GUIDELINES FOR THE MANAGEMENT OF WASTEWATER AND SOLID WASTE AT EXISTING WINERIES

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This document is available in English and Afrikaans on the following websites

www.sawislibrary.co.za

www.winetech.co.za

www.ipw.co.za

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GLOSSARY AND ABBREVIATIONS

BOD, Biological Oxygen Demand
A measure of the amount of organic pollution that is present in water. Measured as the amount of oxygen which is taken up from a sample containing a known amount of oxygen and maintained at 20°C for five days. Low BOD values indicate little pollution, whereas high BOD's indicate increased activity of heterotrophic micro organisms and therefore heavy pollution. BOD values in winery wastewater tend to be around 60 5 to 66% of the COD.

Buffer zone
Distance between the site of an activity and that of a neighbouring activity.

COD, Chemical oxygen demand
A measure of total organic content expressed in terms of the amount of oxygen required to bring about its destruction through oxidation. COD is used by the Department of Water Affairs and Forestry to monitor water quality for regulatory purposes. Where pollution levels are high the COD may exceed the rate at which oxygen can reach the rate of consumption. This leads to depletion of the oxygen concentration of the water or soil. Low oxygen concentrations inhibit root growth and may give lead to the production of unpleasant odours.

Composting
The process by which organic material is converted to a stable end product (compost) by natural degradation is known as composting. The sustained high temperatures generated during effective composting kill most parasites, rendering the material relatively safe to handle. Composting is facilitated by the presence of oxygen and moisture.

DE, Diatomaceous earth (Kieselguhr)
Fine grained hydrated silica composed of the silicaceous cell walls of diatoms (unicellular, plankton algae). Used as filter aid during winemaking.

Deflocculation
Separation of the individual components of a soil, commonly caused by changes in the electrolyte concentration and / or composition of the soil solution. It frequently occurs in soils which are characterised by low soluble salt concentrations (low electrolyte concentration) but with high exchangeable sodium percentages. Deflocculation leads to severe degradation in the physical condition of the soil and to increased susceptibility to erosion.

DWAF
The Department of Water Affairs and Forestry.

EC, Electrical conductivity
The EC of the wastewater is an indication of the concentration of dissolved salts in the water. The greater the usage of salts by the winery, the higher the EC of the wastewater will be. EC is measured in milli Siemens per meter (mS/m).

ESP, Exchangeable sodium percentage
The percentage of the cation exchange capacity (CEC) of the soil (where CEC is expressed in cmol of charge/kg soil) that is occupied by sodium. ESP is calculated as follows:
(amount of exchangeable sodium in $cmol_c$/kg soil / (CEC in $cmol_c$/kg soil) x 100.

Essential element
A chemical element that is required for the normal growth of plants, without which plants cannot complete their lifecycle.

Eutrophication
The artificial or natural enrichment of a river, dam or lake by influx of those nutrients which enhance the growth and spread of aquatic plants.

Feacal Coliforms
The presence of faecal coliform bacteria indicates that faecal pollution is taking place. Faecal coliform counts in polluted water range from 100 to 100 000 bacteria per 100 ml. A count of 20 000 / 100 ml is considered to be high, and indicates that unacceptable amounts of human or animal waste are entering the water prior to irrigation. The faecal coliform count should always be measured in order that remedial measures, such as the application of quaternary ammonia, may be prescribed where necessary.

IPW, Integrated production of Wine
A scheme which was developed to ensure the environmentally friendly production of wine in South Africa. The essence of this scheme is the implementation of management plans in which are integrated the latest information and technology concerning sustainability, conservation and the protection of biodiversity (see www.ipw.co.za). The IPW scheme was promulgated under the Act on Liquor Products, and fully supports Act 108 of 1996, Article 24, which concerns constitutional aims regarding environmental health and the conservation of the environment for future generations.

Leaching
The removal of soluble constituents (e.g. salts and nutrients) from the soil by water moving through the soil profile.

Lees
Winery fermentation sediment (yeasts, tartrates and pulp).

Marc (grape solids)
The stalks, pips and skins which remain behind after the grapes have been crushed and pressed. Grape solids are sometimes referred to as 'marc' in international literature.

mS/m or milli Siemens per meter
See EC

pH
The degree of acidity or alkalinity, defined as the negative log (base 10) of the hydrogen ion activity in water (or in a soil extract or suspension). A pH of 7.0 is neutral. pH values below or above 7.0 indicate acidic or alkaline conditions, respectively.

SACNSP, South African Council for Natural Scientific Professions
A council wherein professional scientists may register in specific fields of expertise relating to their professional qualifications and related experience. The council guarantees the competence of its registered scientists, and ensures the maintenance of high levels of professional and ethical standards. In terms of Article 20(1) of the Natural Scientific Professions Act (Act Nr 27 of 2003 as published in R 1738 of the

Government Gazette No. 25774: 28 Nov 03) only a registered person may practice in a consulting capacity.

Saline soil
A soil which contains sufficient soluble salts to adversely effect the growth of most crop plants.

SAR, Sodium adsorption ratio
A measure of the amount of sodium present in the wastewater relative to calcium and magnesium. In effect, SAR represents the quality of a solution (saturation extract, irrigation water) with regard to sodium. Since soils tend to equilibrate with the SAR of the wastewater, this value is of considerable importance when assessing hazards due to salt accumulation. SAR is defined as:
Na divided by the square root of (Ca + Mg)/2, where all values are concentrations expressed in $mmol/dm^3$.

Sodic soil
A soil which has a low soluble salt content but which nevertheless contains sufficient adsorbed sodium to have caused significant deflocculation.

Storm water
Rain water that drains from buildings, paved areas and other surfaces.

Waterlogging
Soil or land which is saturated with water. Leads to oxygen depletion and to the onset of anaerobic conditions. Waterlogged soils often have a characteristic unpleasant odour.

Water table
The surface below which the soil is saturated with water. Where the water table rises above ground level a body of standing water will form.

GUIDELINES FOR THE MANAGEMENT OF WASTEWATER AND SOLID WASTE AT EXISTING WINERIES

1. Introduction

Increases in wine production in South Africa over the past decade have exacerbated the pressure which the industry exerts on natural resources such as water, soil and vegetation. This increase has occurred at a time when national legislation and foreign markets are becoming increasingly stringent in their demands that all factors which have the potential to affect the environment should be controlled. Such control can only be achieved through the implementation of effective environmental management systems (Van Schoor, 2000a; Van Schoor & Visser, 2000; Winetech, 2003, Vol. 2).

Over the last few years Winetech has pro-actively funded research, through its Waste Product handling Committee, to identify and address the most important environmental issues at wineries. Wastewater is regarded as the most significant environmental risk at wineries (Van Schoor, 2000b) and because water is a limited natural resource in South Africa, water monitoring and saving should be encouraged. Therefore, Winetech have prioritised these aspects. Various scientific papers are referred to throughout this document and have been published. A CD containing details of this research, as well as international data and input from various experts, is available on request from Winetech (Tel: 021-807 3387) (Winetech, 2003 (Vol. 1-9): see Appendix 1 for summary).

The purpose of this guideline document is to present recommendations for the management and disposal of winery wastes at existing wineries. These recommendations are intended to facilitate the development of wastewater management plans which will ensure compliance with both environmental legislation and with the principals embodied in the Integrated Production of Wine (IPW, 2003) concept.

It is important to note that the Department of Water Affairs and Forestry (DWAF) supports the beneficial irrigation of crops with treated winery wastewater and the development of a specific General Authorisation for this purpose is currently being investigated. In contrast, irrigation with untreated or treated winery wastewater which is carried out purely as a means of wastewater disposal is not an acceptable practice.

2. Potential environmental impacts

The by-products of cellar practices that most commonly have negative impacts on the environment are:

- Wastewater generated during cleaning
- Process water
- Solid wastes such as skins, pips, stems and lees
- Used filter materials and filter aids
- Sedimentation substances

(Van Schoor, 2000b; Van Schoor, 2001a; Chapman, Baker & Wills, 2001).

Wastewater can cause salination and eutrophication of water resources (natural streams, rivers, dams, ground water and wetlands). Furthermore, wastewaters can cause soil sodicity, salinity, contamination with a wide range of chemicals, waterlogging and anaerobiosis, loss of soil structure and increased susceptibility to erosion. These impacts may be exacerbated by process interruptions. Process interruptions may stem from power failure, fire, flood, storms, overloading/ underloading of wastewater treatment systems, temporary unavailability of wastewater holding dam capacity and the absence of trained operators. Where solid wastes are present, offensive odours may be generated and seepage may result in the contamination of soil and water resources, inhibiting vegetative performance (Chapman, Baker & Hills, 2001).

To manage winery wastes and their potential environmental impacts effectively and to make provision for emergency situations, it is important for cellar managers to know what the potential pollutants are, how they are generated and what management options are available to minimise their impacts (Van Schoor, 2000b).

3. Guidelines for the development of winery wastewater and solid waste management plans at existing wineries

The objective is to facilitate the development, **at existing wineries,** of winery-specific wastewater management plans that comply with environmental legislation and which also meet the requirements of IPW (Van Schoor & Rossouw, 2004; Van Schoor, 2001b). Once developed, such a plan provides the winery with all of the strategies needed to ensure that its wastewater and solid waste handling is in line with the policies of DWAF, in addition to forming the basis of an application for authorisation to DWAF for the disposal of winery wastewater and solid waste. The plan and its contents are components of the application for authorisation and become legally enforceable once the winery, through its management, has committed itself to implementing the plan as part of the application for authorisation (Van Schoor & Rossouw, 2004).

Although winery staff can assist in completing such a plan, specialized input is required with regard to wastewater treatment, soil studies, vineyard irrigation, environmental risk assessment and legal requirements. Winery management should ensure that only a credible consultant with relevant experience in the handling and/or treatment of winery wastewater, is appointed. In terms of Article 20(1) of the Natural Scientific Professions Act (Act Nr 27 of 2003 as published in R 1738 of the Government Gazette No. 25774: 28 Nov 03) only a registered person may practice in a consulting capacity. A consultant should therefore be registered with the South African Council for Natural Scientific Professions (or similar body for Engineers) and also be able to provide appropriate references and proof of other projects if required. Consultants thus qualified should be able to provide guidance at an acceptable level, and be able to develop a plan acceptable to DWAF. The consultant should discuss the proposed plan, in full, with winery management to ensure that all aspects and their implications are understood and accepted. Such a discussion will serve as a "training session" before the plan is submitted to DWAF.

Winery management should be aware that there is no such thing as a single, generic plan that will apply to all wineries. Each winery must develop its own. The plan which is adopted must be fully, unreservedly and officially approved by management, since it will be that management body which will be responsible for its implementation. Consultants should only submit to DWAF those plans which have been thus approved (Van Schoor & Rossouw, 2004). In fact the winery management should preferable submit these approved plans to DWAF themselves, as DWAF would want to be sure that the management of the winery is aware of the contents and have made some commitment to implement the contents thereof. Aspects which must be covered in an acceptable report will be discussed in this document. A technical summary should also be filled out as presented in Appendix 2. The following steps (Table 1) indicate how the guidelines presented in this document should be used.

Table 1. Summary of steps to be taken during the development of a plan for the management of winery wastewater and derived solid wastes.

Step No.	Action	Paragraph
1	Define current end-use of wastewater (e.g. irrigation)	4.1
2	Determine feasibility of irrigation practice (disposal vs. beneficial crop irrigation) by conducting soil study	4.2
3	Determine legal compliance of current irrigation and wastewater collection practices	4.3
4	Determine crop requirements (water balance) to avoid over-irrigation	4.4.1 & 4.4.2
5	Determine water quality requirements relating to specific crop(s)	4.4.3
6	Determine origin of wastewater and associated pollutants	5
7	Develop procedures for continuous monitoring of wastewater quality	5 & 8
8	Develop procedures for continuous monitoring of wastewater volumes	6 & 8
9	Determine minimum size of collection dams to ensure integrity	7
10	Develop procedures for continuous soil monitoring	9
11	Develop and implement cleaner production strategies in winery	10
12	Develop procedures for responsible storage and handling of chemicals	11
13	Determine and implement immediate wastewater treatment practices	12
14	Develop procedure for cleaning of collection dams	14
15	Implement procedure for solid waste management	15
16	Compile data and develop management plan and evaluate using an environmental risk assessment and summary chart	16 & Appendix 2
17	Implement staff training procedures	17
18	Apply and obtain relevant Authorisation from Dept. Water Affairs and Forestry	18
19	Implement management plan and cleaner production strategies	10
20	Monitor wastewater volumes and quality after implementation of cleaner production strategies	5, 6 & 8
21	Determine if higher-technology treatment is necessary and identify specific option	13
22	Compile new data	16 & Appendix 2
23	Re-apply for relevant authorisation if necessary	Repeat relevant steps

4. End use of winery wastewater

4.1 Introduction

More than 95% of South African wineries currently irrigate their wastewater onto land through sprinkler systems (Van Schoor, 2004). It is important to use the current wastewater end use (i.e. irrigation) as the starting point when developing the winery wastewater plan, and to determine whether the current irrigation practice is beneficial or detrimental to the particular soil and crop. Under ideal conditions irrigation with winery wastewater should be no more complicated than irrigating a crop with water which contains added fertilizer (fertigation). Seasonal fluctuations and variability in winery wastewater composition may nevertheless cause imbalances. Such imbalances usually stem from mismatches between combinations of wastewater composition and irrigation method / delivery rate and the ability of the land to absorb and fully neutralize the wastewater. Run-off, or seepage resulting in pollution of soils, ground water or water courses may then occur. Since rehabilitation of contaminated soil is both costly and time consuming (Thomas, 1992), such imbalances must be avoided.

4.2 Feasibility of wastewater irrigation

Determining the feasibility of wastewater irrigation on a specific site entails measuring and evaluating the relative importance of a surprisingly large number of interacting factors. Since such activities lie outside the scope of most wineries it is usually advisable to appoint a certified soil scientist who has knowledge of winery wastewater irrigation. In order to determine whether the irrigation site and crop can utilize the wastewater beneficially, the soil scientist should provide the following information for both the currently irrigated sites as well as proposed sites (where relevant):

- A description of the physical soil characteristics of the site (5 profile pits per ha)
- Distance from water resources, including wetlands and boreholes providing drinking water
- Distance from residential areas or other sensitive localities or areas
- Slope of irrigated area and possibility of runoff
- Depth of water table and potential for pool formation due to soil saturation
- Types of crops and suitability of crop for irrigation with wastewater
- Effective root depth of crop
- Chemical soil characteristics of irrigated soil (three samples per profile pit at 30 cm increments (i.e. 0-30 cm; 30 cm-60 cm and 60 cm-90 cm).
- Evaluation of the chemical and physical characteristics of at least one control site. The purpose of the control is to enable current pollution levels to be determined and to serve as a reference against which long term changes may be assessed
- Procedure for annual soil sampling on irrigated and control sites

- Alternative irrigation sites on, or in the vicinity of the winery site, where beneficial wastewater irrigation may be possible (these sites should also be investigated if the current site cannot tolerate the irrigation practice being employed)
- Alternative crop(s) that can be irrigated beneficially on the specific site(s)
- The total area (hectares) required of the specific soil (and crop) to be able to utilize the total amount and seasonal fluctuation of wastewater beneficially
- The amount of wastewater that can be irrigated beneficially on the specific site, taking into consideration seasonal peaks in the generation of wastewater (mostly summer) and the type of irrigation employed (i.e. overhead sprinklers, micro-irrigation or drippers)
- Any factors or potential developments that may result in wastewater irrigation becoming detrimental in nature. These could include climatic variables, soil structural decline or changes in such parameters as wastewater characteristics, leaching rate, waterlogging, organic loading or surface runoff
- Determine the capacity of any storage facilities which may be required to retain wastewater during periods when disposal by irrigation is not feasible, possibly because of a seasonally high water table or excessive rainfall.

4.3 Legal requirements for winery wastewater irrigation and storage

In terms of the General Authorisations published in Government Notice Nr. 399 (26 March 2004) in terms of section 39 of the National Water Act (1998), untreated wastewater from wine cellars would rarely if ever qualify for discharge into natural water resources. Therefore, wastewater must either be treated prior to discharge into a water resource, or disposed of by some alternative method. Alternative methods of disposal are subject to the requirements of the National Water Act, 1998 and must be authorised by the DWAF (National Water Act, 1998; Van Schoor, 2001b; Winetech 2003, Vol. 6). The most common alternative method of disposal employed by South African wineries is land irrigation (Van Schoor, 2004; Mulidzi, 2001). Where the end use is land irrigation the following requirements must be complied with.

The intended water use must be registered with the DWAF before irrigation may commence.

Where granted, the General Authorisation stipulates that up to 500 m^3 of wastewater may be irrigated (for crop production, including grazing) on any given day provided that:

- Electrical conductivity is less than 200 milli Siemens per meter (mS/m).
- pH is between 6 and 9.
- The faecal coliforms count is less than 100 000 per 100 ml.
- Sodium adsorption ratio (SAR) is less than 5.
- The chemical oxygen demand (COD) is less than 400 mg/l. If the COD value is higher than 400 mg/l, but less than 5 000 mg/l, irrigation (after registration) may not exceed 50 m^3 on any given day.

If the treated wastewater complies with the following quality requirements, up to 2000 m^3 may be irrigated on any given day provided that:

- Faecal coliforms do not exceed 1000 per 100 ml.
- COD does not exceed 75 mg/l.
- pH is not less than 5,5 or more than 9,5 pH units.
- Ammonia (ionised and un-ionised), as nitrogen, does not exceed 3 mg/l.
- Nitrate/nitrite, as nitrogen, does not exceed 15 mg/l.
- Chlorine, as free chlorine, does not exceed 0,25 mg/l.
- Suspended solids do not exceed 25 mg/l.
- Ortho-phosphate, as phosphorus, does not exceed 10 mg/l.
- Fluoride does not exceed 1 mg/l.
- Soaps, oils and greases do not exceed 2.5 mg/l.
- During its passage through the winery the EC of the water must not increase by more than 70 mS/m. In other words, if, for example, the EC of the water which is pumped from a borehole is 20 mS/m, then the EC of the water when it leaves the winery must not exceed 90 mS/m. Regardless of the EC of the water which enters the winery, the EC of the waste may not exceed 150 mS/m.

In all the above instances:

- Irrigation may only take place above the 100 year flood line or at a distance greater than 100 meters from the edge of a water resource or borehole which is used for drinking water or stock watering, whichever is the greatest.
- No contamination of ground- or surface water may take place.

- The winery must measure the quantity of wastewater irrigated on a weekly basis.
- The winery must measure the quality of the irrigated wastewater on a monthly basis. Samples should be drawn from the irrigation system from a point located immediately prior to the emitters.
- Written records concerning irrigated wastewater quantities and qualities must be kept for inspection by the responsible authority (DWAF or IPW Auditor) or sent to them on request.
- Existing, as well as possible or proposed irrigation areas must be demarcated on a 1: 10 000 orthophoto and a 1: 50 000 topographic map. Details of the crops under irrigation, irrigation techniques and details of emergency procedures must also be recorded.
- Waterlogging, damage to soil, the occurrence of flies and mosquitoes, bad odours, secondary pollution, penetration of any surface resources and unauthorised use of water by members of the public must be prevented at all times.
- Solid particles must be removed before irrigation and disposed of safely and efficiently.
- Stormwater (rain water) originating from the irrigation area must be collected to prevent contamination of any surface water resource.

If more than 1000 m^3 wastewater is to be stored for subsequent disposal by beneficial irrigation on any given day (up to a maximum of 10 000 m^3 per property or up to 50 000 m^3 per wastewater dam system) the winery must register for this water use. If more than 500 m^3 is to be stored on any given day for recycling purposes, it must also be registered (a maximum of 5 000 m^3 will be allowed). Registration is also mandatory where more than 50 m^3 wastewater is disposed of in an evaporation pan or wastewater dam system on any given day (a maximum of 1 000 m^3 per day will be allowed). The same monitoring requirements pertain to all the above uses, as explained under Irrigation with Wastewater. The wastewater dams and disposal terrains both have to be situated away from a watercourse, above the 100-year flood line or alternatively further than 100 meters from the edge of a water resource or borehole used for drinking water or stock watering, whichever is the greater distance. This authorisation is valid for 5 years from the date of publication unless the date of authorisation is extended. If any storage dam exceeds a capacity of 50 000 m^3, and if the wall of the dam has a vertical height of more than 5 meters, it is declared as a dam with an associated safety risk. Such a dam must be registered as such in terms of Sections 117 and 120 of the National Water Act, 1998.

4.4 Irrigation scheduling

4.4.1 General

The purpose of wastewater irrigation should not be the mere disposal of wastewater, but rather the beneficial use of water to irrigate crops. Over-irrigation results in leaching, which entails the transport of materials which are potentially of use to the crop to depths below the reach of the roots. This process not only results in the rootzone becoming nutrient-depleted and increasingly acid (due to the removal of base cations), but also in water wastage and the possible transportation of pollutants into the ground water (Chapman, Correl & Ladd, 1995; Chapman, 1995; Mulidzi, 2002). A further effect of over-irrigation is that of waterlogging. Waterlogging occurs where the rate at which water is applied to the surface exceeds that at which water is able to drain through the profile. In the waterlogged state the macropores, which normally drain freely under gravity, remain water-filled and are unable to participate in the exchange of gasses with the overlying atmosphere. Oxygen levels rapidly become depleted under these conditions, suppressing the activities of roots and of other aerobic organisms (Chapman, Baker & Wills, 2001). Over-irrigation must therefore be avoided at all times. To this effect wineries should develop, in consultation with a certified soil scientist, a monthly water balance that accounts for all forms of input, storage and loss.

4.4.2 Monthly water balance

Water balances enable the capacities of storage, treatment and discharge systems to be calculated for individual wineries. In the case of the disposal site, capacity will usually need to be sufficient to accommodate both rain and wastewater during the wet months. The following formula, which was developed by Chapman, Baker and Wills (2001), may be used to calculate irrigation water application rates (in mm/ha). Adherence to these rates will ensure that no over-irrigation occurs.

$$I = [(E_T + D + S) - P] / IE$$

Where:

I = Depth of irrigation

E_T = Depth of water used by plants and lost via evaporation and is given by:

E_{pan} x Crop factor

D = Depth of water lost as drainage below rootzone

S = Depth of water stored in the rootzone, usually based on readily available water for plant uptake

P = depth of water added by precipitation

IE = Irrigation efficiency

From this formula it will be apparent that the maximum amount of wastewater that can be applied at any time will be specific to the crop, the site and the prevailing conditions. This means that, in order to allow such environmental variables as precipitation to be taken into account, application rates can not be calculated accurately until immediately prior to each irrigation event. The effect of crop type will also be evident. In the case of Kikuyu pastures, which need only 50-70 cm of unsaturated soil for strong root development, more waste water may be applied than in a vineyard, where 60 – 120 cm of non-waterlogged soil is required. Although some crops and rootstocks are able to tolerate occasional waterlogging, protracted periods of saturation will cause even these to suffer damage. To ensure that no such damage occurs, it is thus important that a soil scientist should be called upon to calculate the weekly water requirement for each specific crop / soil combination under the prevailing climatic conditions. The accuracy of these calculations should then be checked by continuous soil moisture monitoring.

4.4.3 Crop selection

In addition to vineyards, wineries are often surrounded by gardens, lawns and a variety of ornamental and orchard trees. As discussed previously, the majority of wineries irrigate their wastewater onto crops, especially Kikuyu grass pastures. Nevertheless, even these may suffer damage from over-irrigation and from the use of high-strength untreated wastewaters. In contrast, if the winery uses only environmentally friendly chemicals and implements its water balance correctly, it is often possible to irrigate Kikuyu pastures, gardens, shrubs, trees and vines beneficially after only limited treatment of the wastewater. Such treatment may be possible in a wastewater holding-dam. The following norms for vineyard irrigation (Table 2) were developed by Ryder (1995). These should be regarded as guidelines for winery wastewater which are used for vineyard irrigation.

Table 2: Reclaimed Effluent quality standards for vineyard re-use (Ryder 1995)

Parameter	Units	Optimum value	Maximum values
pH	(KCl)	6.5 - 8.4	6.0 – 9.0
EC	mS/m	< 75	< 150
TDS	mg/L	< 500	< 1000
Alkalinity	mg/L $CaCO_3$	< 150	< 250
Hardness	mg/L $CaCO_3$	< 250	< 400
Ca	mg/L	< 60	< 100
Mg	mg/L	< 25	< 50
Na	mg/L	< 65	< 100
K	mg/L	< 5	< 10
Fe	mg/L	< 5	< 5
Mn	mg/L	< 0.2	< 0.5
Cu	mg/L	< 0.01	< 0.05
Zn	mg/L	< 2	< 5
Bicarbonate	mg/L	< 200	< 300
Carbonate	mg/L	< 5	< 10
Chloride	mg/L	< 70	< 120
Sulfate	mg/L	< 150	< 250
N	mg/L	< 5	< 10
P	mg/L	< 5	< 10
B	mg/L	< 0.5	< 1
SAR		< 6	< 9
COD*	mg/L	< 60	< 100
Coliforms	MPN/100ml	< 23	< 230

* Adjusted from biological oxygen demand (BOD) where BOD = 66% of COD

To reiterate, although winery wastewater can be beneficially applied to a variety of crops, crop selection must take into account such factors as soil characteristics and climatic conditions as well as wastewater quality and quantity. It is therefore essential that specialists be consulted during the selection process to avoid detrimental impacts on the receiving environment and/or crop.

5. Origin of winery wastewater and associated pollutants

5.1 General

Wineries vary in size, operational procedures and management practices. They undertake similar, yet highly site-specific processes. These variables result in the production of different qualities and quantities of wastewater. The wine production process is divided into two main periods namely, the vintage period, and the non-vintage period, each generating a different kind of waste.

During the vintage period grapes are harvested, pressed and the juice is fermented into wine. The non-vintage period, in contrast, is characterised by other cellar activities, such as stabilisation, filtration, maturation, blending and bottling. At large cellars where processes associated with the non-vintage period take place throughout the year there may be little division between these two periods (Van

Schoor, 2000b). More specifically, Chapman (1996) identified the following wastewater production stages, or periods, at wineries:

1. **Pre-harvest** (1 to 4 weeks): during this period bottling takes place and tanks are washed out with sodium or potassium hydroxide. Other equipment is also washed to prepare for the harvest period.
2. **Early harvest** (2 to 3 weeks): wastewater generation increases drastically during this period and reaches 40% of the maximum weekly rate measured at peak. White wine production dominates harvest activities.
3. **Peak harvest** (3 to 14 weeks): wastewater generation and harvest activities reach their peak.
4. **Late harvest** (2 to 6 weeks): wastewater generation decreases to 40% of the maximum (peak) weekly flow and red wine production dominates harvest activities. Distillation of ethanol may take place.
5. **Post-harvest** (6 to 12 weeks): pre-fermentation activities come to a close and maximum usage of hydroxide occurs.
6. **None harvest** (10 to 20 weeks): wastewater volume is at its minimum (less than 30% of the peak weekly flow). Wastewater quality depends on daily activities.

Medium to large wineries (generating more than 1,5 million litres of wastewater per annum) with year-round operations produce approximately 50% of their wastewater during the vintage period, whereas small wineries (< 1,5 million litres of wastewater per annum) may generate up to 80% of their wastewater during harvest (Chapman, Baker & Wills, 2001).

5.2 Categories of winery wastewater

The major form of wastewater from wineries is that which is used for cleaning processes. The main contributors to the total wastewater stream are listed in Table 3 (Winetech 2003 (Vol.4); Winetech, 2003 (Vol. 7); Chapman, Baker & Hills, 2001):

Table 3: Major processes related to winery wastewater generation and their associated contribution to wastewater quality and quantity.

WINERY OPERATION	CONTRIBUTION TO TOTAL WASTEWATER QUANTITY	CONTRIBUTION TO WASTEWATER QUALITY	EFFECT ON LEGAL WASTEWATER QUALITY PARAMATERS
CLEANING WATER			
Alkali washing (removal of K-bitartrate) and neutralization	Up to 33%	Increase in Na, K, COD and pH Decrease in pH	Increase in EC, SAR, COD Variation in pH
Rinse water (tanks, floors, transfer lines, bottles, barrels, etc)	Up to 43%	Increase in Na, P, Cl, COD	Increase in EC, SAR, COD Variation in pH
PROCESS WATER			
Filtration with filter aid	Up to 15%	Various contaminants	Increase COD and EC
Acidification and stabilization of wine	Up to 3%	H_2SO_4 or NaCl	Increase COD and EC Decrease in pH
Cooling tower waste	Up to 6%	Various salts	Increase COD and EC
OTHER SOURCES			
Laboratory practices	Up to 5-10%	Various salts, variation in pH, etc.	Increase COD and EC

5.3 Characteristics of wastewater generated in South African wineries

Although various parameters may be used to evaluate winery wastewater, pH, SAR, COD and EC are of particular importance. Table 4 indicates the ranges over which these parameters vary in South African wineries, and compares these ranges with the legal requirements for irrigation water quality. These data indicate that the majority of South African wineries are not able to irrigate crops beneficially with wastewater unless the water is first subjected to an effective form of pre-treatment.

Table 4: pH, SAR, COD and EC ranges in untreated wastewater from South African wineries and legal requirements for irrigation (after Van Schoor, 2004).

PARAMETER	MINIMUM	MAXIMUM	AVERAGE	LEGAL REQUIREMENTS FOR IRRIGATION
pH (KCl)	2.7	7.9	5.1	Between 6 & 9
SAR	0.3	29	5.2	<5
COD (mg/L)	15	70683	7433	<5000, 400 or 75*
EC (mS/m)	16	2570	279	<200

*Maximum irrigation of 50 m^3/day when COD <5000 mg/L; Maximum irrigation of 500 m^3/day when COD <400 mg/L: and maximum irrigation of 2000 m^3/day when < 75 mg/l

6. Guidelines for monitoring wastewater volumes

Most wineries do not have records concerning the volumes of wastewater produced in past seasons. In these cases it is necessary to estimate the quantity of wastewater generated. Reasonable accuracy is needed in order to ensure that (1) the holding-dam is large enough to contain the wastewater and (2) the wastewater irrigation site is of adequate size to accommodate the wastewater volume to be disposed of or, alternatively, (3) that the treatment facilities are of adequate size to treat the wastewater prior to irrigation or disposal. The estimation of wastewater volumes should also take into consideration the percentage of wastewater generated in the peak harvest period (depending on the size of the winery) and to determine the volume of water that can be re-used or irrigated during this period. Self evidently, storm water (rain water) which needs no processing should always be kept separate from the wastewater. If wineries measure and record the volumes of wastewater generated, the estimation of disposal requirements becomes relatively easy, although some excess capacity should be incorporated into the calculation to cope with emergencies such as wine spills.

If no records are available however, the winery must estimate the quantity of wastewater generated. Such estimates are regarded positively by the authorities since they indicate that there is already an awareness of the need for water conservation and quality maintenance. Worldwide, winery wastewater production ranges from 0.5 to 14 liters of wastewater for every liter of wine produced (excluding evaporation during ageing). In the absence of monitoring or reliable estimates, a reasonable estimate is that 4 to 5 liters of wastewater will be produced per liter of wine, estimates of 6 to 8 liters wastewater per liter of wine are nevertheless likely to prove more acceptable to the authorities. Since estimates of wastewater production form the basis of all effluent handling plans, such estimates should err on the side of over, rather than under estimation of probable wastewater output. **However, wherever possible, wineries should physically measure their wastewater output volumes, rather than relying on estimates.**

When planning wastewater measuring systems it should be noted that not all water meters can tolerate highly concentrated wastewater. Use in effluent pipelines of water meters that are designed for this purpose is therefore essential. An alternative to direct measurement of effluent volume is to meter the fresh water which enters the winery and use this value to determine the volume of wastewater produced. Clearly, this method will be useless if other sources of water (rainwater, water from non-metered pipelines) contribute to wastewater generation.

7. Guidelines for constructing wastewater holding-dams

Prior to any wastewater disposal the wastewater should be contained, measured and treated if necessary. The size of the holding dam or pit in which the wastewater is contained is therefore of extreme importance. The volume of the wastewater holding-dam will be dependent on the size of the irrigation area, soil, crop and rate of irrigation as well as on the need to store wastewater during periods when no irrigation is possible (because of a high soil water table, for instance). Aesthetics may also play a predetermining role in dam size. Some wineries, for example, prefer the dam to remain full throughout the year. When constructing the irrigation dam, the following guidelines should be followed:

- The integrity of the waterproof lining of the dam is vital. All of the liner seams must be sealed to prevent any untreated wastewater from entering the environment.
- The pipelines which carry the wastewater must be of a sufficient size that no back-up of effluent occurs during even the heaviest of the peak flow periods. The pipelines and fittings must be of high enough quality to withstand the flow of wastewater for many years without leakage.
- Wastewater holding dams must be able to accommodate the maximum volume of wastewater which is likely to occur at any one time, plus sufficient reserve volume to cope with possible emergencies.
- Holding dams should be large enough that sufficient time elapses for solids to settle out and for organic matter to break down, before the water is released or used for irrigation.
- Holding dams should be constructed in such a way that the entry of storm water is prevented.
- Irrigation systems must be designed in such a way that leakages do not occur.

8. Guidelines for wastewater sampling

In wineries which do not have records concerning wastewater volumes and qualities, an intensive monitoring program should be carried out over a two or more year period to determine whether the winery complies with the legal authorisation parameters. In the absence of pre-treatment it is highly unlikely that the wastewater will comply with these norms. It is therefore important that a sampling procedure for wastewater be implemented. The monitoring program should calculate, on a monthly basis, the volume of wastewater, the normal variation in volume between key periods of wastewater production and the normal variation in chemical composition between key periods of wastewater production, as well as the potential environmental and social impacts of the recycling or disposal activities.

After the initial two or more year intensive monitoring program, a routine monitoring program should be instituted. The purpose of routine monitoring is to confirm and record variation in wastewater volume and chemical composition. The winery should also monitor the impact of wastewater on soil, water resources, vegetation and human health. In due course each cellar will evolve and follow its own monitoring program, adapted to the pattern and intensity of activities.

A successful and effective monitoring program will always go hand in hand with a thorough, representative, sampling procedure. The winery should take samples during the first two years at the six key stages shown in Table 8, although more frequent sampling may be desirable if unusual circumstances occur (Van Schoor, 2000b; Chapman, Baker & Wills, 2001; Winetech, 2003, Vol. 3):

Table 8: Sampling periods and frequencies

PERIOD	FREQUENCY
Pre-harvest period	fortnightly
Early harvest period	weekly
Peak harvest period	weekly
Late harvest period	weekly
Post-harvest period	fortnightly
No harvest period	every 6 to 8 weeks

When taking waste water samples, attention should be paid to the following:

- Sample the wastewater at the point where it is discharged into the holding dam. Alternatively, the wastewater should be sampled in the dam, at the depth of the outflow / irrigation intake, immediately before an irrigation event takes place. Be consistent in the sampling method employed.
- At least 500 ml of wastewater must be collected in a clean glass or plastic container (the lid, seal and bottle should be rinsed with boiling water before use) and stored below 4°C, or in accordance with the directions of the

analytical laboratory which will do the analysis. The samples should be delivered to the laboratory as soon as possible after being collected, but within 24 hours.

- A note should be made of the winery activities which are taking place at the time when samples are collected, especially where only one or two processes are contributing a high percentage of the total volume of wastewater being produced.
- Keep records of all actions taken.
- Determine if the water quality complies with the requirements for crop specific irrigation (consult a certified soil scientist)

9. Soil monitoring

Determination of wastewater quality prior to irrigation events is essential to ensure that wastewater, which is of unacceptable quality, is not discharged onto the soil and crops. Wastewater containing high levels of sodium (reflected in the SAR) may cause structural degradation, soil compaction, anaerobic conditions, sodicity, etc. (South African Water Quality Guidelines, 1996). Curiously, although a few plant varieties are able to utilise sodium as a nutrient, plants seem to lack mechanisms by which the uptake of unwanted salts may be avoided. Inadvertent uptake of sodium may suppress the uptake of potassium and nitrogen through competition and may, together with the associated chloride anion, have direct toxic effects. Wastewaters which are high in potassium may also be detrimental, since excess potassium in the grape causes high must pH levels and may lead to colour extraction problems in red wines. It is therefore important that soil samples should be taken from wastewater-irrigated soils and analysed, at least on a three monthly basis. Soil sampling should, in fact, run parallel with the wastewater sampling program. The soil samples must be analysed (at least for the first year) for: pH, electrical resistance/conductivity, Ca, Mg, Na, K, Fe, Mn, Cu, Zn, Cl, S, N, P, B and ESP. A control area (where no irrigation has occurred) must also be sampled to facilitate comparison between wastewater-irrigated and wastewater-free soils. A certified soil scientist must interpret these results and make ameliorant and/or fertilizer recommendations which may be necessary (Van Schoor, Conradie & Raath, 2000). Soil samples must be taken at three depth intervals at a minimum of five locations per hectare and analyzed by an accredited laboratory. If any indications of soil degradation are identified, the area should be rehabilitated and another area or disposal method must be identified and utilised in collaboration with DWAF and other specialists.

10. Guidelines for cleaner production

10.1 General

Every winery should be committed to responsible environmental management and should implement cleaner production strategies which will ensure that usage of chemicals and water are at a minimum. Wineries should also ensure that beneficial crop irrigation occurs (Wine Growers NZ, 1995; Chapman, 1996). The following are examples of how to implement cleaner production strategies at wineries.

10.2 Reducing water pollution

Changes in certain common practices, procedures, policies and habits can often result in marked improvements in wastewater quality. Here are some examples of how to reduce water pollution:

- **Phase out all products which contain sodium.** This will have a direct, beneficial effect on SAR. The most commonly used sodium carrier is sodium hydroxide (NaOH), which is used to dissolve the potassium bitartrate which precipitates in tanks and other equipment during fermentation and the cold stabilization process. Since potassium bitartrate can also be dissolved with potassium hydroxide (KOH), this material is an obvious alternative. Where there are already very high K levels present in the soils of the irrigation area, the use of KOH and, indeed, of the wastewater itself will need to be evaluated by a soil scientist (Van Schoor, 2001d).
- **Reduce the COD of the wastewater.** This can be readily achieved by screening out solids larger than 0.5 – 1.0 mm with basket screens. Screening should be followed by a period of settling in a tank. In effect, the shorter the period that the solids remain in contact with the wastewater, the lower the COD of the wastewater will be. COD can also be reduced if the KOH wash is followed by flushing-out with phosphoric acid instead of the more commonly used citric acid (Glaetzer, 2000).
- **Eliminate the use of salts (e.g. K, Ca, Na, Mg) in the winery**. This strategy may alone be sufficient to reduce the **EC** to within legal limits for beneficial crop irrigation. Replacing disinfectants and cleaning agents with ozone, will reduce both the EC and the COD of the wastewater.
- The winery should request data sheets from chemical suppliers to ensure that only environmentally friendly products are being used.
- When wastewater treatment is limited to low tech and low cost systems prior to beneficial crop irrigation, sewage water should not be combined with

winery wastewater. This will ensure that bacteria, viruses and parasites such as the tapeworm do not form a threat to health. The possibility of a high faecal coliforms and *E. coli* counts will also be reduced.

10.3 Reducing water consumption

By reducing water usage in the cellar to the absolute minimum, the amount of wastewater that must be managed will also be reduced, possibly to the point where compliance with national legislation and IPW requirements for disposal by irrigation may be achieved with little pretreatment. Since wastewater treatment is costly, wineries should follow the following guidelines to reduce water usage to an absolute minimum:

- Separate all rainwater from the wastewater collection systems.
- Where possible, use rainwater for irrigation of gardens or in the cooling system of the winery. Do not contaminate rainwater with wastewater.
- Use treated wastewater for beneficial crop irrigation (e.g. gardens, vineyards, etc)
- Install water meters to measure water usage. Where possible, meters which monitor wastewater outflow should also be fitted.
- Use brooms or pressure mops for rinsing floors instead of using a normal water hose.
- Use high pressure hoses with warm water to reduce water volumes.
- Check pipe connections and taps for leaks. Do this at least once each day.
- Do not crush more grapes than can be handled by the next process.
- Install alarms to indicate when tanks are in danger of overflowing.
- Re-use wash water where possible. Wash water which contains KOH can continue to be used until the point is reached where it ceases to be effective as a bitartrate dissolving agent. Do not dispose this water or lees into the wastewater stream, but rather sell it to a recycling organization.

11. Responsible handling of chemicals

Statutory prescriptions regarding the handling of chemicals must be adhered to. The general requirements for handling and storage of chemicals are as follows:

- Chemicals used for cleaning and disinfection must be stored separately from chemicals which are used in wine production. The objective of separate storage is to minimize the risk that cleaning materials may be accidentally introduced into the wine.

- All products should be used in strict accordance with the instructions listed on the label. Unlabelled containers should be regarded as suspect and disposed of safely.
- All chemicals must be locked in a separate store. The design of the store should comply with legal requirements.
- Chemical stores must be watertight, well ventilated, maintained at a moderate temperature and sufficiently well illuminated that labels can be read easily.
- The design of chemical stores and of areas where chemicals are handled must be such that environmental pollution will not occur even if severe spillage occurs.
- Effective measuring facilities must be used.
- Washing facilities must be available for people and clothing. These facilities should include showers.
- A record must be kept of the acquisition, usage and disposal of all chemicals.
- Persons who handle chemicals must receive thorough training, wear appropriate protective clothing at all times, and undergo annual medical examinations.
- Chemicals which are left over from any process may not be disposed of into ditches, rivers or storage dams. Disposal must conform to IPW guidelines.

12. Initial treatment of wastewater in holding dams

In order to prevent pollution the disposal of winery wastewater by beneficial irrigation may only take place where the quality of the wastewater conforms to specifications and where the volume falls within prescribed limits. Where water quality falls outside of these limits, certain treatments may be applied which will allow the wastwater to be irrigated both responsibly and legally. The following are examples of possible treatment options:

- If the pH of the wastewater in the holding dam is lower than the legal or crop requirement, the pH may be increased by the addition and thorough mixing-in of chlorine-free hydrated lime. This operation should be carried out in a well constructed and sealed sedimentation pit. Winery wastewaters are unlikely to have high pH levels (exceeding 9). Where high pH levels do occur, they are likely to drift downward over a fairly short time period.

- Where the COD exceeds the legal or crop requirement, the installation and operation of a mechanical aerator in the holding dam will slowly reduce the COD. Some microorganisms are able to decrease COD levels in the wastewater and this is the principle employed in artificial wetlands (Van Schoor, 2002) and various bioreactors. It is nevertheless important that the design and capacity of such facilities should be precisely matched to the characteristics and volumes of the wastewaters that are to be processed. This should be done by a qualified and experienced consultant.

13. Higher technology treatment options

As discussed elsewhere, the end use to which winery wastewater will be put is the most important factor to consider when deciding on treatment options. Each winery generates wastewater with a unique quality, quantity and seasonal variation pattern. Soil characteristics and crop requirements will also be specific to that winery. Where a particular winery uses only environmentally friendly chemicals and has effective screening processes in place, it will usually be possible to irrigate the wastewater beneficially on certain soils and crops without the need to resort to particularly technologically advanced methods of treatment. However, if the area of the disposal site is small and if the soils are of low potential, then the likelihood that crops may be beneficially irrigated with wastewater will be small unless highly sophisticated methods of pretreatment are employed.

The first step should be to conduct a winery audit with the assistance of an environmental specialist. The objective will be to determine whether the implementation of different production strategies, such as the use of more environmentally friendly chemicals, can be used to reduce the amount of wastewater generated, or to improve wastewater quality. Parallel with this audit, a study of the soil should be carried out by a soil scientist. This study should aim to determine the total area required for beneficial irrigation. If the irrigation area is too small, or the scope for introducing cleaner production strategies is limited, then alternative treatment options (other than liming and aeration) must be considered.

Although many effective treatment options exist, these are usually associated with high capital-installation and running costs. To limit the cost of high technology treatment systems, it is essential that an effective wastewater monitoring procedure be followed (as discussed in this document) prior to the decision to ensure that the treatment facility is not over or under designed. The following are examples of higher technology treatment options available for the treatment of winery wastewater (OIV, 1999; Winetech 2003, Vol. 5). A specialist should be consulted to assist in decision making. It is recommended that more than one option should be considered, especially taking into consideration capital construction, operating and maintenance costs:

- Biological aerobic systems.
- Artificial wetlands (reed beds).
- Aeration of wastewater dams.
- Sequenced batch reactors (SBR).
- Activated sludge.
- Bacterial beds.
- Biological disks.
- Biological anaerobiosis.
- Physio-chemical treatment.
- Membrane techniques and reverse osmosis.
- Evapo-concentration to fractional condensation (ECCF).
- Combinations of processes.

It is important to remember that specific treatment systems have different goals. As an example, COD levels can be decreased significantly with a bioreactor, but salts (e.g. Na) cannot be removed by a bioreactor. In contrast, reverse osmosis can be used to remove salts, but might require the reduction of COD before it can be used effectively.

14. Guidelines for cleaning holding dams

Wineries should follow the following guidelines concerning the cleaning of wastewater dams:

- The wastewater dam, pipes and other equipment should be cleaned regularly to pre-empt the possibility that nuisances such as unpleasant odour or the clogging of irrigation equipment may arise from blockages or from the excessive build-up of sludge. The sludge which is removed from the dam may only be applied to the soil once the chemical composition of the sludge has been determined and certified safe for application to a specific soil. Sludge which contains high concentrations of certain elements (sodium and heavy metals) is unsuitable for soil application since the soil, water sources and plant performance will be negatively affected.

- An attempt should be made to conduct the cleaning operation in the summer months to allow rapid breakdown, thus minimising the generation and persistence of unpleasant odours.

15. Guidelines for solid waste management

Should the winery decide to make use of a licensed solid waste disposal site, or of a composting plant on the property, to dump or compost skins, stems, pips, lees, filter aids (e.g. DE), bentonite clay etc., that winery will need to apply for a permit from the relevant authority (currently DWAF), prior to any disposal. Conversely, if the winery decides not to use an on-site waste disposal site, the following guidelines should be followed (Winetech, 2003, Vol. 9).

- Skins, stems, pips and lees must be stored on an impenetrable base (clay, cement or plastic) to prevent organic acids from seeping downward and having negative effects on soil and groundwater. The design of the base should be such that leachates may be collected for disposal via the winery wastewater system. Alternatively, leachates may be collected, stored in sealed waste bins and disposed of by an authorized contractor. After breaking down into compost the solid residues may be applied to the soil, provided that analysis of a representative (usually composite) sample indicates that it is safe to do so.
- The storage area should preferably be at least 200 m from dwellings to reduce the likelihood that unpleasant odour or insect pests will cause annoyance.
- If no storage space is available, such solid wastes as skins, stems, pips and lees may be disposed of in the form of animal feed.
- Solid winery waste, as well as sedimentation and waste filter material (e.g. diatomaceous earth and bentonite clay), must be stored temporarily before being removed to prevent unpleasant odours.
- Wherever possible, alcohol and tartaric acid should be recovered from used filtration materials to prevent soil and water pollution.
- Packaging material, “dry” stock, excess apparatus and equipment, paint, oils, lubricants and solvents must be disposed of in an environmentally friendly way at a waste disposal site approved by the responsible authority (currently DWAF).

16. Guidelines for conducting an Environmental risk asessment

The potential impact of winery wastewater on the receiving environment differs between wineries. An environmental risk assessment is a useful tool to determine whether a proposed wastewater management plan will be successful if implemented. During May 2001, Van Schoor's formula for prioritizing and quantifying potential environmental impacts in the wine industry was published in the Wineland magazine for this specific purpose (Van Schoor, 2001c). By substituting information concerning the proposed winery wastewater management plan in this formula, it is possible to determine the potential impact of the current wastewater management situation compared to the situation after the implementation of the proposed wastewater management plan. The impact on the receiving environment is then calculated in percentage terms (0 –100) where any value greater than 15 can be regarded as significant. The formula and its criteria are as follows:

$$S = [(fd + int + sev + ext + loc) \times (leg + ipw + pol + ia + str) \times P]$$

Where

S = Van Schoor's significance value (Van Schoor, 2001c)
fd = frequency and duration of the impact
int = intensity of the impact
sev = severity of the impact
ext = extent of the impact
loc = sensitivity of locality
leg = compliance with legal requirements
ipw = conformance to requirements for integrated production of wine (IPW)
pol = covered by company policy
ia = impact on interested and affected parties
str = strategy to solve issue
P = probability of occurrence of impact

Numerical criteria

The following numerical criteria for the above-mentioned parameters should be used in the formula. The criteria may be adjusted for specific site differences:

***fd* = frequency and duration of the impact**					
low frequency (monthly or longer); low duration (minutes)	1	medium frequency (weekly); low duration (minutes)	1.5	high frequency (daily or less); low duration (minutes)	2
low frequency (monthly or longer); medium duration (hours)	1.5	medium frequency (weekly); medium duration (hours)	2	high frequency (daily or less); medium duration (hours)	2.5
low frequency (monthly or longer); high duration (days or longer)	2	medium frequency (weekly); high duration (days or longer)	2.5	high frequency (daily or less); high duration (days or longer)	3
***int* = intensity of the impact**					
low pollutant concentration; low pollutant quantity	1	medium pollutant concentration; low pollutant quantity	1.5	high pollutant concentration; low pollutant quantity	2
low pollutant concentration; medium pollutant quantity	1.5	medium pollutant concentration; medium pollutant quantity	2	high pollutant concentration; medium pollutant quantity	2.5
low pollutant concentration; high pollutant quantity	2	medium pollutant concentration; high pollutant quantity	2.5	high pollutant concentration; high pollutant quantity	3

***sev* = severity of the impact**	
changes immediately reversible	1
changes medium/long-term reversible	2
changes not reversible	3

***ext* = extent of the impact**	
locally (on-site contamination)	1
regionally (groundwater contamination)	2
globally (ozone depletion)	3

***loc* = sensitivity of location**	
not sensitive	1
moderate (e.g. low water table)	2
sensitive (e.g. wetlands)	3

***leg* = compliance with legal requirements**	
compliance	0
non-compliance	1

***ipw* = conformance to IPW requirements**	
Conformance	0
non-conformance	1

***pol* = covered by company policy**	
covered in policy	0
not covered/no policy	1

***ia* = impact on interested and affected parties**	
not affected	1
partially affected	2
totally affected	3

***str* = strategy to solve issue**	
strategy in place	0
strategy to address issue partially	0.5
no strategy present	1

***P* = probability of occurrence of impact**	
not possible (0% chance))	0
not likely, but possible (1 - 25% chance)	0.25
likely (26 - 50% chance)	0.50
very likely (51 - 75% chance)	0.75
certain (75 - 100% chance)	0.95

Where wineries irrigate wastewater in the absence of a wastewater management plan, the negative impact on the environment usually exceeds 90% (Van Schoor, 2001c). After the implementation of such a plan, the impact on the receiving environment is mostly less than 15%, which is not significant (Van Schoor, 2001c). From these figures it is clear that the implementation of a wastewater management plan at any winery will decrease the potential impact on the environment significantly. It is therefore essential that each winery commits itself to such a wastewater management plan to reduce the impact on the receiving environment as far as possible. This will also ensure compliance with national environmental legislation, conformance to IPW requirements as well as sustainable acceptance and therefore competitiveness on the international export market.

17. Guidelines for staff training

Education of employees forms an essential component of the planning and implementation of a winery wastewater plan. All staff and contractors who have operational, monitoring, maintenance and construction activities should be made aware of the potential impacts of their activities on the environment and of how to limit wastewater production and the use of chemicals to the absolute minimum. Attending annual IPW courses and a series of simple and practical training sessions can be used.

18. Application for the necessary authorisation from the Department of Water Affairs and Forestry

After a winery wastewater plan has been developed (for a specific winery), the final step is to apply for authorisation (General Authorisation or license) from the Department of Water Affairs and Forestry. The application for such an authorisation must be in the form of a Water Quality Management Report. Completed standard water use registration or license application forms must also be included, as must the license application fee, currently R114, VAT included. No application fee is required if the winery complies with the requirements of a General Authorisation. Application forms can be obtained from the following address:

Department of Water Affairs and Forestry, Private Bag X16, Sanlamhof 7532.

The application for authorisation may require additional information to that which is contained in the winery wastewater plan and must state very clearly what is being applied for. The authorisation will contain conditions that must be complied with and these will be based on the information supplied in the application.

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