroxydim	1343	3.13	25%		1.40	1	0.00	1635	1.79	6.31	6.9	1.66	6.19	12	0.42	5.86	4.5	0.85	6.38
fluroxypyr	500	2.70	100%		2.00	1	0.00	2405	1.62	6.32	100	0.50	5.20	0.1	4.00	8.48	0.0089	3.55	9.41
fluzifop-p-butyl	2500	3.40	21%		1.33	1	0.00	2451	1.61	6.33	1.37	2.36	7.09	3.5	0.96	5.73	3.5	0.96	5.73
simazine	4500	3.65	50%		1.70	1	0.00	5000	1.30	6.65	100	0.50	5.85	0.0089	3.55	9.41	0.0089	3.55	9.41
tralkoxydim	1629	3.21	40%		1.60	1	0.00	934	2.03	6.84	7.2	1.64	6.46	12	0.42	5.86	4.5	0.85	6.38
glyphosate	12110	4.08	36%		1.56	1	0.00	5600	1.25	6.89	86	0.57	6.20	0.0089	3.55	9.41	0.0089	3.55	9.41
diuron	5515	3.74	50%		1.70	1	0.00	3400	1.47	6.91	5.6	1.75	7.19	4.5	0.85	6.38	4.5	0.85	6.38
molinate	500	2.70	96%		1.98	1	0.00	369	2.43	7.11	1.3	2.39	7.07	0.0089	3.55	9.41	0.0089	3.55	9.41
metribuzin	4550	3.66	75%		1.88	1	0.00	2000	1.70	7.23	64	0.69	6.23	0.0089	3.55	9.41	0.0089	3.55	9.41
paraquat	1500	3.18	20%		1.30	1	0.00	157	2.80	7.28	32	0.99	5.47	0.0089	3.55	9.41	0.0089	3.55	9.41
tau-fluvalinate	1000	3.00	24%		1.38	30	1.48	3000	1.52	7.38	0.0029	5.04	10.89	3.5	0.96	5.73	3.5	0.96	5.73
imazaill	800	2.90	75%		1.88	1	0.00	227	2.64	7.42	1.5	2.32	7.10	0.0089	3.55	9.41	0.0089	3.55	9.41

Pesticide	Volume	Quantity Score	Active % Product	Active % Score	Drift rating	Application Drift Score	LD50 Rat	Rat Toxicity Score	Rat Total Score	LC50 Rainbow Trout		LC50 Algae		LC50 Daphnia	
										R. Trout Score	R. Trout Toxicity Score	LC50 Algae Toxicity Score	Algae Total Score	LC50 Daphnia Toxicity Score	Daphnia Total Score
ammonium glufosinate salt	30000	4.48	20%	1.30	1	0.00	1620	1.79	7.57	710	-0.35	5.43	560	-1.25	4.53
bromoxynil	5262	3.72	20%	1.30	1	0.00	190	2.72	7.74	0.46	2.84	7.86	12.5	0.40	5.43
tebufenozide	1400	3.15	70%	1.85	30	1.48	5000	1.30	7.77	5.7	1.74	8.21	3.8	0.92	7.39
pendimethalin	20500	4.31	33%	1.52	1	0.00	1050	1.98	7.81	0.14	3.35	9.18			
diquat	16430	4.22	12%	1.06	1	0.00	231	2.64	7.91	21	1.18	6.45	0.02	4.70	9.98
chlorothalonil	30000	4.48	50%	1.70	5.5	0.74	10000	1.00	7.92	0.049	3.81	10.73	0.07	2.65	9.57
endosulfan	2229	3.35	30%	1.48	1	0.00	70	3.15	7.98	0.002	5.20	10.02	75	-0.38	4.45
phosmet	1773	3.25	15%	1.18	5.5	0.74	113	2.95	8.11	0.23	3.14	8.30	0.0085	3.57	8.74
2,4-D	12000	4.08	70%	1.85	1	0.00	639	2.19	8.12	1.1	2.46	8.38	235	-0.87	5.05
imidacloprid	1000	3.00	20%	1.30	30	1.48	450	2.35	8.12	211	0.18	5.95	85	-0.43	5.35
atrazine	30000	4.48	90%	1.95	1	0.00	1869	1.73	8.16	4.5	1.85	8.28	6.9	0.66	7.09
MCPA	29784	4.47	50%	1.70	1	0.00	900	2.05	8.22	232	0.13	6.31	100	-0.50	5.67
esfenvalerate	1000	3.00	5%	0.70	30	1.48	75	3.12	8.30	0.00007	6.65	11.83	0.00024	5.12	10.30
dimethoate	21340	4.33	30%	1.48	1	0.00	290	2.54	8.34	6.2	1.71	7.51	4.7	0.83	6.63
bifenthrin	2943	3.47	8%	0.90	5.5	0.74	54.5	3.26	8.38	0.00015	6.32	11.44	0.00016	5.30	10.41
propiconazole	5000	3.70	25%	1.40	30	1.48	1517	1.82	8.39	5.3	1.78	8.35	4.8	0.82	7.39
chlorpyrifos	23943	4.38	50%	1.70	16	1.19	3000	1.52	8.79	0.003	5.02	12.29	0.0017	4.27	11.54
amitrole	35000	4.54	20%	1.30	10	1.00	1100	1.96	8.80	1000	-0.50	6.35	10	0.50	7.35
carbaryl	3000	3.48	50%	1.70	30	1.48	500	2.30	8.95	1.3	2.39	9.04	0.006	3.72	10.38
metiram	40000	4.60	80%	1.90	30	1.48	10000	1.00	8.98	1.1	2.46	10.44	2.55	1.09	9.08
pirimicarb	1000	3.00	50%	1.70	30	1.48	147	2.83	9.01	29	1.04	7.21	0.08	2.60	8.77
fenthion	2000	3.30	55%	1.74	30	1.48	250	2.60	9.12	0.87	2.56	9.08	0.0052	3.78	10.30
sulfur	80000	4.90	50%	1.70	30	1.48	5000	1.30	9.38	100	0.50	8.58			
thiram	14000	4.15	80%	1.90	30	1.48	620	2.21	9.73	0.13	3.39	10.91			
mancozeb	240,000	5.38	75%	1.88	16	1.19	5000	1.30	9.75	2.2	2.16	10.60	0.053	2.78	9.76
thiodicarb	4000	3.60	80%	1.90	30	1.48	66	3.18	10.16	2.55	2.09	9.08	0.0065	3.69	11.89
copper hydroxide	400000	5.60	26%	1.41	16	1.19	1000	2.00	10.21	0.08	3.60	11.80	0.0287	3.04	10.04
ziram	50000	4.70	76%	1.88	30	1.48	320	2.49	10.55	5	1.80	9.86			
methomyl	6350	3.80	100%	2.00	16	1.19	17	3.77	10.76	3.4	1.97	8.96			
omethoate	24286	4.39	80%	1.90	16	1.19	25	3.60	11.08	9.1	1.54	9.02	0.022	3.16	10.64
parathion methyl	17000	4.23	50%	1.70	30	1.48	6	4.22	11.63	2.7	2.07	9.48	0.0073	3.64	11.04
azinphos-methyl	80000	4.90	50%	1.70	30	1.48	9	4.05	12.12	0.02	4.20	12.28	0.0011	4.46	12.54

Volume (based on 2001 G-MW data); Quantity score (log of volume); Active % score (log of active product); drift rating (based on Table 4-6); and Application drift score (log of drift rating score), and so on as explained in Section 3.3.1.

Appendix 10. Drift – Pesticide Risk Rating by Receptor Grouping

Pesticide	Receptors:		Rainbow Trout Overall Rating	Algae Overall Rating	Daphnia Overall Rating
	Food Industry, Human Consumption, Domestic & Stock	Aquaculture : aquatic flora & fauna			
thiobencarb	Very Low		Very Low		
trifluralin	Very Low		Low	Very Low	Very Low
metalaxyl	Very Low		Very Low		Very Low
bensulfuron	Very Low		Very Low		Very Low
triasulfuron	Very Low		Very Low	Moderate	Very Low
fipronil	Very Low		Very Low		Very Low
chlorsulfuron	Very Low		Very Low		Very Low
oryzalin	Very Low		Low	Low	Low
propaquizafop	Low		Moderate	Moderate	Very Low
phorate	Low		Very Low		
imazethapyr	Low		Very Low	Low	Very Low
rimsulfuron	Low		Very Low		Very Low
penconazole	Low		Low		Very Low
metsulfuron-methyl	Low		Very Low	Very Low	Very Low
fenoxaprop-p	Low		Moderate		Very Low
carbendazim	Low		Moderate		Moderate
diflufenican	Low		Very Low	Low	Very Low
alpha-cypermethrin	Low		Moderate		Moderate
beta-cypermethrin	Low		Moderate		Moderate
quizalofop-p	Low		Moderate	Moderate	Very Low
clomazone	Low		Low	Moderate	
oxyflufen	Low		Moderate		Low
butoxydim	Moderate		Moderate	Moderate	Low
fluroxypyr	Moderate		Low	Low	Very Low
fluazifop-p-butyl	Moderate		Moderate	Moderate	Low
simazine	Moderate		Low	Moderate	Very Low
tralkoxydim	Moderate		Moderate	Moderate	
glyphosate	Moderate		Moderate	Low	Very Low
diuron	Moderate		Moderate		Low
molinate	Moderate		Moderate		
metribuzin	Moderate		Moderate		Moderate
paraquat	Moderate		Low	Moderate	
tau-fluvalinate	Moderate		High		Moderate
imazalil	Moderate		Moderate		Low
ammonium glufosinate	Moderate		Low		Very Low
bromoxynil	Moderate		Moderate	Low	Low
tebufenozide	Moderate		Moderate		Moderate
pendimethalin	Moderate		Moderate		
diquat	Moderate		Moderate	High	
chlorothalonil	Moderate		High	High	High
endosulfan	Moderate		High		Very Low
phosmet	Moderate		Moderate		Moderate
2,4-D	Moderate		Moderate	Moderate	Low
imidacloprid	Moderate		Low		Low
atrazine	Moderate		Moderate	High	Moderate
MCPA	Moderate		Moderate	Moderate	Low
esfenvalerate	Moderate		Very High		High
dimethoate	Moderate		Moderate		Moderate
bifenthrin	Moderate		Very High		High
propiconazole	Moderate		Moderate		Moderate
chlorpyrifos	Moderate		Very High		Very High
amitrole	Moderate		Moderate	Moderate	Moderate
carbaryl	Moderate		Moderate		High
metiram	Moderate		High	Very High	Moderate
pirimicarb	Moderate		Moderate		Moderate
fenthion	Moderate		Moderate		High
sulfur	Moderate		Moderate	Moderate	
thiram	High		High		
mancozeb	High		High		
thiodicarb	High		Moderate		High
copper hydroxide	High		Very High		Very High
ziram	High		High		
methomyl	High		Moderate		High
omethoate	Very High		Moderate		High
parathion methyl	Very High		Moderate		Very High
azinphos-methyl	Very High		Very High		Very High

Appendix 11. Spills – Pesticide Risk Rating by Receptor Grouping

Pesticide	Receptors		Rainbow Trout Overall Rating	Algae Overall Rating	Daphnia Overall Rating
	Food Industry, Human Consumption, Domestic & Stock	Aquaculture : aquatic flora & fauna			
	Mammal Overall Rating				
bensulfuron	Very Low		Very Low		Very Low
triasulfuron	Very Low		Very Low	Low	Very Low
chlorsulfuron	Very Low		Very Low		Very Low
rimsulfuron	Very Low		Very Low		Very Low
metsulfuron-methyl	Very Low		Very Low	Very Low	Very Low
quizalofop-p	Very Low		Very Low	Very Low	Very Low
butoxydim	Very Low		Very Low	Low	Very Low
fluzifop-p-butyl	Very Low		Low	Low	Very Low
thiobencarb	Very Low		Very Low		
fipronil	Very Low		Very Low		Very Low
tralkoxydim	Very Low		Very Low	Very Low	
oryzalin	Very Low		Low	Low	Low
diuron	Very Low		Low		Very Low
propaquizafop	Low		Moderate	Moderate	Very Low
imazethapyr	Low		Very Low	Low	Very Low
penconazole	Low		Low		Very Low
chlorothalonil	Low		Moderate	High	Moderate
metribuzin	Low		Very Low		Very Low
fenoxaprop-p	Low		Moderate		Very Low
metiram	Low		Moderate	High	Low
ammonium glufosinate	Low		Very Low		Very Low
diflufenican	Low		Very Low	Low	Very Low
alpha-cypermethrin	Low		High		High
beta-cypermethrin	Low		Moderate		Moderate
metalaxyl	Low		Very Low		Very Low
chlorpyrifos	Low		Very High		High
bifenthrin	Low		High		Moderate
clomazone	Low		Low	Moderate	
oxyfluorfen	Low		Moderate		Low
carbendazim	Low		Moderate		Moderate
sulfur	Low		Low	Low	
tau-fluvalinate	Low		Very High		Moderate
atrazine	Moderate		Moderate	High	Low
thiram	Moderate		Moderate		
tebufenozide	Moderate		Moderate		Low
fluroxypyr	Moderate		Low	Low	Very Low
mancozeb	Moderate		Moderate		
imidacloprid	Moderate		Very Low		Very Low
simazine	Moderate		Low	High	Very Low
esfenvalerate	Moderate		Very High		High
glyphosate	Moderate		Moderate	Low	Very Low
propiconazole	Moderate		Moderate		Low
copper hydroxide	Moderate		High		High
trifluralin	Moderate		Very High	Moderate	Moderate
ziram	Moderate		Moderate		
molinate	Moderate		Moderate		
paraquat	Moderate		Low	High	
phosmet	Moderate		Moderate		Moderate
imazalil	Moderate		Moderate		Low
carbaryl	Moderate		Moderate		High
pirimicarb	Moderate		Low		Moderate
fenthion	Moderate		Moderate		High
bromoxynil	Moderate		Moderate	Low	Low
amitrole	Moderate		Low	Moderate	Moderate
pendimethalin	Moderate		Very High		
diquat	Moderate		Moderate	Very High	
endosulfan	Moderate		Very High		Very Low
phorate	High		Moderate		
2,4-D	High		High	Moderate	Low
MCPA	High		Moderate	Moderate	Low
dimethoate	High		Moderate		Moderate
thiodicarb	High		Moderate		High
methomyl	Very High		Moderate		High
omethoate	Very High		Moderate		Very High
parathion methyl	Very High		Moderate		Very High
azinphos-methyl	Very High		Very High		Very High

Appendix 12. Spills - Pesticide Risk Rating Calculation Sheet

Pesticide	Mammalian Overall Rating	Volume	Quantity	Active %	Product	Active %	Liquid Score	LD50 Rat	Rat Toxicity Score	Rat Total Score	LC50 Rainbow Trout	R. Trout Toxicity Score	R. Trout Total Score	LC50 Algae	Algae Toxicity Score	Algae Total Score	LC50 Daphnia	Daphnia Toxicity Score	Daphnia Total Score
2,4-D	High	12000	4.08	70%		1.85	1	639	2.19	9.12	1.1	2.46	9.38	33.2	1.48	8.40	235	-0.87	6.05
alpha-cypermethrin	Low	6000	3.78	0%		-0.80	1	250	2.60	6.58	0.0028	5.05	9.04				0.0003	5.02	9.01
amitrole	Moderate	35000	4.54	20%		1.30	1	1100	1.96	8.80	1000	-0.50	6.35	8.96	2.05	8.89	10	0.50	7.35
ammonium glufosinate salt	Low	30000	4.48	20%		1.30	-1	1620	1.79	6.57	710	-0.35	4.43	0.043	4.37	9.80	560	-1.25	3.53
atrazine	Moderate	30000	4.48	90%		1.95	-1	1869	1.73	7.16	4.5	1.85	7.28				6.9	0.66	6.09
azinphos-methyl	Very High	80000	4.90	50%		1.70	1	9	4.05	11.65	0.02	4.20	11.80				0.0011	4.46	12.06
bensulfuron	Very Low	3	0.46	60%		1.78	-1	5000	1.30	2.54	150	0.32	1.56				100	-0.50	0.74
beta-cypermethrin	Low	4000	3.60	0%		-0.80	1	166	2.78	6.59	0.0028	5.05	8.86				0.00026	5.09	8.89
bifenthrin	Low	2943	3.47	8%		0.90	-1	54.5	3.26	6.64	0.00015	6.32	9.70				0.00016	5.30	8.67
bromoxynil	Moderate	5262	3.72	20%		1.30	1	190	2.72	8.74	0.46	2.84	8.86	140	0.85	6.88	12.5	0.40	6.43
butoxydim	Very Low	1343	3.13	25%		1.40	-1	1635	1.79	5.31	6.9	1.66	5.19	0.71	3.15	6.67	3.7	0.93	4.46
carbaryl	Moderate	3000	3.48	50%		1.70	1	500	2.30	8.48	1.3	2.39	8.56				0.006	3.72	9.90
carbendazim	Low	2000	3.30	50%		1.70	1	15000	0.82	6.82	0.83	2.58	8.58				0.13	2.39	8.39
chlorothalonil	Low	30000	4.48	50%		1.70	-1	10000	1.00	6.18	0.049	3.81	8.99	0.13	3.89	9.06	0.07	2.65	7.83
chlorpyrifos	Low	23943	4.38	50%		1.70	-1	3000	1.52	6.60	0.003	5.02	10.10				0.0017	4.27	9.35
chlorsulfuron	Very Low	52	1.72	75%		1.88	-1	5545	1.26	3.85	250	0.10	2.69				370	-1.07	1.52
clomazone	Low	143	2.16	48%		1.68	1	1369	1.86	6.70	19	1.22	6.06	2.1	2.68	7.51			
copper hydroxide	Moderate	400000	5.60	26%		1.41	-1	1000	2.00	8.02	0.08	3.60	9.61				0.0065	3.69	9.70
diflufenican	Low	3015	3.48	3%		0.40	1	2000	1.70	6.58	56	0.75	5.63	10	2.00	6.88	10	0.50	5.38
dimethoate	High	21340	4.33	30%		1.48	1	290	2.54	9.34	6.2	1.71	8.51				4.7	0.83	7.63
diquat	Moderate	16430	4.22	12%		1.06	1	231	2.64	8.91	21	1.18	7.45	0.02	4.70	10.98			
diuron	Very Low	5515	3.74	50%		1.70	-1	3400	1.47	5.91	5.6	1.75	6.19				12	0.42	4.86
endosulfan	Moderate	2229	3.35	30%		1.48	1	70	3.15	8.98	0.002	5.20	11.02				75	-0.38	5.45
esfenvalerate	Moderate	1000	3.00	5%		0.70	1	75	3.12	7.82	0.00007	6.65	11.35				0.00024	5.12	9.82
fenoxaprop-p	Low	5000??	3.70	1%		0.11	1	2500	1.60	6.41	0.48	2.82	7.63				3.18	1.00	5.81
fenthion	Moderate	2000	3.30	55%		1.74	1	250	2.60	8.64	0.87	2.56	8.60				0.0052	3.78	9.83
fipronil	Very Low	29	1.46	2%		0.30	1	100	3.00	5.76	0.34	2.97	5.73				0.19	2.22	4.98

Pesticide	Mammalian Overall Rating	Volume	Quantity Score	Active % Product	Active % Score	Liquid Score	LD50 Rat	Rat Toxicity Score	Rat Total Score	LC50 Rainbow Trout			LC50 Algae			LC50 Daphnia	Daphnia Toxicity Score	Daphnia Total Score
										LC50 Rainbow Trout	R. Trout Toxicity Score	R. Trout Total Score	LC50 Algae	Algae Toxicity Score	Algae Total Score			
fluzifop-p-butyl	Very Low	2500	3.40	21%	1.33	-1	2451	1.61	5.33	1.37	2.36	6.09	2.1	2.68	6.40	2	1.20	4.92
fluroxypyr	Moderate	500??	2.70	100%	2.00	1	2405	1.62	7.32	100	0.50	6.20	100	1.00	6.70	100	-0.50	5.20
glyphosate	Moderate	12110	4.08	36%	1.56	1	5600	1.25	7.89	86	0.57	7.20	485	0.31	6.95	780	-1.39	5.25
imazalil	Moderate	800	2.90	75%	1.88	1	227	2.64	8.42	1.5	2.32	8.10	3.5	0.96	6.73	3.5	0.96	6.73
imazethapyr	Low	72	1.86	70%	1.85	1	5000	1.30	6.00	340	-0.03	4.67	50	1.30	6.00	1000	-1.50	3.20
imidacloprid	Moderate	1000	3.00	20%	1.30	1	450	2.35	7.65	211	0.18	5.48	85	-0.43	4.87	85	-0.43	4.87
mancozeb	Moderate	240000	5.38	75%	1.88	-1	5000	1.30	7.56	2.2	2.16	8.41						
MCPA	High	29784	4.47	50%	1.70	1	900	2.05	9.22	232	0.13	7.31	392	0.41	7.58	100	-0.50	6.67
metalaxyl	Low	5000	3.70	50%	1.70	-1	633	2.20	6.60	100	0.50	4.90	100	-0.50	3.90	100	-0.50	3.90
methomyl	Very High	6350	3.80	100%	2.00	1	17	3.77	10.57	3.4	1.97	8.77				0.0287	3.04	9.84
metiram	Low	40000	4.60	80%	1.90	-1	10000	1.00	6.51	1.1	2.46	7.96	0.3	3.52	9.03	2.55	1.09	6.60
metribuzin	Low	4550	3.66	75%	1.88	-1	2000	1.70	6.23	64	0.69	5.23				4.5	0.85	5.38
metsulfuron-methyl	Very Low	126	2.10	60%	1.78	-1	5000	1.30	4.18	150	0.32	3.20	100	1.00	3.88	150	-0.68	2.20
molinate	Moderate	500??	2.70	96%	1.98	1	369	2.43	8.11	1.3	2.39	8.07				0.022	3.16	10.45
omethoate	Very High	24286	4.39	80%	1.90	1	25	3.60	10.89	9.1	1.54	8.83				1.7	1.27	6.14
onyazalin	Very Low	600	2.78	13%	1.10	1	10000	1.00	5.88	3.26	1.99	6.86	51	1.29	6.17			
oxyfluorfen	Low	1143	3.06	24%	1.38	1	5000	1.30	6.74	0.41	2.89	8.33				1.5	1.32	6.76
paraquat	Moderate	1500	3.18	20%	1.30	1	157	2.80	8.28	32	0.99	6.47	0.1	4.00	9.48			
parathion methyl	Very High	17000	4.23	50%	1.70	1	6	4.22	11.15	2.7	2.07	9.00				0.0073	3.64	10.57
penconazole	Low	300	2.48	10%	1.00	1	2125	1.67	6.15	1.7	2.27	6.75				7	0.65	5.13
pendimethalin	Moderate	20500	4.31	33%	1.52	1	1050	1.98	8.81	0.14	3.35	10.18						
phorate	High	8000	3.90	20%	1.30	-1	1.6	4.80	9.00	0.013	4.39	8.59				0.0085	3.57	9.00
phosmet	Moderate	1773	3.25	15%	1.18	1	113	2.95	8.37	0.23	3.14	8.56				0.08	2.60	8.30
pirimicarb	Moderate	1000	3.00	50%	1.70	1	147	2.83	8.53	29	1.04	6.74						
propanil	Low	500	2.70	10%	1.00	1	5000	1.30	6.00	1.2	2.42	7.12	2.1	2.68	7.38			
propiconazole	Moderate	5000	3.70	25%	1.40	1	1517	1.82	7.92	5.3	1.78	7.87				4.8	0.82	6.92
quizalofop-p	Very Low	500	2.70	10%	1.00	-1	1182	1.93	4.63	0.51	2.79	5.49	3.2	2.49	5.19			
rimsulfuron	Very Low	80	1.90	70%	1.85	-1	5000	1.30	4.05	390	-0.09	2.66				360	-1.06	1.69
simazine	Moderate	4500	3.65	50%	1.70	1	5000	1.30	7.65	100	0.50	6.85	0.26	3.59	9.94			

Pesticide	Mammalian Overall Rating	Volume	Quantity Score	Active % Product	Active % Score	Liquid Score	LD50 Rat	Rat Toxicity Score	Rat Total Score	LC50 Rainbow Trout	R. Trout Toxicity Score	R. Trout Total Score	LC50 Algae	Algae Toxicity Score	Algae Total Score	LC50 Daphnia	Daphnia Toxicity Score	Daphnia Total Score
sulfur	Low	80000	4.90	50%	1.70	-1	5000	1.30	6.90	100	0.50	6.10	180	0.74	6.35	0.0089	3.55	8.93
tau-fluvalinate	Low	1000??	3.00	24%	1.38	1	3000	1.52	6.90	0.0029	5.04	10.42						
tebufenozide	Moderate	1400	3.15	70%	1.85	1	5000	1.30	7.29	5.7	1.74	7.74				3.8	0.92	6.91
thiobencarb	Very Low	429	2.63	80%	1.90	-1	1300	1.89	5.42	3.6	1.94	5.48				0.053	2.78	9.28
thiodicarb	High	4000	3.60	80%	1.90	1	66	3.18	9.69	2.55	2.09	8.60						
thiram	Moderate	14000	4.15	80%	1.90	-1	620	2.21	7.26	0.13	3.39	8.44						
tralkoxydim	Very Low	1629	3.21	40%	1.60	-1	934	2.03	5.84	7.2	1.64	5.46	7.6	2.12	5.93			
triasulfuron	Very Low	29	1.46	75%	1.88	-1	5000	1.30	3.64	100	0.50	2.84	0.035	4.46	6.79	100	-0.50	1.84
trifluralin	Moderate	14430	4.16	40%	1.60	1	5000	1.30	8.06	0.01	4.50	11.26	12.2	1.91	8.67	0.56	1.75	8.51
ziram	Moderate	50000	4.70	76%	1.88	-1	320	2.49	8.07	5	1.80	7.38						

Appendix 13. Unlawful Acts –Pesticide Risk Rating Calculation Sheet

Pesticide	Volume	Quantity	Active %	Product	Active %	Sub Score	LD50 Rat	Rat Toxicity Score	Rat Total Score	LC50 Rainb. Trout	R Trout Toxic Score	R Trout Total Score	LC50 Algae	Algae Toxicity Score	Algae Total Score	LC50 Daphnia	Daphnia Toxic Score	Daphnia Total Score	
bensulfuron	2.9	0.46	1.78	2.2	60%	1.78	2.2	5000	1.30	3.54	150	0.32	2.56	100	-0.50	1.74			
triasulfuron	29	1.46	1.88	3.3	75%	1.88	3.3	5000	1.30	4.64	100	0.50	3.84	0.035	4.46	7.79	100	-0.50	2.84
fipronil	29	1.46	0.30	1.8	2%	0.30	1.8	100	3.00	4.76	0.34	2.97	4.73	0.19	2.22	3.98	370	-1.07	2.52
chlorsulfuron	52	1.72	1.88	3.6	75%	1.88	3.6	5545	1.26	4.85	250	0.10	3.69	51	1.29	5.17	1.7	1.27	5.14
oryzalin	600	2.78	1.10	3.9	13%	1.10	3.9	10000	1.00	4.88	3.26	1.99	5.86	2.1	2.68	6.38	2	1.20	4.90
proprazafop	500	2.70	1.00	3.7	10%	1.00	3.7	5000	1.30	5.00	1.2	2.42	6.12	50	1.30	5.00	1000	-1.50	2.20
imazethapyr	72	1.86	1.85	3.7	70%	1.85	3.7	5000	1.30	5.05	390	-0.09	3.66	7	0.65	4.13	360	-1.06	2.69
rimsulfuron	80	1.90	1.85	3.7	70%	1.85	3.7	5000	1.67	5.15	1.7	2.27	5.75	100	1.00	4.88	7	0.65	4.13
penconazole	300	2.48	1.00	3.5	10%	1.00	3.5	2125	1.30	5.18	150	0.32	4.20	10	2.00	5.88	150	-0.68	3.20
metsulfuron-methyl	126	2.10	1.78	3.9	60%	1.78	3.9	5000	1.30	5.41	0.48	2.82	6.63	3.18	1.00	4.81	3.18	1.00	4.81
fenoxaprop-p	5000??	3.70	0.11	3.8	1%	0.11	3.8	2500	1.60	5.41	56	0.75	4.63	10	0.50	4.38	10	0.50	4.38
diflufenican	3,015	3.48	0.40	3.9	3%	0.40	3.9	2000	1.70	5.58	0.0028	5.05	8.04	0.0003	5.02	8.01	0.0003	5.02	8.01
alpha-cypermethrin	6000	3.78	-0.80	3.0	0%	-0.80	3.0	250	2.60	5.58	0.0028	5.05	7.86	0.00026	5.09	7.89	0.00026	5.09	7.89
beta-cypermethrin	4000	3.60	-0.80	2.8	0%	-0.80	2.8	166	2.78	5.59	0.51	2.79	6.49	3.2	2.49	6.19	2.1	1.18	4.88
quizalofop-p	500	2.70	1.00	3.7	10%	1.00	3.7	1182	1.93	5.63	19	1.22	5.06	2.1	2.68	6.51	1.5	1.32	5.76
clomazone	143	2.16	1.68	3.8	48%	1.68	3.8	1369	1.86	5.70	0.41	2.89	7.33	0.13	2.39	7.39	0.13	2.39	7.39
oxyfluorfen	1143	3.06	1.38	4.4	24%	1.38	4.4	5000	1.30	5.74	0.83	2.58	7.58	0.0089	3.55	7.93	0.0089	3.55	7.93
carbendazim	2000	3.30	1.70	5.0	50%	1.70	5.0	15000	0.82	5.82	0.0029	5.04	9.42	3.8	0.92	5.91	3.8	0.92	5.91
tau-fluvalinate	1000	3.00	1.38	4.4	24%	1.38	4.4	3000	1.52	5.90	5.7	1.74	6.74	0.71	3.15	7.67	0.71	3.15	7.67
tebufenozide	1400	3.15	1.85	5.0	70%	1.85	5.0	5000	1.30	6.29	6.9	1.66	6.19	100	1.00	5.70	100	-0.50	4.20
butoxydim	1343	3.13	1.40	4.5	25%	1.40	4.5	1635	1.79	6.31	1.37	2.36	7.09	2.1	2.68	7.40	2.1	2.68	7.40
fluroxypyr	500	2.70	2.00	4.7	100%	2.00	4.7	2405	1.62	6.32	100	0.50	5.20	2	1.20	5.92	2	1.20	5.92
fluzifop-p-butyl	2500	3.40	1.33	4.7	21%	1.33	4.7	2451	1.61	6.33	1.37	2.36	7.09	2	1.20	5.92	2	1.20	5.92
thiobencarb	429	2.63	1.90	4.5	80%	1.90	4.5	1300	1.89	6.42	3.6	1.94	6.48						

Pesticide	Volume	Quantity	Active %	Product	Active %	Sub Score	LD50 Rat	Rat Toxicity Score	Rat Total Score	LC50 Rainb. Trout	R Trout Toxic Score	R Trout Total Score	LC50 Algae	Algae Toxicity Score	Algae Total Score	LC50 Daphnia	Daphnia Toxic Score	Daphnia Total Score
imidacloprid	1000	3.00	20%		1.30	4.3	450	2.35	6.65	211	0.18	4.48				85	-0.43	3.87
simazine	4500	3.65	50%		1.70	5.4	5000	1.30	6.65	100	0.50	5.85	0.26	3.59	8.94	100	-0.50	4.85
esfenvalerate	1000	3.00	5%		0.70	3.7	75	3.12	6.82	0.00007	6.65	10.35				0.00024	5.12	8.82
tralkoxydim	1,629	3.21	40%		1.60	4.8	934	2.03	6.84	7.2	1.64	6.46	7.6	2.12	6.93	780	-1.39	4.25
glyphosate	12110	4.08	36%		1.56	5.6	5600	1.25	6.89	86	0.57	6.20	485	0.31	5.95			
diuron	5515??	3.74	50%		1.70	5.4	3400	1.47	6.91	5.6	1.75	7.19				12	0.42	5.86
propiconazole	5000	3.70	25%		1.40	5.1	1517	1.82	6.92	5.3	1.78	6.87				4.8	0.82	5.92
trifluralin	14430??	4.16	40%		1.60	5.8	5000	1.30	7.06	0.01	4.50	10.26	12.2	1.91	7.67	0.56	1.75	7.51
molinate	500	2.70	96%		1.98	4.7	369	2.43	7.11	1.3	2.39	7.07				0.07	2.65	8.83
chlorothalonil	30000	4.48	50%		1.70	6.2	10000	1.00	7.18	0.049	3.81	9.99	0.13	3.89	10.06			
metribuzin	4550	3.66	75%		1.88	5.5	2000	1.70	7.23	64	0.69	6.23				4.5	0.85	6.38
paraquat	1500	3.18	20%		1.30	4.5	157	2.80	7.28	32	0.99	5.47	0.1	4.00	8.48			
phosmet	1773	3.25	15%		1.18	4.4	113	2.95	7.37	0.23	3.14	7.56				0.0085	3.57	8.00
imazalil	800	2.90	75%		1.88	4.8	227	2.64	7.42	1.5	2.32	7.10				3.5	0.96	5.73
carbaryl	3000	3.48	50%		1.70	5.2	500	2.30	7.48	1.3	2.39	7.56				0.006	3.72	8.90
metiram	40000	4.60	80%		1.90	6.5	10000	1.00	7.51	1.1	2.46	8.96	0.3	3.52	10.03	2.55	1.09	7.60
pirimicarb ammonium	1000	3.00	50%		1.70	4.7	147	2.83	7.53	29	1.04	5.74				0.08	2.60	7.30
glufosinate salt	30000	4.48	20%		1.30	5.8	1620	1.79	7.57	710	-0.35	5.43				560	-1.25	4.53
metalaxyl	5000	3.70	50%		1.70	5.4	633	2.20	7.60	100	0.50	5.90				100	-0.50	4.90
chlorpyrifos	23943??	4.38	50%		1.70	6.1	3000	1.52	7.60	0.003	5.02	11.10				0.0017	4.27	10.35
bifenthrin	2943	3.47	8%		0.90	4.4	55	3.26	7.64	0.00015	6.32	10.70				0.00016	5.30	9.67
fenthion	2000	3.30	55%		1.74	5.0	250	2.60	7.64	0.87	2.56	7.60				0.0052	3.78	8.83
bromoxynil	5262	3.72	20%		1.30	5.0	190	2.72	7.74	0.46	2.84	7.86	140	0.85	5.88	12.5	0.40	5.43
amitrole	35000	4.54	20%		1.30	5.8	1100	1.96	7.80	1000	-0.50	5.35	8.96	2.05	7.89	10	0.50	6.35
pendimethalin	20500	4.31	33%		1.52	5.8	1050	1.98	7.81	0.14	3.35	9.18						
sulfur	80000	4.90	50%		1.70	6.6	5000	1.30	7.90	100	0.50	7.10	180	0.74	7.35			

Pesticide	Volume	Quantity	Active %	Sub Score	LD50 Rat	Rat Toxicity Score	Rat Total Score	LC50 Rainb. Trout	R Trout Toxic Score	R Trout Total Score	LC50 Algae	Algae Toxicity Score	Algae Total Score	LC50 Daphnia	Daphnia Toxic Score	Daphnia Total Score
diquat	16430	4.22	12%	1.06	231	2.64	7.91	21	1.18	6.45	0.02	4.70	9.98	75	-0.38	4.45
endosulfan	2229	3.35	30%	1.48	70	3.15	7.98	0.002	5.20	10.02				235	-0.87	5.05
2,4-D	12000	4.08	70%	1.85	639	2.19	8.12	1.1	2.46	8.38	33.2	1.48	7.40	6.9	0.66	7.09
atrazine	30000	4.48	90%	1.95	1869	1.73	8.16	4.5	1.85	8.28	0.043	4.37	10.80	100	-0.50	5.67
MCPA	29784	4.47	50%	1.70	900	2.05	8.22	232	0.13	6.31	392	0.41	6.58	4.7	0.83	6.63
thiram	14000	4.15	80%	1.90	620	2.21	8.26	0.13	3.39	9.44						
dimethoate	21340	4.33	30%	1.48	290	2.54	8.34	6.2	1.71	7.51						
mancozeb	240000	5.38	75%	1.88	5000	1.30	8.56	2.2	2.16	9.41				0.053	2.78	8.28
thiodicarb	4000	3.60	80%	1.90	66	3.18	8.69	2.55	2.09	7.60				0.0065	3.69	10.70
copper hydroxide	400000	5.60	26%	1.41	1000	2.00	9.02	0.08	3.60	10.61						
ziram	50000	4.70	76%	1.88	320	2.49	9.07	5	1.80	8.38				0.0287	3.04	8.84
methomyl	6350	3.80	100%	2.00	17	3.77	9.57	3.4	1.97	7.77				0.022	3.16	9.45
omethoate	24286	4.39	80%	1.90	25	3.60	9.89	9.1	1.54	7.83						
phorate	8000	3.90	20%	1.30	2	4.80	10.00	0.013	4.39	9.59				0.0073	3.64	9.57
parathion methyl	17000	4.23	50%	1.70	6	4.22	10.15	2.7	2.07	8.00						
azinphos-methyl	80000	4.90	50%	1.70	9	4.05	10.65	0.02	4.20	10.80				0.0011	4.46	11.06

Appendix 14. Unlawful Acts Pesticide Risk Rating by Receptor Grouping

Pesticide	Receptors		Rainbow Trout Overall Rating	Algae Overall Rating	Daphnia Overall Rating
	Food Industry, Human Consumption, Domestic & Stock	Aquaculture : aquatic flora & fauna			
bensulfuron	Very Low		Very Low		Very Low
triasulfuron	Very Low		Very Low	Moderate	Very Low
fipronil	Very Low		Very Low		Very Low
chlorsulfuron	Very Low		Very Low		Very Low
oryzalin	Very Low		Low	Low	Low
propaquizafop	Low		Moderate	Moderate	Very Low
imazethapyr	Low		Very Low	Low	Very Low
rimsulfuron	Low		Very Low		Very Low
penconazole	Low		Low		Very Low
metsulfuron-methyl	Low		Very Low	Very Low	Very Low
fenoxaprop-p	Low		Moderate		Very Low
diflufenican	Low		Very Low	Low	Very Low
alpha-cypermethrin	Low		Moderate		Moderate
beta-cypermethrin	Low		Moderate		Moderate
quizalofop-p	Low		Moderate	Moderate	Very Low
clomazone	Low		Low	Moderate	
oxyfluorfen	Low		Moderate		Low
carbendazim	Low		Moderate		Moderate
tau-fluvalinate	Low		High		Moderate
tebufenozide	Moderate		Moderate		Low
butoxydim	Moderate		Moderate	Moderate	Low
fluroxypyr	Moderate		Low	Low	Very Low
fluazifop-p-butyl	Moderate		Moderate	Moderate	Low
thiobencarb	Moderate		Moderate		
imidacloprid	Moderate		Very Low		Very Low
simazine	Moderate		Low	High	Very Low
esfenvalerarate	Moderate		Very High		High
tralkoxydim	Moderate		Moderate	Moderate	
glyphosate	Moderate		Moderate	Low	Very Low
diuron	Moderate		Moderate		Low
propiconazole	Moderate		Moderate		Low
trifluralin	Moderate		Very High	Moderate	Moderate
molinat	Moderate		Moderate		
chlorothalonil	Moderate		High	Very High	High
metribuzin	Moderate		Moderate		Moderate
paraquat	Moderate		Low	Moderate	
phosmet	Moderate		Moderate		Moderate
imazalil	Moderate		Moderate		Low
carbaryl	Moderate		Moderate		High
metiram	Moderate		High	Very High	Moderate
pirimicarb	Moderate		Low		Moderate
ammonium glufosinate	Moderate		Low		Very Low
metalaxyl	Moderate		Low		Very Low
chlorpyrifos	Moderate		Very High		Very High
bifenthrin	Moderate		Very High		High
fenthion	Moderate		Moderate		High
bromoxynil	Moderate		Moderate	Low	Low
amitrole	Moderate		Low	Moderate	Moderate
pendimethalin	Moderate		High		
sulfur	Moderate		Moderate	Moderate	
diquat	Moderate		Moderate	High	
endosulfan	Moderate		Very High		Very Low
2,4-D	Moderate		Moderate	Moderate	Low
atrazine	Moderate		Moderate	Very High	Moderate
MCPA	Moderate		Moderate	Moderate	Low
thiram	Moderate		High		
dimethoate	Moderate		Moderate		Moderate
mancozeb	Moderate		High		
thiodicarb	Moderate		Moderate		Moderate
copper hydroxide	High		Very High		Very High
ziram	High		Moderate		
methomyl	High		Moderate		High
omethoate	High		Moderate		High
phorate	Very High		High		
parathion methyl	Very High		Moderate		High
azinphos-methyl	Very High		Very High		Very High

Appendix 15. Combined Pesticide Risk Rating with Land Use

Receptors:	Humans	Aqua-	Aquatic ecosystems		Over all	Land Use					Districts where used								
	Animals	culture					Fruit	Vegies	Vines	Pasture	Crops	Rice	CG	MV	Boort	Kerang	Rochester	Swan Hill	Pyramid Hill
Pesticide	Rat Rating	R Trout Rating	Algae Rating	Daphnia Rating	Sum*														
azinphos-methyl	Very High	Very High		Very High	12.08														
copper hydroxide	High	Very High		Very High	10.76														
parathion methyl	Very High	High		Very High	10.47														
chlorpyrifos	Moderate	Very High		Very High	10.32														
omethoate	Very High	Moderate		Very High	10.08														
esfenvalerarate	Moderate	Very High		Very High	9.91														
methomyl	Very High	Moderate		High	9.77														
thiram	High	Very High			9.74														
mancozeb	High	Very High			9.67														
bifenthrin	Moderate	Very High		Very High	9.67														
ziram	High	High			9.62														
thiodicarb	High	Moderate		High	9.44														
fenthion	Moderate	Moderate		Very High	9.23														
chlorothalonil	Moderate	Very High	Very High	High	9.18														
metiram	Moderate	High	Very High	Moderate	9.18														
carbaryl	Moderate	Moderate		Very High	9.18														
tau-fluvalinate	Moderate	Very High		High	9.00														
pendimethalin	Moderate	High			8.68														
sulfur	Moderate	Moderate	Moderate		8.37														
phosmet	Moderate	Moderate		Moderate	8.34														
pirimicarb	Moderate	Low		Moderate	8.08														
atrazine	Moderate	Moderate	Very High	Low	8.05														
propiconazole	Moderate	Moderate		Moderate	7.87														
endosulfan	Moderate	Very High		Very Low	7.86														
diquat	Moderate	Low	Very High		7.81														
dimethoate	Moderate	Moderate		Low	7.73														
tebufenozide	Moderate	Moderate		Moderate	7.59														
amitrole	Moderate	Low	Moderate	Moderate	7.58														
2,4-D	Moderate	Moderate	Moderate		7.51														
alpha-cypermethrin	Very Low	Moderate		Moderate	7.34														
molinate	Moderate	Moderate			7.27														
beta-cypermethrin	Very Low	Moderate		Moderate	7.24														
bromoxynil	Moderate	Moderate	Low	Very Low	7.15														
imazalil	Moderate	Moderate		Very Low	7.00														
MCPA	Moderate	Low	Low	Very Low	6.96														
paraquat	Moderate	Very Low	Moderate		6.89														
carbendazim	Very Low	Moderate		Moderate	6.86														
fipronil	Low	Moderate		Very Low	6.52														
tralkoxydim	Low	Low	Low		6.51														
oxyflufen	Very Low	Moderate		Very Low	6.49														
metribuzin	Moderate	Low		Low	6.45														
rimsulfuron	Low	Low	Moderate	Very Low	6.41														
simazine	Low	Low	High	Very Low	6.39														
imidacloprid	Moderate	Very Low		Very Low	6.33														
glyphosate	Moderate	Low	Low	Very Low	6.07														
chlorsulfuron	Low	Low	Moderate	Very Low	6.03														
phorate	Low	Very Low			5.98														
penconazole	Very Low	Low		Very Low	5.85														
fenoxaprop-p	Moderate	Very Low		Very Low	5.74														
clomazone	Very Low	Very Low	Low		5.74														
oryzalin	Very Low	Low	Low	Very Low	5.67														
triasulfuron	Very Low	Low	Low	Very Low	5.59														
fluroxypyr	Low	Very Low	Very Low	Very Low	5.53														
thiobencarb	Very Low	Low	Very Low	Very Low	5.47														
imazethapyr	Very Low	Very Low		Very Low	5.25														
diflufenican	Very Low	Very Low	Low	Very Low	5.19														
trifluralin	Very Low	Low	Very Low	Very Low	4.80														
quizalofop-p	Very Low	Very Low		Very Low	4.71														
bensulfuron	Very Low	Very Low	Very Low	Very Low	4.15														
fluazifop-p-butyl	Very Low	Very Low	Moderate	Very Low	4.12														
propaquizafop	Very Low	Very Low	Very Low	Very Low	4.05														
ammonium glufosinate	Very Low	Very Low		Very Low	3.69														
diuron	Very Low	Very Low		Very Low	3.58														
metsulfuron-methyl	Very Low	Very Low			2.63														
butoxydim	Very Low	Very Low		Very Low	2.49														
metalaxyl	Very Low	Very Low		Very Low	2.39														

Appendix 16. Mitigation of Pesticide Spills

This section of the report has used ideas from the University of Nebraska website. (<http://pested.unl.edu/study11.htm>). Knowing what to do in the event of a spill will help you minimize adverse effects and save you expensive clean-up costs. Users of pesticides should always be prepared to handle spills before they occur. Contamination can be much more serious if response to a pesticide spill is delayed.

Spills may be relatively minor, involving one or a few leaking containers. However major spills, such as when a truck overturns and the contents are spilled, can occur. Regardless of the magnitude of the spill, the proper response is the same-

1. Control the spill;
2. Contain the spill;
3. Clean it up.

These three steps are called the "Three C" program of spill management.

Control

Everything possible should be done to stop the leak or spill of a pesticide immediately at its source. Leaking containers can be repacked; leaking sprayers should be turned off immediately.

Stopping large leaks or spills often is very difficult.

Personnel should not risk unnecessary exposure in such a situation. Protective clothing and equipment should always be carried when transporting pesticides and they should be worn whenever there is a pesticide emergency.

Contain

After the leak has been stopped as much as the possible, the spilled material should be contained in as small an area as possible. If the spill is liquid, a dam should be built to prevent the chemical from spreading. It is particularly important to prevent any chemical from getting into any body of water, or storm sewer. Do not hose down the area; this will cause further spread of the chemical.

Liquid spills can be further contained by spreading absorbent materials such as fine sand, vermiculite, sawdust, or clay over the entire spill. For absorbing small spills and minor leaks, kitty litter is particularly useful. (Note: Do not use sawdust or sweeping compounds if the pesticide is a strong oxidizer. Such a combination is a fire hazard.)

Reporting

Spills on public property and all spills involving pesticides that are considered to be highly hazardous must be reported immediately to the local and state emergency planning agencies. Law enforcement officials are the usual local contacts for reporting such spills. During a major spill, someone must remain at the site at all times until it has been effectively contained and cleaned up. The contaminated area should be isolated, preferably by roping it off. Keep people (and animals) at least 30 feet from the spill. Avoid coming into contact with drift or fumes from the spill. Depending on the circumstances, it may be necessary to evacuate people downwind from the spill. Do not use road flares if you suspect the material to be flammable.

Clean-up

When cleaning up the spill, spread absorbent material over the contaminated area, if not already done. Sweep up the saturated material and put it in a heavy-duty plastic bag. Continue to add absorbent and pick up the saturated material until all the liquid has been soaked up. It may then be necessary to decontaminate and neutralize the area, particularly if highly hazardous pesticides are involved. Use a mixture of full-strength bleach and hydrated lime. Work the solution into the spill area with a coarse broom, and then add absorbent material to soak up the cleaning solution. Sweep and place the contaminated material in a heavy-duty plastic bag. Repeat the procedure until the area is thoroughly decontaminated.

When large amounts of pesticides are spilled on soils, effective decontamination is often not possible. In these instances, the top 2-3 inches of soil should be removed. Cover the contaminated soil with at least 2 inches of lime, and then cover with fresh topsoil.

Where there are minor spills on soil, activated charcoal can be used in clean up. The charcoal may absorb and tie-up enough chemical to avoid significant long-term injury.

Prevention

It is much better to prevent spills than to mitigate them. This topic is beyond the scope of this brief, but the following points should be observed.

The risk can be removed by not using that pesticide.

- Minimising the distance travelled can reduce transportation risk;
- Using safer transport (perhaps reducing speed
- Using safe containers.

Appendix 17. Major channels categories and their width and depth.

Capacity (ML/D)	Width (Meter)	Depth (meter)
00-20	5.8	1.0
21-50	6.8	1.1
50-100	8.4	1.5
101-200	10.8	1.95
201-500	17.2	2.3
501-1000	24.6	2.4
1001-1500	30.4	2.6
1501-2000	37.9	2.6
2001-2500	41.2	2.8

*Information based on Asset Service, Tatura

Appendix 18. Channel width and different farming practices in the six irrigation areas

	Central Goulburn	Shepparton	Murray Valley	Rochester-Campaspe	Torrumbarry	Pyramid-Boort
VEGETABLES						
Tomatoes	5.8-10.8, some 17.8	7	-	6.8 (60%); 17.2 (20%); 41.2 (20%)	10.8	17.2-24.6
Other vegetables				6.8	10.8	
FRUITS						
Grapes				41.2 (most)		24.6
Olives						24.6
Orchards/ Stone fruit, Pome fruit, Citrus, Vine	5.8-10.8	7	8.4-10.8, few 5.8			
CROPS						
Crops	-	8.4-10.8	5.8-6.8	6.8 (80%); 10.8 (20%)	17.2	10-17.2
Crops (rice)			5.8-6.8		10.2	
Pastures	5.8-10.8	8.4-10.8	8.4-10.8			6.8-17.2
					17.2-24	

*Information supplied by Ian Hetherington (Torrumbarry), Gary Whyte (Central Goulburn), David Derby (Murray Valley), Bary Russell (Shepparton), David Hellesten (Pyramid-Boort), Geoff Enever (Rochester-Campaspe)