Potential Issues Relating to the use of Agrochemicals in the Proposed Makhathini Sugar Cane Project

1. Project Proposal
The objective of the project is to create a sustainable socio-economic development aimed at facilitating broad based Black Economic Empowerment in the Makhathini area in Northern KwaZulu Natal. The project will establish an agri-processing business cluster on the Makhathini Flats comprising sugar cane farming, a fuel ethanol distillery, electricity co-generation and/or raw sugar production.

The project will be implemented in a phased manner with the initial investment comprising approximately 8,220ha of new sugar cane land and 1,200 ha of existing developed land, a fuel ethanol distillery and electricity co-generation.

Issues raised during the early stages of impact assessment for the proposed project included concerns with regard to the potential effects of agrochemicals on the environment in and around the project area. As a result of this issue being raised, Mr D Pringle of Andisa Agri requested Ms V King of Metamorphosis Environmental Consultants to undertake an investigation into the potential risks and mitigation options relating to the use of agrichemicals in the project. This report presents the findings of this investigation.

The project area is typified by low lying land, interspersed with drainage channels, rivers and wetlands. Groundwater resources are of critical importance in the area both for ecological and water supply reasons, therefore any activity which potentially threatens the groundwater in the area must be carefully considered.

2. Scope of Work
To identify the potential environmental risks associated with the use of agrochemicals in the production of sugar cane in the Makhathini Flats project and identify possible mitigation methodologies. Agrochemicals include herbicides, fungicides, insecticides, nematicides, plant growth regulators and fertilizers. Many of these compounds are harmful to man and the environment if not used responsibly.

The Food and Agriculture Organisation of the United Nations established an ‘International Code of Conduct for the Distribution and Use of Pesticides’ which provides guidance for all aspects of

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\[1\] Information taken from Project Information Brief dated 17 November 2011.
management of pesticides. This was updated in 2006 to incorporate the provisions of the Globally
Harmonised System of Classification and Labelling of Chemicals (GHS), and this standard has recently
been incorporated into South African legislation via SANS 10234:2008. This standard covers the labeling,
transportation, handling etc of all listed substances. All substances classified as hazardous in the code
require a Safety Data Sheet (SDS) which complies with the requirements of the code in terms of data
presented and this includes mammalian and aquatic toxicity. It is therefore critical that these SDSs are
available for each chemical to be used in the farming operations. These must form the basis of use and
training on each specific chemical.

This report does not deal in detail with the significant field of human risk related to the use of
agrochemicals, but the application of the management measures recommended in this report, together
with the implementation of appropriate legislation and systems will ensure that these risks are also
minimized.

3. Methodology
Interaction was undertaken with the relevant personnel from the South African Sugar Association, who
provided a significant amount of information on the subject. An extensive internet search was also
undertaken and this generated a huge amount of information on the impacts of agrochemicals on the
environment and potential management and mitigation strategies.

4. Relevant Legislation
The key legislation relating to agrochemicals includes:

- Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act 36 of 1947;
- Hazardous substances Act 15 of 1973;
- National Water Act 36 of 1998;
- Occupational Health and Safety Act 85 of 1993;
- National Environmental Management Act 107 of 1998;
- Conservation of Agricultural Resources Act 43 of 1983.

Legislation controls the registration, manufacture, importation, packaging, storage, transport, disposal,
handling and application of agrochemicals.

The National Water Act and National Environmental Management Act deal with potential pollution
issues related to the use, storage, transportation etc of chemicals.

Chemicals may only be used in the industry if they have been registered for the control of a particular
weed, pest or disease. Nematacides used in the sugar cane industry are extremely toxic and must be
used with extreme caution.

5. Impact of Agrochemical Usage in the Sugar Industry
The use of insecticides and fungicides in sugar cane production is below the average for comparable
cash crops. However, there are still clearly significant environmental risks associated with the use of
agrochemicals in the industry. Impacts vary from local and social (contamination of ground and surface
water supplies), localized soil contamination etc, to a global scale where toxic chemicals accumulate in
the food chain and are found in the ‘pristine’ polar regions (Blais etc al 1998). Inappropriate chemical
control can also destroy the natural balance between organisms in a field (eg between pests, their
predators and parasitoids), leading to later damage through the proliferation of pests.
Assessing the impacts of these chemicals is highly complex and often leads to disagreement between stakeholders and scientists. Disagreements often involve the perception of risk and the interpretation of the precautionary principle. Stakeholders disagree on who should bear the ‘burden of proof’, i.e. whether industry should demonstrate that its products are proven safe— with a reasonable degree of certainty— or whether anyone opposing the introduction of a chemical should be able to demonstrate a scientific link between exposure to the chemical and harmful impacts.

Box 12.5 Some toxic chemicals used in sugarcane

Aldicarb is used in Australia, Brazil and South Africa to control nematodes in sugarcane. Although it is rated as extremely hazardous, the risk it poses to the user is lower than similarly rated chemicals because the product granules are coated to prevent formation of dust, and are impregnated with Bitrex (denatonium benzoate) – a substance that induces vomiting – thus making accidental poisoning less likely. Also, strict stewardship conditions are imposed on users; they must be registered and trained and tight controls are in place to keep track of the chemical, up to the point of application. In South Africa many of the problems with aldicarb arise from misuse off-farm.

Paraquat is a toxic liquid herbicide which is effective on large weeds. The potential for inhalation and skin contact is high if incorrect application methods are used and if the required protective clothing is not worn. There is no proven antidote for paraquat (CDC 2011), which makes this a very dangerous chemical for accidental ingestion. In the USA this is a restricted use herbicide and can only be applied by licensed applicators. Formulations used in the USA are required to have a dye, a strong odour and an additive which induces vomiting. Its use has been banned in a number of countries and its use is not permitted for certification in various sustainability standards. (www.sanstandards.org) However the benefits and safety of its use if recommendations are strictly adhered to (www.paraquat.com) make this a classic example of a toxic product which can be used safely in well regulated circumstances but which under practical conditions in under regulated countries and hot climates can be a serious risk to operators health. (http://archive.pic.int/INCS/CRC7/k11/add3/English/CRC-7-11-Add-3_Berne%20Declaration-4-Paraquat%20in%20developing%20countries.IJOEH.%20pdf.pdf)

These products must be used with extreme care and they should be targets for replacement as soon as safer products or alternative methods become available.

The main reasons (internationally) for inappropriate agrochemicals use which leads to health and environmental impacts include:²

- Workers not using the correct equipment.
- Chemicals are applied at the wrong time, in inappropriate ways, too often or in excessive amounts.
- Outsourcing the application of pesticides sometimes allows companies to evade their social and environmental responsibilities.
- Storage containers are handled, stocked and traced inadequately.
- Persons handling the chemicals lack sufficient training and information on the associated hazards and appropriate user practices.
- Legislation for chemical control and occupational health is lacking or inappropriate.

² Ethical Sugar Status Report on Sugar Cane agrochemicals management 2009
• Chemicals approval and registration procedures are lacking, inadequate or poorly implemented and enforced.
• Government subsidies keep the price and availability of agrochemicals artificially low.
• Farmers mistrust the experts and their advice on chemical hazards.

**Pesticides**

There has been a significant change in pesticide use over the last 20 years as understanding of the impacts of some of the chemicals has improved. The Stockholm Convention on Persistent Organic Pollutants (POPs) entered into force in 2004. It identified 12 chlorine based POPs (the Dirty Dozen) as targets for global phase out. These are: PCBs, Dioxins, Furans, Aldrin, Dieldrin, DDT, Endrin, Chlordane, Hexachlorobenzene, Mirex, Heptachlor and Toxaphene. South Africa ratified the Convention on the 4th September 2002, thus committing the country to a phase out of these chemicals.

The EU developed a REACH Regulation (REACH is the European Community Regulation on chemicals and their safe use (EC 1907/2006). It deals with the Registration, Evaluation, Authorisation and Restriction of Chemical substances. The law entered into force on 1 June 2007), which identified Substances of Very High Concern (SVHC) and aims to ensure proper control of risks and promotes their progressive replacement by suitable alternatives. The list comprises substances which are carcinogenic, mutagenic or toxic to reproduction, persistent, bioaccumulative and toxic or very persistent and very bioaccumulative.

**Case Study: Brazil**

The growth in the agrochemical industry in the sugar cane industry in Brazil was particularly high between 1999 and 2004, at 355%. More than 80% of these chemicals are herbicides, with insecticides accounting for only approximately 10%. Use of these agrochemicals has caused severe water pollution, especially in areas with intensive large scale sugarcane cultivation, such as the watershed area of the Corumbatai River. This is not only an environmental problem, it is also a health issue as the chemicals have affected surface and groundwater resources which they use for water supply. It has been established that the extent to which the agrochemicals reach the groundwater depends mainly on the prevailing climatic conditions and soil characteristics. Contamination tends to be highest during the rainy season and in areas where the soils are relatively permeable. High organic content of soils has been found to favour the adsorption of chemicals, increasing the effect of contamination in certain situations. The main herbicides used in the sugarcane industry in Brazil persist for up to 2 years in the soil, increasing the risk to aquifers and rivers.

The most problematic chemicals have been herbicides of the triazine group (including Atrazine and Ametryne). Glyphosphate and its metabolite AMPA were also commonly detected in Corumbatai.

Poor compliance with legislation has been identified as a major issue in the mis-use of agrochemicals in Brazil. A study found organochloride compounds in the sediment of the Piracicaba River basin in 1997, despite the fact that these chemicals had been banned in Brazil in 1985. Poisoning as a result of mis-use of agrochemicals is a major problem in Brazil, with estimates being made of up to 500 000 cases of acute poisoning occurring per annum.

**5.1 Fertilizers**

If correctly used, fertilizers are environmentally benign products, they are not detrimental to soil or water.
5.1.1 Rationale for usage

Fertilisers consist of naturally occurring plant nutrients essential for maintaining soil fertility and securing adequate and sustainable food production.

5.1.2 Commonly used fertilizers

Fertilisers generally comprise some combination of Phosphorus, Nitrogen and Potassium, Sulphur, Calcium and Magnesium with trace elements such as Zinc, Iron, Copper and Manganese.

5.1.3 Environmental Risks

Phosphorus is immobile in soil as it bonds strongly to soil particles. Phosphorus fertilizer is therefore rarely found at elevated levels in groundwater as a result of fertilizer application. The same generally applies to potassium.

Nitrogen, in nitrate form, can leach out of soils, particularly during heavy rains or in waterlogged soils. Nitrates adversely affect water quality and ecological habitat in surface water bodies, where an excess of nutrients can lead to eutrophication, excessive growth of algae and smothering of organisms, as well as a reduction in oxygen supply in the water body. The pollution is typically measured as BOD (Biochemical Oxygen Demand) and high BOD can lead to oxygen depletion, jeopardizing fish and other aquatic species. Increased nutrient loading in surface water bodies can also result from domestic sewage, industrial effluents and atmospheric inputs (fossil fuel burning, veld fires and wind-borne dust) and the potential for cumulative impact with the sugarcane should be considered.

Some fertilizers give rise to atmospheric ammonia after they have been spread on the fields. Urea and Ammonium sulphate can lose up to 30% of their nitrogen to atmosphere. Farm animals and manure generate greater levels of ammonia and this must be considered when using animal manures as fertilizer. Air quality is unlikely to be noticeably affected by the increased ammonia, but on deposition the ammonia contributes to acid rain, soil acidification, changes in ecological composition and possibly forest damage.

It should be noted however, that lime and N:P:K fertilizers are used in moderate amounts in fish farming to increase productivity, so it is clear that some increased nutrient load may in certain circumstances, improve the environment for certain species of fish.

Source

- Over application or the application of fertilizers close to water bodies, in waterlogged soils or heavy rains, can lead to leaching of the chemicals into water bodies.

Pathway

- Direct application of fertilizer into wetlands, water bodies etc.
- Wash off into wetlands/drainage channels.
- Spillage onto sensitive areas/wash into water resources.
- Washing of containers/equipment into water courses/wetlands.

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4 VO Ngbede *Environmental Impact Assessment of Agrochemicals for fish production – A Review Paper*. Fisheries Department, University of Agriculture, Makurdi.
5.1.4 Management and Mitigation Recommendations

**Source**

- Ensure that the fertilizer chosen is determined based on the soil conditions and needs of the crop.
- Take soil and leaf samples to determine fertilizer requirements.
- Do not over apply (frequency and quantity).
- Ensure that fertilizers are appropriately stored.
- Trash cane instead of burning to return nutrients to the soil.
- If using organic fertilizers such as filtercake or chicken litter, ensure that soil conditions are appropriate and that the correct application rates are used.

**Pathway**

- Do not apply close to water bodies, drainage channels etc.
- Do not apply in heavy rain or onto waterlogged soils.

**Receptor**

- Do not apply close to water bodies, drainage channels etc.
- Do not store close to water resources.
- Do not apply fertilizers in sensitive areas.

5.2 Herbicides and fungicides

**5.2.1 Rationale for usage**

Herbicides are applied for the control of weeds within the sugar industry. Certain herbicides are effective on grasses, others will kill both broadleaf weeds and grasses. Watergrasses are also a problem in the industry and specific herbicides are used to eliminate these. Herbicides are designed to be used at specific time in the target plants lifecycle, some are effective only before the plants emerge, whilst others are effective pre and post emergence. Others must be used only post emergence. Information regarding usage is presented on ALL chemicals available as long as they are in their original undamaged containers.

Mechanical weed control may also be undertaken but this is more labour intensive and not commonly carried out.

Studies have shown that sugar cane yields can be reduced by up to 50% if no weed control measures are undertaken.\(^5\)

Fungicides are not commonly used in the sugar industry, but Bayleton is used as required but is toxic to fish and bees so application directions must be followed with care.

5.2.2 Commonly used herbicides
There are several key chemicals found in the branded herbicides, the more common ones include:

- Acetochlor*
  - Carcinogen
  - Suspected endocrine disruptor
  - Not registered in the EU
- Alachlor
- Ametrin*
  - Potential groundwater contaminant
  - Not registered in the EU
- Atrazine*
  - Carcinogen
  - Groundwater contaminant
  - Suspected endocrine disruptor
  - Not registered in the EU.
- Diuron
  - Groundwater contaminant
  - Carcinogen
  - Developmental or reproductive toxin
  - Registered in EU but forbidden for use in some countries (e.g., France)
- EPTC
- Glyphosphate
  - Organophosphate with non-specific effects
  - Potential groundwater contaminant
  - Low acute toxicity and relatively less harmful than many alternatives
- Hexazinone*
  - Acutely toxic
  - Known and pervasive groundwater contaminant due to its high solubility
  - Not registered in EU or used in the majority of Europe
- MCPA
  - Possible carcinogen
- Metolachlor
- Metribuzin
  - Developmental or reproductive toxin
  - Suspected endocrine disruptor
  - Potential groundwater contaminant
- MSMA*
  - Carcinogen
  - Potential groundwater contaminant
  - Not registered in EU.
- Paraquat*
  - WHO classification Class II of acute toxicity
  - Highly contentious chemical, subject of much legal debate
  - Banned in the EU
- Commonly used as a suicide agent
- Easily absorbed through the skin
- **Tebuthiuron**
  - Developmental or reproductive toxin
  - Potential groundwater contaminant
  - Not registered in the EU.
  *Denotes not registered in EU.

Many of these chemicals are combined in the branded herbicides, but herbicides should not be mixed without prior consultation of an expert as some chemicals may cause adverse effects when mixed.

### 5.2.3 Environmental Risks

The tables below present the mobility (Groundwater Ubiquity Score (GUS)) and toxicity of some of the commonly used herbicides (an x indicates toxicity). It can clearly be seen that the majority are toxic to fish and daphnia (representing other aquatic fauna) and moderately toxic to insects, birds and mammals. Certain chemicals, such as Paraquat, are highly toxic to mammals.

The mobility of the chemicals and therefore the likelihood of them contaminating waterways depends on the rate and methods of application, the nature of the soils and the proximity of wetlands and drainage channels/ribes.

In terms of the philosophy of pollution as adopted by the Department of Water Affairs, source, pathway, receptor, the risks associated with the use of each chemical in different locations will vary and the management recommendations must aim to reduce the site specific risk.

The relative persistence of the herbicide in the environment is of key importance when considering the potential environmental impact.

Bayleton (fungicide) is toxic to fish and bees and so the correct application processes must be followed.

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GUS was developed to classify herbicides for their water contamination potential. It is based on the soil/water partitioning coefficient and the soil half life of each herbicide. The basis of the model is that pesticides that are weakly absorbed and have a high soil persistence will have a greater potential to contaminate groundwater.

* - indicates the potentially most problematic substances, they are on the Pesticide Action Networks 'bad actor' chemicals list. None of these are registered in the EU.

However, other aspects will influence the potential to pollute groundwater, these include soil conditions, application methods and irrigation practices.
### Definitions of Risk to Human Health (Label Band Colour) and Scores for Environmental Risk (Leaching Potential and Effect on Animals)

<table>
<thead>
<tr>
<th>Risk to humans</th>
<th>Environmental risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Toxicity to humans is in three ways:</strong></td>
<td><strong>Category</strong></td>
</tr>
<tr>
<td>1) by mouth (oral), 2) through the skin (dermal) or 3) through the nose (inhalation)</td>
<td><strong>GUS</strong></td>
</tr>
<tr>
<td></td>
<td>sand or clay</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Herbicides are classified according to their toxicity:**

<table>
<thead>
<tr>
<th>Class 1 - red band</th>
<th>Highly toxic, requiring extreme caution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 2 - yellow band</td>
<td>Toxic and described as harmful</td>
</tr>
<tr>
<td>Class 3 - blue band</td>
<td>Toxic with caution required</td>
</tr>
<tr>
<td>Class 4 - green band</td>
<td>Relatively safe herbicide</td>
</tr>
</tbody>
</table>

1. Low toxicity to mammals (ORAL LD50 2000-8000 mg/kg)
2. Medium toxicity to mammals (ORAL LD50 1000-2000 mg/kg)
3. High toxicity to mammals (ORAL LD50 280-1000 mg/kg)
4. Very high toxicity to mammals (ORAL LD50 48-160 mg/kg)

1. Low toxicity to birds (LD50 2000-20000 mg/kg)
2. Medium toxicity to birds (LD50 900-2000 mg/kg)
3. High toxicity to birds (LD50 200-900 mg/kg)
4. Very high toxicity to birds (LD50 75-200 mg/kg)

1. Low or no toxicity to bees (LD50 1000 ug/BEE - NON TOXIC)
2. Medium high toxicity to bees (LD50 70-1000 ug/BEE)
3. High toxicity to bees (LD50 50-70 ug/BEE)
4. Very high toxicity to bees (LD50 11-50 ug/BEE)

1. Low toxicity to fish (LC50 1800 mg/L - NON TOXIC)
2. Medium toxicity to fish (LC50 50-300 mg/L)
3. High toxicity to fish (LC50 1-20 mg/L)
4. Very high toxicity to fish (LC50 0.023-1.0 mg/L)

1. Low toxicity to daphnia (LC50 900 mg/L - NON TOXIC)
2. Medium toxicity to daphnia (LC50 45-300 mg/L)
3. High toxicity to daphnia (LC50 4-25 mg/L)
4. Very high toxicity to daphnia (LC50 0.11-4.0 mg/L)

Refer to the Table on page 61 for colour banding of the herbicides. Remember that all herbicides are toxic even if they belong to Class 4, and must be used according to the precautions stated on the label.

Each grower should be familiar with the herbicides used and remedies for accidental intake by operators.

In case of accidents, contact the poison control centre at:

082 911 (Netcare)  
St Augustine’s Hospital Poison Centre 0800 333 444

Avoid roots - the label stipulates that the herbicide should be used away from root zones of neighbouring plants.

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* Human toxicity is based on LD50 values. LD50 = the dose lethal to 50% of the test animals, usually rats.
** Animal toxicity is based on LD50 or LC50 values = the concentration of herbicide in the air, water or diet that will kill 50% of the test animals.
### List of Herbicides Registered for Use in Sugarcane and Their Label in Colours

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Trade name</th>
<th>Active ingredients</th>
<th>Label colour band</th>
<th>Leaching potential</th>
<th>Toxicity to terrestrial and aquatic environments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GUS sand                              GUS clay</td>
</tr>
<tr>
<td>Acetochlor</td>
<td>acetochlor</td>
<td>Blue</td>
<td></td>
<td>1</td>
<td>1 2 1 3 3</td>
</tr>
<tr>
<td>Alachlor</td>
<td>alachlor</td>
<td>Yellow</td>
<td>4</td>
<td>1</td>
<td>3 2 2 4 4</td>
</tr>
<tr>
<td>Ametryn</td>
<td>ametryn</td>
<td>Yellow</td>
<td>4</td>
<td>2</td>
<td>1 1 2 4 3</td>
</tr>
<tr>
<td>Arsenal</td>
<td>imazapyr</td>
<td>Blue</td>
<td>4</td>
<td>4</td>
<td>x  x 1 2 2</td>
</tr>
<tr>
<td>Atrazine</td>
<td>atrazine</td>
<td>Yellow</td>
<td>4</td>
<td>3</td>
<td>2 2 1 3 2</td>
</tr>
<tr>
<td>Authority</td>
<td>sulfentrazone</td>
<td>Blue</td>
<td>3</td>
<td></td>
<td>1 1 1 2 2</td>
</tr>
<tr>
<td>Caballo</td>
<td>sulcotron + atrazine</td>
<td>Yellow</td>
<td>4</td>
<td>3</td>
<td>1 1 1 2 2</td>
</tr>
<tr>
<td>Diuron</td>
<td>diuron</td>
<td>Green</td>
<td>3</td>
<td>3</td>
<td>x 1 2 1 3</td>
</tr>
<tr>
<td>Eptam Super</td>
<td>EPTC</td>
<td>Yellow</td>
<td>2</td>
<td>1</td>
<td>1 1 4 3 3</td>
</tr>
<tr>
<td>Extreme Plus</td>
<td>chlorimuron-ethyl + metribuzin</td>
<td>Blue</td>
<td>4</td>
<td></td>
<td>x 2 4 2 3</td>
</tr>
<tr>
<td>Falcon Gold</td>
<td>S-metolachlor</td>
<td>Yellow</td>
<td>4</td>
<td></td>
<td>1 1 2 3 3</td>
</tr>
<tr>
<td>Fusilade Forte</td>
<td>fluzifop-butyl</td>
<td>Yellow</td>
<td>1</td>
<td>1</td>
<td>x 1 1 2 3</td>
</tr>
<tr>
<td>Garlon 4</td>
<td>triclopyr</td>
<td>Yellow</td>
<td>3</td>
<td>2</td>
<td>2 2 2 2 2</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>glyphosate</td>
<td>Green-blue</td>
<td>1</td>
<td>1</td>
<td>1 1 1 3 3</td>
</tr>
<tr>
<td>Gramoxone</td>
<td>paraquat</td>
<td>Yellow</td>
<td>1</td>
<td>1</td>
<td>3 3 3 3 3</td>
</tr>
<tr>
<td>Lumax</td>
<td>mesotrione+S-metol.+terbuthyl</td>
<td>Yellow</td>
<td>4</td>
<td></td>
<td>1 2 1 3 2</td>
</tr>
<tr>
<td>MCPA</td>
<td>MCPA</td>
<td>Yellow</td>
<td>2</td>
<td>1</td>
<td>3 3 1 2 2</td>
</tr>
<tr>
<td>Merlin</td>
<td>isoxaflutole</td>
<td>Green</td>
<td>4</td>
<td>1</td>
<td>x 1 1 2 2</td>
</tr>
<tr>
<td>Metribuzin</td>
<td>metribuzin</td>
<td>Yellow</td>
<td>4</td>
<td>1</td>
<td>2 3 2 2 3</td>
</tr>
<tr>
<td>MSMA</td>
<td>MSMA</td>
<td>Yellow</td>
<td>4</td>
<td>1</td>
<td>3 2 2 1 2</td>
</tr>
<tr>
<td>Parabat Extra 660</td>
<td>pendimethalin+metribuzin+chlorimuron-ethyl</td>
<td>Yellow</td>
<td>4</td>
<td></td>
<td>x 2 4 2 4</td>
</tr>
<tr>
<td>Servian</td>
<td>halosufuron</td>
<td>Green</td>
<td>4</td>
<td></td>
<td>1 1 2 2 2</td>
</tr>
<tr>
<td>Tebusan</td>
<td>terbuthiuron</td>
<td>Yellow</td>
<td>4</td>
<td></td>
<td>x x 3 2 1 2 2</td>
</tr>
<tr>
<td>Terbo</td>
<td>terbutylazine+bromoxynil</td>
<td>Blue</td>
<td>4</td>
<td>1</td>
<td>x 1 4 3 4 4</td>
</tr>
<tr>
<td>Velpar</td>
<td>hexazinone</td>
<td>Yellow</td>
<td>4</td>
<td></td>
<td>x x 3 1 1 2 2</td>
</tr>
</tbody>
</table>

South African Sugarcane Research Institute  Herbicide Guide August 2010
Source

- Most herbicides have negative effects on the environment.

Pathway

- Spray drift onto adjacent areas/animals/people.
- Wash off into wetlands/drainage channels.
- Spillage onto sensitive areas/wash into water resources.
- Washing of containers/equipment into water courses/wetlands.
- Direct contact with people applying chemicals

Receptor

- Groundwater
- Wetlands.
- Water bodies.
- Rivers.
- Oceans.
- Surrounding plants and animals.
- Farm workers.

5.2.4 Management and Mitigation Recommendations

Source

- Trashing sugar cane results in a mulch effect which reduces weed growth.
- Use mechanical/cultural and biological means to control weeds wherever possible.
- Do not combine chemicals without expert advice.
- Aim to apply herbicides soon after harvest to control weeds when they are small (cheaper and less chemicals in the environment).
- Treat small patches of weeds before they expand.
- Clean vehicles and implements to prevent the spread of weeds within and between fields.
- Do not handweed verges and throw weeds/grass onto fields.
- Do not spread kraal manure on fields if cattle have grazed on Cynodon, Digitaria and paspalum grasses.
- Kill or remove weeds before they set seed.
- Keep field edges, fencelines, roadsides, waterways etc free of weeds to prevent the spread of seeds, runners and tubers into the fields.
- Do not continually use the same herbicide as the weeds will become resistant to it.
- Do not use herbicide more than once in a season if there is a use restriction.
- Do not ‘over apply’ herbicides (in terms of both frequency and amount).
- Use soil conservation agents such as Curasol AH which reduces herbicide mobility in the soil.

Pathway

- Plant a line of cane along the field edge to prevent drift of chemicals.
- Do not over-irrigate or apply herbicide when heavy rains are expected.
- Correct drainage problems.
- Minimise runoff and prevent erosion.
• Try to increase organic matter in soils, especially where there is a high water table.
• Do not use on sandy soils if there is a soil use restriction.
• Do not wash out contaminated containers or equipment in any area where the chemicals may affect ground and surface water.

**Receptor**

• Do not use chemicals in close proximity to water courses, wetland or sensitive ecological areas.
• Select pesticides based on the ones offering the ‘least damage’ to the local environment.
• If there are sensitive species in the area the method for weed control must be carefully chosen.

### 5.3 Insecticides

#### 5.3.1 Rationale for usage

Monocultures of any description are susceptible to pests. The hot and humid conditions in KwaZulu-Natal increase the prevalence of pests as breeding conditions are ideal for many species.

#### 5.3.2 Commonly used pesticides

Insecticides are used within the sugar industry, although biological control is used wherever possible. Many cane varieties are also resistant to certain pests.

Insecticides are used for borers (Fastac), nematodes (aldicarb and carbofuran), Numicia – green leaf sucker (Endosulfan and Malathion) and Deltamethrin for grasshoppers (although this is not registered for use against grasshoppers in SA).

- **Fastac** is a pyrethroid—highly toxic to many aquatic and terrestrial organisms. It has a low solubility and so tends to be adsorbed into the sediments. Its effects on aquatic flora and fauna can exacerbate the effects of eutrophication. It is dangerous to bees.

- **Aldicarb** (Sanacarb and Temik) is banned in Europe and has recently been banned in the US. It is lethal to humans and animals. It is toxic via oral, dermal and inhalation exposure. It is a Restricted Use chemical in SA.

- **Carbofuran** (Carbosan and Curaterr) is highly toxic to fish and birds, as well as honey bees. It is banned in the US and EU.

- **Endosulfan** (Thiodan) was added to the United Nations’ list of persistent organic pollutants to be eliminated worldwide in May 2011. The action puts the widely-used pesticide on track for elimination from the global market by 2012. The governments agreed to list endosulfan in Annex A to the Stockholm Convention, with specific exemptions. When the amendment enters into force in one year, endosulfan will become the 22nd POP to be listed under the Convention. Endosulfan is an organochlorine insecticide used on crops worldwide, mainly on cotton, coffee and tea. Endosulfan acts as an endocrine disruptor, causing reproductive and developmental damage in both humans and animals. It has been banned in more than 80 countries.

- **Malathion** has a relatively low human toxicity, it is, however, toxic to fish, aquatic organisms and aquatic life cycle stages of amphibians. It is toxic to bees on direct contact.

- **Deltamethrin** is acutely toxic to crustaceans, less toxic to fish and invertebrates and non toxic to microorganisms, birds and mammals. It has a WHO Acute Toxicity rating of II (moderately toxic).
5.3.3 Environmental Risks

- Kill both pests and natural predators giving rise to secondary, more serious outbreaks.
- Can be toxic to humans, animals, fish, birds and aquatic life.
- Can pollute water resources.
- Can move down rivers into the ocean.
- Bio magnification – deposited in the fatty tissues of animals and humans where the potency increases.
- Can affect bees and other pollinators.
- Pesticide resistance.
- Chronic pesticide exposure can lead to an increase in the risk of developmental and reproductive disorders, immune system disruption, endocrine disruption, impaired nervous system function and development of certain cancers.

Source

- Most insecticides have negative effects on the environment.

Pathway

- Spray drift onto adjacent areas/animals/people.
- Wash off into wetlands/drainage channels.
- Spillage onto sensitive areas/wash into water resources.
- Washing of containers/equipment into water courses/wetlands.
- Direct contact with people applying chemicals

Receptor

- Groundwater
- Wetlands.
- Water bodies.
- Rivers.
- Oceans.
- Surrounding plants and animals.
- Farm workers.

5.3.4 Management and Mitigation Recommendations

Source

- Use biological means to control pests wherever possible.
- Do not combine chemicals without expert advice.
- Do not ‘over apply’ pesticides (in terms of both frequency and amount).
- Do not wash implements in areas where wash water can affect the environment.
- Trash cane instead of burning as burning destroys both pests and predators.

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• Never use pesticides in a preventative manner.
• Plant filter strips of vegetation around fields to control erosion and flow of dissolved pesticides into watercourses.

**Pathway**

• Do not apply if rain is expected within 6 hours.
• Plant a line of cane along the field edge to prevent drift of chemicals.
• Do not over-irrigate or apply pesticide when heavy rains are expected.
• Correct drainage problems.
• Minimise runoff and prevent erosion.
• Do not wash out contaminated containers or equipment in any area where the chemicals may affect ground and surface water.

**Receptor**

• Do not use chemicals in close proximity to water courses, wetland or sensitive ecological areas.
• Select pesticides based on the ones offering the ‘least damage’ to the local environment.
• If there are sensitive species in the area the method for pest control must be carefully chosen.

### 5.4 Chemical ripeners

#### 5.4.1 Rationale for usage

Chemical ripening can increase sugar production by up to 1.5 tons per hectare. They are not required for the production of ethanol, but are sometimes used to increase the sucrose content for raw sugar production.

#### 5.4.2 Commonly used chemical ripeners

The two most commonly used ripeners are Ethephon (2 chloroethyl phosphonic acid) and fluazifop-P-butyl. Haloxyfop-R methyl ester and glyphosate and less commonly used.

Ethephon and fluazifop-P-butyl are Group III poisons and are toxic to fish. Ethephon has low to moderate mobility in soils and therefore a low to moderate potential for groundwater contamination. It degrades rapidly in soil.

Fluazifop-P-butyl is practically non toxic to mammals and degrades rapidly in moist soils.

#### 5.4.3 Environmental Risks

• Can be toxic to fish, birds and aquatic life.
• Can pollute water resources.
• Can move down rivers into the ocean.

**Source**

• Can have negative effects on the aquatic environment.

**Pathway**

• Spray drift onto adjacent areas/animals/people.
• Wash off into wetlands/drainage channels.
• Spillage onto sensitive areas/wash into water resources.
• Washing of containers/equipment into water courses/wetlands.

**Receptor**

• Groundwater.
• Wetlands.
• Water bodies.
• Rivers.
• Oceans.

### 5.4.4 Management and Mitigation Recommendations

**Source**

• Do not combine chemicals without expert advice.
• Do not ‘over apply’ ripeners (in terms of both frequency and amount).
• Do not wash implements in areas where wash water can affect the environment.
• Plant filter strips of vegetation around fields to control erosion and flow of dissolved chemicals into watercourses.

**Pathway**

• Do not apply if rain is expected within 6 hours.
• Plant a line of cane along the field edge to prevent drift of chemicals.
• Do not over-irrigate or apply chemicals when heavy rains are expected.
• Correct drainage problems.
• Minimise runoff and prevent erosion.
• Do not wash out contaminated containers or equipment in any area where the chemicals may affect ground and surface water.

**Receptor**

• Do not use chemicals in close proximity to water courses, wetland or sensitive ecological areas.
• Select chemicals based on the ones offering the ‘least damage’ to the local environment.
• Do not use ripeners if are sensitive aquatic environments in the area.

### 6. General Management Recommendations

• Extensive training must be undertaken for every worker (including the managers deciding on the appropriate chemical) involved in the application and handling of agrochemicals.
• Appropriate personal protective equipment (PPE) must be worn at all times.
• All application equipment must be serviced and calibrated regularly and maintained in good working order.
• Keep chemicals in original containers WITH THE LABELS ON.
• Always read the labels and comply with instructions. Note hazard rating and risks.

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8 Some of these recommendations were taken from the IFC Good Management Practices Manual for the Cane Sugar Industry. 2011.
• Avoid the use of pesticides that fall under the WHO Recommended Classification of Pesticides by Hazard Classes 1a and 1b and Hazard Class II.
• Use only pesticides that are manufactured under license and registered and approved by the appropriate authority and in accordance with the FAOs International Code of Conduct on the Distribution and Use of Pesticides.
• Use only pesticides that are labeled in accordance with international standards and norms.
• Keep pesticides away from food.
• Mixing and transfer of chemicals must be undertaken by trained personnel in ventilated and well lit areas, using containers designed and dedicated for this purpose.
• Maintain records of pesticide use and effectiveness.

6.1 **Reduce use of chemicals**
• Commit to investigation of Integrated Pest Management.
• Use alternative pest control measures whenever possible.
• Never use more chemical than recommended.
• Use the appropriate chemical with the lowest potential environmental impact.
• Chemicals must be applied at the correct application rate, at the correct place, at the correct time (crop stage), at the correct dilution and with correctly calibrated equipment.
• Weather conditions must be considered when spraying (temperature, relative humidity and wind speed affect the amount of chemical reaching the target. Spraying should not take place when it is raining, when wind speeds are over 10km/h and in high temperatures with low humidity.

6.2 **Storage of Chemicals**
• The storerooms/buildings where agrochemicals are stored muse be well built, well ventilated and secure.
• Purchase and store no more pesticide than needed and rotate stock on a ‘first in, first out’ principle.
• Store pesticides off the ground.
• All appropriate SANS codes must be complied with for the storage and transportation of chemicals.
• Appropriate warning notices must be placed around the building.
• Any highly toxic Group 1 poisons must be secured in a separate, locked storage area.
• Pack flammable products in between non flammable products of the same group.
• Compliance with the OSHA must be ensured with regard to signage, entry, water and washing facilities, fire fighting equipment etc.
• The area must have a drainage system which feeds to a sealed tank in case of spillage.
• All relevant AVCASA\(^9\) guidelines should be followed and responsible use posters placed in the storage areas
• A daily log should be kept with regard to chemicals taken from and returned to the store.

6.3 **Waste Disposal**
• Disposal of all product containers must be undertaken in an appropriate manner (depending on the nature of the substance previously contained in them).
• Spilled or unused chemical must be collected and re-used.

\(^9\) Association of Veterinary and Crop Associations of South Africa.
• Collect rinse water for re-use (such as the dilution of identical pesticides).
• Triple rinse containers: Empty container into the spray tank, repeat a further 2 times, puncture the container to make it unusable.
• No re-use of containers must be permitted under any circumstances.

6.4 Water Resources
• Establish untreated buffer zones along water sources, rivers, streams, ponds, dams and ditches to help protect water resources.
• Implement groundwater supply borehole setbacks for pesticide application and storage.

6.5 Spillages
• Any spillage should be reported immediately.
• Keep unauthorized people and animals away from the spill.
• Contain the spill by applying absorbent material such as sand and clear away and dispose at an appropriate waste facility.

7. Conclusions and Recommendations

Integrated Pest Management is defined in the International Code of Conduct on the Distribution and Use of Pesticides\textsuperscript{10} as:

“.... the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other human interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agroecosystems and encourages natural pest control mechanisms’

Obviously this should be the main aim of any management planning and mitigation strategy for the reduction of potential impacts of agrochemical usage in the Makhathini Flats area. However, this process must have a champion if it is to succeed.

There is not a great deal of literature on the effects of agrochemicals on water and soil resources in SA, although the Department of Water Affairs is well aware of the problem. Some studies have been undertaken which seem to suggest that contamination is an issue from both a health and ecological perspective\textsuperscript{11}.

International literature also suggests that the use of certain chemicals is an environmental risk and the misuse of almost any chemicals will be a significant environmental risk. It is therefore imperative that chemicals are only used when necessary, that the least harmful chemicals are used and that they are used according to the stringent legislation and conditions regulating their use. Workers must be regularly trained and monitored to ensure correct usage.

If the recommendations presented in the management plans are followed, risk will be reduced, but it will not be possible to completely avoid the potential risks.

\textsuperscript{10} FAO 2003, 6.
\textsuperscript{11} For example The Decline of the Nile Crocodile Population in Loskop Dam, Olifants River, in Water SA.
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