WINERY WASTEWATER TREATMENT AND REUSE: REGULATIONS AND TECHNOLOGIES

Prepared for

BRITISH COLUMBIA WINE GRAPE COUNCIL

Prepared by

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EXECUTIVE SUMMARY

The British Columbia Wine Grape Council (BCWGC) commissioned Insight Environmental Consulting Ltd. (Insight) to prepare two studies:

1. An overview of existing sustainable practices programs from around the world that apply to vineyards and wineries, and an assessment of their approach to environmental sustainability.

2. A synopsis of the current regulatory environment governing the treatment and reuse of winery wastewater, and an overview of recent and promising wine wastewater treatment technology.

Both reports will aid the BCWGC in achieving three objectives: (1) to develop a customized strategy towards a sustainable practices system for the BC grape and wine sectors, (2) to develop a way of communicating initiatives to the consumer, and (3) to eventually develop a sustainable practices self-assessment tool and/or an environmental sustainability certification program.

This report provides an overview of the regulatory environment governing wastewaters in general, the characteristics of winery wastewater, an overview of wastewater treatment stages, a summary of popular wastewater treatment processes being utilized in wineries around the world, and an overview of reclaimed water uses.

Reclaimed wastewater can provide many benefits to winery operators, the general public and the environment. It can provide an additional source of water that can be reused for many applications, it can divert pollutants from sensitive ecosystems, and it can also be used to create or enhance water features, wetlands or riparian habitats.

TABLE OF CONTENTS

List of Appendices

List of Tables

List of Figures

1.0 INTRODUCTION

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This report provides an overview of practical and proven treatment technologies most commonly used by wineries around the world. It also includes possible uses for the treated effluent (reclaimed water) and the current regulatory environment governing these processes and uses.

Winery wastewater quality and volume varies greatly depending on the processes carried out at different production stages. Wastewater production consists of fairly steady daily volumes during non-vintage periods, increases during bottling and washing (i.e., tanks and other equipment), and peaks during vintage. Winery wastewater typically has a high organic load in the form of large suspended matter (i.e., grape skins, stems and seeds), smaller suspended particles (i.e., dead yeast cells, grit, dirt, diatomaceous earth and bentonite), and dissolved contents (i.e., sugars, ethanol, organic acids, microbial fermentation products, soaps and detergents, and cleaning chemicals). All of these constituents give winery wastewater unique characteristics that differ significantly from other food processing wastewaters.

Winery wastewater is mainly composed of water, mixed with undesirable components such as (EPASA et al., 2003):

- Gross solids
- Suspended Organic Matter
- Dissolved Organic Matter
- Diatomaceous Earth
- Nitrogen
- Phosphorus
- Sulphides
- Saline Compounds
- Pathogens

The above-mentioned components give winery wastewater the following properties, which make it unfit for raw discharge or reuse (EPASA et al., 2003):

- Generally low pH (with high pH spikes during caustic washing).
- High Biochemical Oxygen Demand (BOD) due to high organics load.
- High Total Suspended Solids (TSS) due to high load of organics and other solids.
- High nutrients content (Nitrogen and Phosphorus).
- Sulphurous compounds (disinfection and preservatives).
- Moderately saline.

Technologies available for winery wastewater treatment are numerous and each highly customizable to individual sites and operations.

2.0 REGULATORY ENVIRONMENT

The use of reclaimed water by wineries in British Columbia is such a new endeavour that the provincial and local government representatives contacted by the Project Team were not entirely sure of what regulations would apply. Reuse of treated municipal wastewater is not uncommon in the Okanagan (Vernon, Penticton, Osoyoos, etc.) and the provincial regulations that govern this use of reclaimed water were identified by government staff as potentially applying to wineries. The information regarding possible local government bylaws that would apply is based on consultation with regional district and municipal government staff and an Internet search of Bylaws for all local governments in the Okanagan Valley. Correspondence with government staff is included in Appendix B.

2.1 Federal

There are currently no federal Acts or Regulations that govern the reuse of treated wastewater. The Canadian Council of Ministers of the Environment's Committee on Health and Environment is developing *Canadian Guidelines for Household Reclaimed Water*. The guidelines have a narrow focus—they only cover the water quality and risk management issues of using reclaimed water where the water source is household greywater or wastewater—but they are regarded as a first step to a much more comprehensive program for reuse of water in Canada. The national guidelines will assist in the development of appropriate regulatory frameworks.

2.2 Provincial

2.2.1 Municipal Sewage Regulation – Ministry of Environment

The Municipal Sewage Regulation (MSR), administered by the Ministry of Environment under the *Environmental Management Act*, was approved in April 23, 1999 and became effective July 15, 1999. The Municipal Sewage Regulation (MSR) and its Amendments provide requirements that, if met by discharges of municipal sewage or providers of reclaimed water, will ensure their activity is not prohibited by sections 6 (2)[1] and 6 (3)[2] of the *Environmental Management Act*. Compliance with the MSR provides authorization for a discharge of municipal sewage or use of reclaimed water in British Columbia (Ministry of Environment, 2008).

The MSR is essentially a performance-based approach (replacing the previous permit system) that sets standards for the treatment of municipal wastewater, water reuse, and disposal of treated effluent. It provides strict rules for all possible uses of treated wastewater. The list includes

[1] **6** (2) Subject to subsection (5), a person must not introduce or cause or allow waste to be introduced into the environment in the course of conducting a prescribed industry, trade or business.

[2] **6** (3) Subject to subsection (5), a person must not introduce or cause or allow to be introduced into the environment, waste produced by a prescribed activity or operation.

outdoor uses such as agricultural and park irrigation and fire fighting, and inside uses such as flushing toilets and urinals, primarily in commercial or office buildings.

British Columbia is the only province in Canada that defines water reuse within a comprehensive regulation dealing with both unrestricted public access (high risk) and restricted public access (low risk) (Canada Mortgage and Housing Corporation, 2005). According to the MSR, unrestricted public access use, which necessitates significantly higher water quality standards, includes urban (e.g., park and golf course irrigation, toilet flushing), agriculture (e.g., orchards, vineyards, aquaculture), and recreation (e.g., stream augmentation, snowmaking). Restricted public access use includes agriculture (e.g., sod farms, silviculture, nurseries), construction (e.g., dust control, concrete making), industrial (e.g., cooling towers, stack scrubbing), and environmental (e.g., wetlands).

Part 4, Section 10, schedule 2, and portions of schedule 7 of the MSR are most relevant to wastewater reuse. This section and schedules are included in Appendix A.

Code of Practice for the Use of Reclaimed Water

In May 2001, the Province published a *Code of Practice for the Use of Reclaimed Water*. The Code serves as a key reference and guidance document for the use of reclaimed water in British Columbia and is designed to support the regulatory requirements prescribed in the MSR.

The *Code of Practice* contains sections on:

- water quality,
- reclaimed water uses,
- contingency options for surplus reclaimed water,
- storage,
- monitoring,
- labelling, signage, and fencing,
- records and reporting,
- communications,
- emergency response plan,
- and resources.

Registering the Use of Reclaimed Water

The use of reclaimed water must be registered with the Ministry of Environment.

Guidance documents #1 *Registering a Municipal Sewage Discharge with the Ministry of Environment* and #2 *Recommended Pre-registration Activities to be Undertaken Prior to*

Registering a Municipal Sewage Discharge with the Ministry of Environment provide clear instructions regarding the registration of reclaimed water use.

Environmental Impact Study

Under section 8 (2) (a) of the MSR a discharger must not provide for use reclaimed water unless the discharger ensures that a qualified professional conducts and completes an environmental impact study (EIS). The purpose of the EIS is to determine whether the use of reclaimed water will substantially alter or impair the usefulness of the environment or adversely affect human or ecological health (Ministry of Environment, Lands and Parks, 2000).

Condition 8 of Schedule 1 of the MSR sets out in general terms the requirements for an EIS that must be completed at least 90 days prior to providing reclaimed water for use. The *Environmental Impact Study Guideline – A Companion Document to the Municipal Sewage Regulation*, issued by the Ministry of Environment, Lands and Parks in December 2000, provides guidance to the qualified professional for developing an appropriate scope of work for an EIS that will satisfy the requirements of the regulation.

According to the *Environmental Impact Study Guideline,* the following issues need to be examined for environmental and human health impacts of reclaimed water use (as appropriate to the nature of the reclaimed water use and with reference to the *Code of Practice for the Use of Reclaimed Water – A Companion Document to the MSR*):

1. how the use of reclaimed water will affect (potential benefits and detriments) the quality and quantity of any groundwater or surface water, or both, including any impacts on groundwater or surface water that alternate methods of managing surplus volumes of reclaimed water may have;
2. if remote areas of parks, school grounds during vacation periods, and golf courses are proposed to be included under the restricted public access category, then an EIS must determine to the satisfaction of the Manager whether there will be adverse environmental or health impacts;
3. the treatment requirements to maintain water quality guidelines; the temperature effects on the ecosystem; and the effects of nutrient loading when reclaimed water is used for wetland or stream augmentation, impoundments for boating or fishing, and snow making for skiing and snowboarding; and
4. irrigation or impoundment of reclaimed water within 30 m of a domestic water well will require an EIS to determine if lesser or greater setbacks may be acceptable to the Manager.

In addition to the EIS requirements associated with use of reclaimed water and discharges of effluent to the environment, an EIS is required for new or expanded sewage treatment facilities.

Generally, several treatment plant sites, discharge locations, and sites for use of reclaimed water need to be identified as options and evaluated in terms of environmental, social and financial considerations. According to the *Environmental Impact Study Guideline,* for each siting option under consideration, an EIS for a new treatment plant site and all related appurtenances should assess the factors included below.

For the Treatment Plant Sites

1. impact of facility construction on fisheries and wildlife
    a) inventory wildlife that use or traverse the site
    b) inventory fish species in lakes and streams that occupy or traverse the site
    c) identify set back requirements from streams, lakes, wetlands, and wells
    d) identify mitigation measures
2. impact of facility construction on quality of surface water and groundwater
    a) determine baseline water quality
    b) identify if facility structures will infringe on set-back requirements identified in schedule 7 of the MSR
    c) determine if facility structures will alter groundwater, stream, lake, or wetland flow or quality
    d) identify mitigation measures
3. impact of facility construction on air quality with particular reference to potential odour nuisance.
    a) determine site seasonal wind and atmospheric conditions
    b) identify buffer zones between the site (including future expansion) and land use around the site
    c) identify odour mitigation measures to be employed (e.g., enclosed unit processes, odour treatment works)
    d) depending on the available buffer zones, the adjacent land use and the proposed odour treatment works, estimate, using modeling as appropriate, the odour concentrations at the site property line for typical indicator parameters such as H_2S and NH_3
4. impact of facility construction on archeological sites and First Nations lands;
    a) determine if site is registered as an archeological site
    b) determine if site is First Nations land or under active land claim
5. Visual impact of facility on surrounding properties.

5.52 For the Influent and Effluent Pipelines

1. impact of influent and effluent pipelines to and from the site on watercourses or the intertidal zone of a marine foreshore;
    a) identify existing fisheries resources in the waters intersected by the pipelines
    b) identify construction details and methods to mitigate impacts, including works or undertakings that may result in harmful alteration, disruption or destruction of fish habitat.

5.53 For the Discharge Locations

1. typical EIS examples set out in Sections 5.1, 5.2, 5.3 and 5.4 of the Guideline apply.

Operating Plan

In order to meet the requirements of Section 16 of the MSR the discharger must develop an operating plan for the sewage facilities. Guidance document #3 *Recommendations Regarding Developing an Operating Plan* is meant to provide guidance to the qualified professional when preparing an operating plan for a specific sewage facility.

Summary of Key Resources

- Municipal Sewage Regulation – http://www.qp.gov.bc.ca/statreg/reg/E/EnvMgmt/129_99.htm
- Code of Practice for the Use of Reclaimed Water – http://www.env.gov.bc.ca/epd/epdpa/mpp/pdfs/cop_reclaimedwater.pdf
- Environmental Impact Study Guideline: A Companion Document to the Municipal Sewage Regulation – http://www.env.gov.bc.ca/epd/epdpa/mpp/pdfs/EIS_Guideline_Dec2000.pdf
- Compliance Guideline: Meeting the Intent and Requirements of the Municipal Sewage Regulation – http://www.env.gov.bc.ca/epd/epdpa/mpp/pdfs/compliance_guideline.pdf
- Guidelines for Assurance Plans: A Companion Document to the Municipal Sewage Regulation – http://www.env.gov.bc.ca/epd/epdpa/mpp/pdfs/assurance_plan_guidel.pdf
- Guidance on the Municipal Sewage Regulation – http://www.env.gov.bc.ca/epd/epdpa/mpp/gomsr.html
- FS#2 Fact Sheet on the Municipal Sewage Regulation Highlights Regarding Use of Reclaimed Water – http://www.env.gov.bc.ca/epd/epdpa/mpp/fs2reclaimedwater.html
- Guidance Document #1 — Registering a Municipal Sewage Discharge with the Ministry of Environment – http://www.env.gov.bc.ca/epd/epdpa/mpp/gomsrramsd.html
- Guidance Document #2 Recommended Pre-registration Activities to be Undertaken Prior to Registering a Municipal Sewage Discharge with the Ministry of Environment – http://www.env.gov.bc.ca/epd/epdpa/mpp/gomsrrpa.html
- Guidance Document #3 Recommendations Regarding Developing an Operating Plan – http://www.env.gov.bc.ca/epd/epdpa/mpp/guidance_3.htm

2.2.2 Sewerage System Regulation – Ministry of Health Services

The Sewerage System Regulation (SSR), administered by the Ministry of Health Services under the *Health Act*, applies to the construction and maintenance of:

a) a holding tank,
b) a sewerage system that serves a single family residence or a duplex,
c) a sewerage system or combination of sewerage systems with a combined design daily domestic sewage flow of less than **22,700 litres** that serves structures on a single parcel, and

d) a combination of sewerage systems with a combined design daily domestic sewage flow of less than **22,700 litres** that serves structures on one or more parcels or strata lots or on a shared interest (British Columbia Onsite Sewage Association, 2007).

The regulation requires that:

- Discharges do not cause or contribute to a health hazard
- Only authorized persons construct and/or maintain on-site sewage systems – must comply with “standard practice” and must have training and certification
- Systems must be designed in accordance with the regulations including adherence to strict performance standards
- The authorized person files applications for construction or alteration of a system with the health authority
- Establishes maintenance requirements for the system. Ongoing system records be kept, ensuring industry and owner accountability.

The companion document to the SSR, the Sewerage System Standard Practice Manual (SPM), provides a form of standard design, installation, maintenance, and supervision practice for sewerage systems. It serves as a guideline for authorized persons seeking to comply with “standard practice” as required under the SSR.

Summary of Key Resources

- Sewerage System Regulation – http://www.qp.gov.bc.ca/statreg/reg/H/Health/326_2004.htm
- Sewerage System Standard Practice Manual - http://www.health.gov.bc.ca/protect/lup_standards.html

2.2.3 Food Premises Regulation – Ministry of Health Services

The Food Premises Regulation, administered by the Ministry of Health Services under the *Health Act* applies if the winery has a food establishment or tasting/serving area for the public. According to the regulation, a person must not construct or make alterations to food premises unless the plans and specifications for the construction or alteration have been approved by a health official. Another requirement for the food establishment is a potable source of drinking water. If the winery intended to reuse wastewater, the Ministry of Health Services would require assurance that sufficient cross connection control is in place between the potable water supply and the non potable wastewater.

2.3 Local

Local bylaws apply to any winery that discharges wastewater into a municipal sewer system. Table 1 lists the relevant local bylaws for the Okanagan and Similkameen municipalities and regional districts.

Table 2: Okanagan Local Government bylaws relevant to winery wastewater reuse.

Municipality/ Regional District	Bylaws Relevant to Wastewater Reuse
Osoyoos	• Sewer Connection Bylaw No. 754 • Subdivision and Development Servicing Bylaw No. 1100 • Zoning Bylaw 1085
Oliver	• Building Regulation Bylaw No. 917 • Cross Connection Control Bylaw No. 1043 • Zoning Bylaw No. 720
Penticton	• Irrigation, Sewer and Water Bylaw 2005-02 • Subdivision and Development Bylaw No. 2004-81 • Zoning Bylaw No. 87-65
Summerland	• Building Regulation Bylaw No. 92-081 • Fees and Charges Bylaw No. 98-001 (Schedule “O”) • Zoning Bylaw No. 99-001
Peachland	• Sewer Rates Bylaw No. 1671 • Building Bylaw No. 1574 • Cross Connection Control Bylaw No. 1854 • Zoning Bylaw No. 1375
Kelowna	• Sanitary Sewer Storm Drain Regulation Bylaw No. 6618 • Sewerage System User Bylaw No. 3480 • Subdivision, Development and Servicing Bylaw No. 7900 • Zoning Bylaw No. 8000
Lake Country	• Sanitary Sewer Regulation and Rate Bylaw 98-214 • Subdivision and Development Servicing Bylaw No. 97-139 • Zoning Bylaw No. 561
Vernon	• Sewer User Rates Bylaw No. 2955 • Fees and Charges Bylaw No. 3909 (Section 6 Sanitary Sewer Use Bylaw Surcharges) • Sanitary Use Bylaw No. 4863 • Zoning Bylaw No. 5000
Armstrong	• Sanitary Sewer User Rates Amendment By-law No 1393 • Zoning Bylaw No. 1268
Regional District of North Okanagan	• Subdivision Servicing Bylaw No. 726 • Zoning Bylaw 1888
Regional District of Central Okanagan	• Sewer Systems Bylaw No. 1171 • Sewer Systems Fees & Charges Bylaw No. 988 • Subdivision and Development Servicing Bylaw No. 704 • Zoning Bylaw No. 871
Regional District South Okanagan	• Subdivision Servicing Bylaw No. 2000 • Osoyoos Rural Zoning Bylaw No. 2451 • Oliver Rural Zoning Bylaw No. 2453 • Electoral Area 'D' Kaleden-Apex Southwest Sector Zoning Bylaw No. 2457 • Electoral Area 'D' East Skaha, Vaseux Zoning Bylaw No. 2455 • Electoral Area 'E' Zoning Bylaw No. 2459 • Electoral Area 'F' Okanagan Lake West / West Bench Zoning Bylaw No. 2461

2.3.1 Sewer System Use and Rates Bylaws

The *Local Government Act* empowers municipalities and regional districts to regulate and control a wide range of activities. Under this Act, local governments can pass bylaws to control the quality and quantity of wastewater released into their sewer systems. Local governments can also set the rates to be charged to users of the system, including surcharges for high strength wastes.

Pre-treatment may be required where wastewater, or any component of the wastewater, does not meet the provisions of the sewer system use bylaws, may damage or increase maintenance costs on the sanitary sewer system, or may detrimentally affect the operation of the sewage treatment plant. The sewer system use bylaw may require the Owner to retain an engineer to submit a proposal that outlines the method of pre-treatment proposed.

In the Central Okanagan Regional District, for example, a proposal for a pre-treatment facility must contain the following:

i. detailed design of the proposed pre-treatment facility,
ii. detailed list of the wastewater components and the anticipated concentration of each component before and after treatment,
iii. detailed sampling and analysis schedule required to ensure the concentration of the wastewater components remain in compliance to the provisions of this bylaw,
iv. detailed operation and maintenance procedures.

No construction is to take place on the pre-treatment facility until the District Engineer has reviewed the information and approved construction. It is the Owner's responsibility to ensure that all the components of the wastewater will comply with the provisions of the bylaw after the pre-treatment process is completed. The Owner must maintain written records of all cleaning, repair, calibration, maintenance, sampling, and analysis and store the records at the facility for a minimum of three years. The records must be available for examination by the District Engineer at all reasonable times. (Central Okanagan Regional District, 2006)

2.3.2 Subdivision and Development Servicing Bylaws

Subdivision and development servicing bylaws establish procedure and requirements related to works and services a land owner may need to complete or provide with their subdivision or development application. Servicing bylaws contain regulations for the design and construction of sewage disposal systems.

2.3.3 Zoning Bylaws

Zoning bylaws set out detailed regulations for the use and development of lands. The type and extent of servicing required prior to obtaining final approval for a development plan is based on either the parcel zone or the land use designation included in the Zoning Bylaw.

2.3.4 Cross Connection Bylaws

Some municipalities have established cross connection control bylaws to ensure provisions for the elimination and prevention of cross-connections between their potable water and any non-potable water sources. Winery wastewater treatment facilities would need to meet the regulations set out in these bylaws.

2.3.5 Liquid Waste Management Plans

The *Environmental Management Act* allows municipalities and regional districts to develop Liquid Waste Management Plans (LWMP) for approval by the Minister of Environment. The LWMP consists of Operational Certificates; a strategy to ensure liquid waste disposal conforms to Ministry objectives; an implementation schedule; and measures to accommodate future development (Ministry of Environment, 2005). An approved plan authorizes a municipality to discharge waste and store recyclable materials in accordance with the Operational Certificates, other provisions of the waste management plan, and the Minister's requirements.

A LWMP is required to address the potential for waste recycling and utilization. A winery wanting to treat and reuse wastewater may be under the provisions of the LWMP.

3.0 CHARACTERISTICS OF WINERY WASTEWATER

Winery wastewater quality and volume vary greatly depending on the processes being carried out at any given time during the year. Wastewater production consists of fairly steady daily volumes during non-vintage periods, increases during bottling and washing (i.e., tanks and other equipment), and peaks during vintage. Generally speaking, winery wastewater has a high organic load in the form of large suspended matter (i.e., grape skins, stems and seeds), smaller suspended particles (i.e., dead yeast cells, grit, dirt, diatomaceous earth and bentonite), and dissolved contents (i.e., sugars, ethanol, organic acids, microbial fermentation products, soaps and detergents, and cleaning chemicals).

It is estimated that a small winery uses 27 US gallons (~75L) to produce one case of wine. Under this scenario, a typical small winery producing 10,000L of product uses water at a rate of 200L/day in the summer and 300L/day in the winter. The 200L/day rate is comparable to that of a domestic household. The amount of water per case is expected to decline as production increases. (Strachan, personal communication, Dec. 2008)

Winery wastewater is mainly composed of water, mixed with undesirable components such as (EPASA et al., 2003):

- Gross solids
- Suspended Organic Matter
- Dissolved Organic Matter
- Diatomaceous Earth
- Nitrogen
- Phosphorus
- Sulphides
- Saline Compounds
- Pathogens

The above-mentioned components give winery wastewater the following properties, which make it unfit for raw discharge or reuse (EPASA et al., 2003):

- Generally low pH (with high pH spikes during caustic washing).
- High Biochemical Oxygen Demand (BOD) due to high organics load.
- High Total Suspended Solids (TSS) due to high load of organics and other solids.
- High nutrients content (Nitrogen and Phosphorus)
- Sulphurous compounds (disinfection and preservatives).
- Moderately saline.

A variety of effective technologies exist that can allow operators to treat their winery wastewater for reuse. Wastewater treatment is typically carried out in stages, which are described in the next section.

4.0 WASTEWATER TREATMENT STAGES

Wastewater is treated in stages using different processes that are carried out to remove different contaminants present in the wastewater stream. Processes range from physical, mechanical, biological and chemical and can be divided into the following stages of treatment.

4.1 Preliminary Treatment

Wineries are known to produce wastewater with high solid loads. A large portion of the solids found in winery wastewater are organic in nature. This organic matter is partly (but not entirely) responsible for the high BOD levels, and can hinder the effectiveness of subsequent treatment processes. For this reason, it is beneficial to screen solids prior to treatment. Removal of large solids can be achieved using static, rotating or auger screens, and/or by controlling flow rates so as not to stir up the solids as water is transferred to the next step in the process. (EPASA et al., 2003)

4.2 Primary Treatment

Primary treatment consists of mechanically separating large suspended matter and liquid grease (waxes and oils) from the wastewater by allowing settling of sludge and through the use of screens and skimmers. Primary treatment may consist of physical and chemical processes, all with the aim of removing suspended solids from the effluent. These may include sedimentation, flotation, coagulation, flocculation and membrane separation processes.

4.3 Secondary Treatment

Secondary treatment processes are designed to remove the biological components in wastewater, through biochemical processes that breakdown organic matter into sludge and gases so they can then be removed by physical and mechanical processes. Secondary treatment can be divided into aerobic and anaerobic processes.

Aerobic processes are those that occur in the presence of oxygen, while anaerobic processes occur in the absence of oxygen. Both types of processes can be divided into suspended-growth and attached-growth sub-categories. In a suspended-growth process, microorganisms are suspended in the wastewater, while attached-growth processes involve running the wastewater through a media (i.e., pebbles) coated with biofilm (microorganisms).

Aerobic wastewater treatment processes take place in a controlled environment where aerobic microorganisms can consume organic matter in wastewater. Microorganisms (i.e., aerobic bacteria) consume organic matter and other components in the wastewater for energy and convert them into new cells, carbon dioxide and water. This effectively reduces the wastewater's

BOD levels. Some components such as nitrogen and phosphorus are also consumed by biological processes. As colonies of these microorganisms grow, they form "activated sludge" that can be removed through mechanical processes and is sometimes partly re-used in treatment processes (i.e., returned-activated sludge systems) or as a low-level fertilizer as it contains nutrient-rich organic materials. (IPU, 1998)

Some examples of aerobic treatment processes include Aerated Ponds, Constructed Wetlands, Sequencing Batch Reactors, Aerated Fixed-Bed and Moving-Bed Bioreactors, and Biofilters.

Anaerobic processes occur in reactors sealed from the outside environment to prevent the introduction of air and the release of odours. Anaerobic bacteria ultimately convert organic matter in the wastewater into methane and carbon dioxide. Anaerobic systems are more effective in dealing with high solid loads in the wastewater and therefore more effective in reducing BOD levels in wastewater. (DOE, 2003)

Sludge produced in the primary and secondary processes can also be treated anaerobically to allow further breakdown of organics. Some examples of anaerobic treatment processes include Complete-mix, Contact, Fixed-film and Fluidized-Bed Reactors (also called Digesters).

4.4 Tertiary Treatment

Tertiary treatment consists of "polishing" the effluent by removing particulate and suspended solids through physical, mechanical and chemical processes. Nutrients such as nitrogen and phosphorus can be removed through *biological oxidation* and *enhanced biological phosphorus removal* respectively. Treatment may involve Sedimentation, Flocculation, Clarification and Air Flotation.

4.5 Advanced Treatment

Advanced treatment is generally conducted to lower the concentration of microorganisms and remove pathogens, dissolved organic compounds, heavy metals and iron from the reclaimed wastewater. Common methods of advanced treatment include disinfection and contaminant removal through Media or Membrane filtration, oxidation or UV irradiation. In addition to microorganisms, inorganic salts may remain in the treated wastewater after tertiary treatment and further treatment such as Membrane Filtration may be necessary depending on the treatment objectives.

5.0 WASTEWATER TREATMENT TECHNOLOGIES

5.1 Ponds and Lagoons

Ponds and lagoons have long been used for wastewater stabilization. They are impermeable basins designed to hold and treat wastewater for a specific period of time. Wastewater in a pond is naturally stabilized through aeration, photosynthesis and settling processes. There are two main types of treatment ponds, facultative and mixed-ponds. (LSM, 2003)

In a **Facultative Pond**, water is transferred into a lined impermeable basin. As water settles, three separate layers tend to form: an upper aerobic layer, a middle mixed layer and a bottom anaerobic layer. BOD levels are reduced through treatment in the upper aerobic layer due to two main reasons: oxidation and decomposition of oxygen-demanding organic matter. Oxidation occurs when dissolved oxygen, introduced by algal photosynthesis and wind action, reacts with organic matter in the wastewater, thereby reducing the BOD. BOD is further reduced by decomposition as aerobic microorganisms consume the organic matter for food. Organic matter is also broken down in the middle layer, where facultative microorganisms exist. Facultative organisms are those that can adapt and survive in environments with very small to large concentrations of dissolved oxygen. (LSM, 2003)

The oxidizing environment in the upper layer causes gases and other compounds to diffuse up where they are also oxidized. Solids settle and accumulate in the bottom layer and are consumed by anaerobic microorganisms. The biochemical reactions involved in the decomposition of the organic matter produce methane as a by-product. Facultative ponds rely on natural processes to introduce oxygen into the wastewater (i.e., wind action and algae growth), thereby limiting its effectiveness, given the high BOD concentrations typical of winery wastewater. Because of this, the relationship between depth and surface area is an important factor in pond design. Wastewater stabilization in traditional pond systems requires a long detention time to bring BOD to levels acceptable for irrigation. (LSM, 2003)

In **Mixed Ponds**, mechanical mixing distributes dissolved oxygen and increases contact between microorganisms, dissolved oxygen and the organic matter to be digested. In a partial-mix pond, mixing and detention times are carefully managed because facultative and anaerobic processes remain necessary for optimal treatment. However, in some situations where the solids load is low, a complete-mix system can be utilized. This provides a somewhat constant aerobic environment and maintains solids in suspension, in contact with dissolved oxygen and microorganisms. In some setups, air or pure oxygen may be introduced at the bottom of the pond to enhance aerobic processes. (LSM, 2003)

Factors affecting the construction costs of a pond may include land cost, excavation, piping and channelling structures, and pond lining. Operating costs may include power for aeration equipment, regular maintenance and dredging. (EPA, 2002a and EPA, 2002b)

Advantages and Disadvantages

The US EPA identifies the following as advantages and disadvantages of this technology: (EPA, 2002a and EPA, 2002b):

Advantages:

- Most mixed and aerated ponds require less land than facultative ponds.
- Mixed and aerated ponds can resist freezing in winter better than facultative ponds.
- Sludge disposal may be necessary, however, in relatively small quantities compared to other secondary treatment processes.

Disadvantages:

- Aerated ponds not as effective as facultative ponds in removing ammonia nitrogen or phosphorous, unless designed for nitrification.
- In prolonged cold weather, aerated lagoons can experience surface ice formation.
- Biological activity in all ponds is reduced during cold weather.
- A reduction in biological activity (primarily anaerobic reactions), can lead to larger volumes of sludge than during warmer seasons.
- Must be properly maintained to prevent mosquitoes and other insects.
- Aerators and mixing mechanisms require energy input.
- Requires dredging at some point in its service life time.

5.2 Constructed Wetlands

In the natural environment, wetlands act as filters that remove sediments and pollutants from water. "Artificial", "engineered" or "constructed" wetlands are built by employing the use of carefully selected vegetation (i.e., reeds, bullrush, cattails and lillies) to enhance the quality of the wastewater to a point where it can be reused, typically for irrigation. Constructed wetlands are referred to as "reed beds" when a monoculture of reeds is used. A simplified constructed wetland schematic is shown in Figure 1. (Larson, 1999)

The two main types of constructed wetlands are Open Water Surface (also known as free water surface) and Sub-surface Flow wetlands. In Open Water Surface wetlands, the water surface is exposed to the air, while a Sub-surface Flow wetland is designed so water does not breach the surface of the bed or channel it flows through. This is to minimize odours and breeding of insects. Another benefit of a sub-surface system is that the gravel provides additional surface area on which bacteria and other microorganisms can grow. (EPA, 2000a)

A basic constructed wetland process begins with the removal of large solids from the wastewater, either through pre-treatment in a pond or through the use of screens. While a wetland system may be able to handle a relatively high solids load, large solids need to be screened to avoid clogging of feed lines in the system. Holding wastewater in tanks or ponds prior to transferring to the wetland is important to prevent shock to the wetland caused by accidental or non-ideal effluent such as spill of sterilization liquid or full-strength juice that would destabilize the treatment ecosystem. (Larson, 1999)

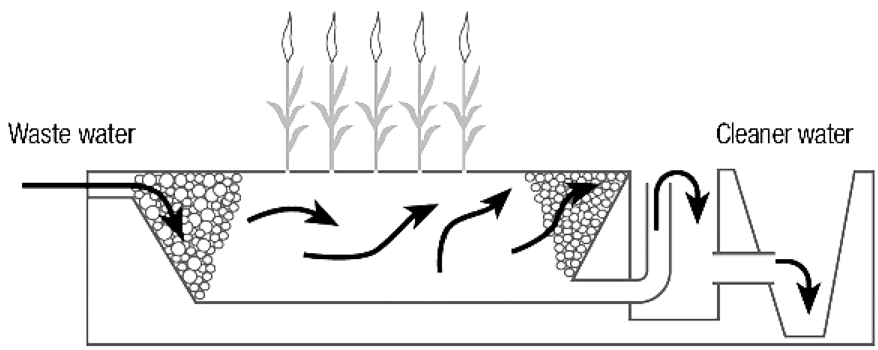

Figure 1: Simplified constructed wetland schematic. Water flow may be Open Water Surface or Sub-Surface. (Source: http://www.unep.org/geo/yearbook/yb2003/images/fresh_img_g_40.jpg)

Once solids have been separated, the wastewater is transferred to a lined, shallow basin or channel with submerged plants and soil layer. This is where physical, biological and chemical processes effectively reduce BOD, suspended solids, nitrogen and phosphorus with carefully calculated retention times. Plants and bacteria form a symbiotic relationship (i.e., a relationship that benefits both), and this reduces the chances of beneficial bacterial die-off due to lack of food (supplied by the wastewater), in low-flow seasons. (Larson, 1999)

Wetland systems require little maintenance and no equipment is necessary, however, they may take up a lot of land so they are a more cost effective treatment alternative where suitable land is available at reasonable cost. Constructed wetlands can decrease BOD and nutrient levels more effectively than ponds or lagoons, are more aesthetically attractive and reduce smells. However, ponds and wetlands can be combined to create an ideal treatment process. Sub-surface wetlands tend to be smaller than open-surface wetlands with similar effluent treatment efficacy; however, the high cost of the gravel media in the sub-surface wetland can result in higher construction costs. (EPA, 2000a)

Capital costs for wetlands are similar to ponds. These may include land, surveys, site clearing, excavation, lining, gravel, soil, plants, piping and feed lines, fencing, legal, contingencies, and contractor’s fees. (EPA, 2000a and EPA 2000b)

Advantages and Disadvantages

Some advantages and disadvantages of wetlands are listed below (EPA, 2000a and EPA, 2000b):

Advantages:

- Effective passive treatment
- Reduced need for specialized equipment, energy input, and operator training.
- Usually less expensive to operate and maintain than mechanical treatment processes.
- Can resist freezing to some extent and be available year round.
- Can be designed for advanced or tertiary treatment.
- A sub-surface wetland resists freezing better than open-surface wetlands.
- Can enhance natural environment by providing habitat for some wildlife, and may provide recreational opportunities.
- Wetland treatment is effective in treating solids and minimize (sometimes eliminate) the need for further treatment or disposal.
- Wetland treatment is effective in removing BOD and suspended solids. Effectiveness can be enhanced by increasing detention time in the wetland. Long detention times can improve the effectiveness of nitrogen and phosphorus removal.
- Sub-surface flow wetlands prevent mosquitoes and similar insects from becoming a problem, as long as the system is properly operated and a subsurface water level maintained. The risk of human contact with partially treated wastewater is also eliminated.

Disadvantages:

- Wetlands typically require more land than mechanical treatment processes.
- Contaminants accumulate in wetland sediments over time.
- Cold temperatures reduce the rate of BOD and nitrogen compounds removal. If temperatures are not severe, increased detention time can compensate, however, wetland treatment may not be feasible in extremely cold climates.
- Sub-surface flow wetlands are not as effective in reducing nitrogen compounds due to limited oxygen availability. Longer detention times or a combination of treatment methods may prove effective.
- Sub-surface flow wetlands may not be as effective as open-surface or other treatment methods in completely removing organic compounds, suspended solids and nitrogen compounds.

Note: A BCWGC member recommended the Constructed Wetlands website (http://www.constructedwetlands.org). The website provides information on wetland design, construction, operation, maintenance and benefits, and how these can be used to reduce wastewater treatment costs and conserve nature.

5.3 Trickling Filters

Trickling filters is a treatment process where wastewater effluent is passed through media coated with beneficial microorganisms (attached-growth), which remove organic matter from the wastewater through physical and biological action. The trickling process is utilized in rotating biological contactors and in packed bed reactors. Trickling filters are increasingly being used in conjunction with other technologies (discussed in this report) to improve reclaimed water quality. (EPA, 2000c)

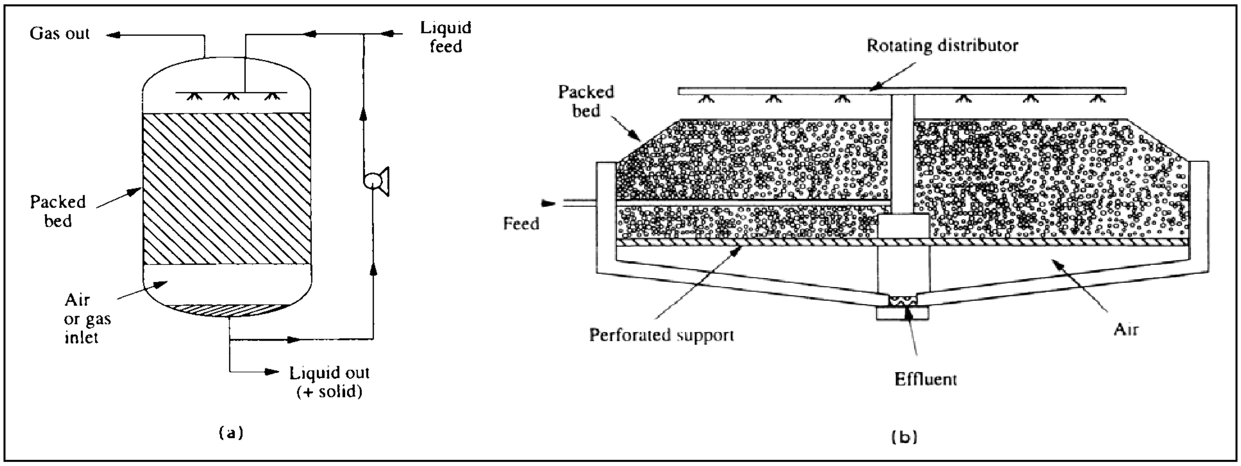

Figure 2: Diagrams of (a) packed bed trickling filter and (b) rotating biological contactor trickling filter. (Source: http://biomine.skelleftea.se/html/BioMine/Reactors/Bioreractors/page_14.htm)

Trickling filter systems have been proven to be reliable; however, the potential for problems exists due to issues such as excessive growth of biofilm, improper design, changing wastewater characteristics and equipment failure. Trickling filter systems are unique to each operation they are installed in, but general costs of running a system include construction, labour, operation, maintenance, and materials. (EPA, 2000c)

Advantages and Disadvantages

Some advantages and disadvantages of trickling filter systems are summarized below (EPA, 2000c):

Advantages:

- Simple, reliable, biological process.
- Suitable in areas where land not available for land intensive treatment systems.
- Effective in treating high concentrations of organics.
- Rapidly reduce soluble BOD in applied wastewater.
- Efficient nitrification units.
- Durable process elements.

- Low power requirements.
- Moderate level of skill and technical
- Expertise needed to manage and operate the system.

Disadvantages:

- Additional treatment may be needed to meet more stringent discharge standards.
- Possible accumulation of excess biomass that cannot retain an aerobic condition and can impair trickling filter performance (maximum biomass thickness is controlled by hydraulic dosage rate, type of media, type of organic matter, temperature and nature of the biological growth).
- Requires regular operator attention.
- Incidence of clogging is relatively high.
- Requires low loadings depending on the medium.
- Flexibility and control are limited in comparison with activated-sludge processes.
- Vector and odour problems.
- Snail problems.

5.4 Sequencing Batch Reactors

A Sequencing Batch Reactor system is a “fill-and-draw” bioreactor system where wastewater is added to a single bioreactor tank (“batch” reactor). Figure 3 shows the Sequencing Batch Reactor treatment process. Wastewater is treated by aeration, settling, decanting, and idling, with each step conducted in sequence (Herzbrun et al., 1985). A Sequencing Batch Reactor removes the need for primary and secondary clarifiers, reducing operation and maintenance costs. (EPA, 1999a)

Wastewater is pre-screened to remove large solid particles and transferred into the tank, which may be partially filled with activated sludge. The biological and chemical breakdown of organic material occurs in a closed system, as opposed to the continuous flow found in other activated sludge bioreactors. The wastewater is aerated and mixed until enough time has passed for biological processes to have worked effectively. Settling is allowed to occur and the treated liquid (supernatant) is removed. Some of the sludge is wasted to maintain a constant biomass-to-influent ratio for the next batch. Optimal performance of a Sequencing Batch Reactor system is achieved with the use of two or more tanks, each carrying out its own sequence of processes, but all also working in sequence as system. Sequencing Batch Reactors have a small footprint compared to ponds and wetlands and are better suited for low or intermittent flows and places where space is limited. (EPA, 1999a)

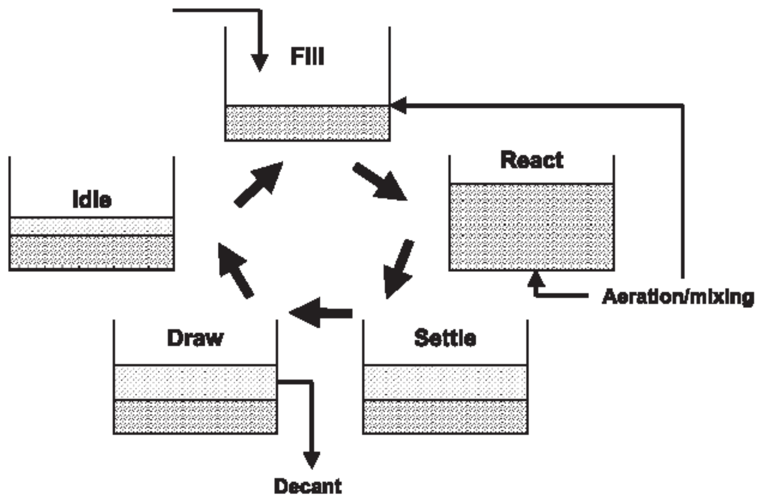

Figure 3: Sequencing Batch Reactor Process.
(Source: http://www.epa.gov/nrmrl/pubs/625r00008/html/html/tfs3fig1.gif)

Sequencing Batch Reactor effluent is sometimes filtered to remove solids that may interfere with disinfection if needed. Some of the costs of running a Sequencing Batch Reactor may include expenses in buying or running: tanks, site preparation (i.e., excavation), engineering, aeration equipment, automated valves, mixers, pumps, chemicals, safety and training, laboratory testing and solids handling.

Advantages and Disadvantages

Some advantages and disadvantages of Sequencing Batch Reactors are summarized below (EPA, 1999a):

Advantages:

- Equalization, primary clarification (in most cases), biological treatment, and secondary clarification can be achieved in a single reactor vessel.
- Operating flexibility and control.
- Minimal footprint.
- Potential capital cost savings by eliminating clarifiers and other equipment.

Disadvantages:

- A higher level of sophistication is required (compared to conventional systems), especially for larger systems, of timing units and controls.
- Higher level of maintenance (compared to conventional systems) associated with more sophisticated controls, automated switches, and automated valves.
- Potential of discharging floating or settled sludge during the decanting.
- Potential plugging of aeration devices during selected operating cycles, depending on the aeration system used by the manufacturer.

- Potential requirement for equalization after the Sequencing Batch Reactor, depending on the downstream processes.

5.5 Membrane Bioreactors

Most bioreactors and secondary treatment processes in general, rely on suspended-growth treatment of wastewater. Membrane Bioreactors were developed to combine, in a single unit, the biological efficacy of bioreactors with the optimized solids and contaminant removal of membranes (see Figure 4). Membranes are chosen depending on the contaminants to be removed from the effluent. Depending on their pore size, membranes can aid in the removal of nitrogen, phosphorus, bacteria, biochemical oxygen demand (BOD), and total suspended solids (TSS), and reduce overall salinity of the effluent. In some cases where Membrane Bioreactors are employed in secondary treatment, the need for Advanced Treatment of the effluent may be eliminated. (EPA, 2007)

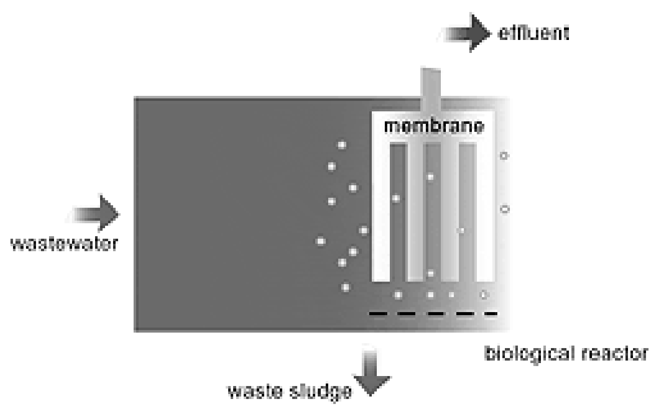

Figure 4: Membrane Bioreactor Schematic.
(Source: http://net2client.hscg.net/ZZZ/08/08200/Image/membr-bioreact.gif)

The capital, operating and maintenance costs of a Membrane Bioreactors system tend to be higher than conventional secondary treatment systems because of the cost of specialized membranes and higher energy consumption for air scouring to reduce membrane fouling. The costs of running a Membrane Bioreactors system, however, may not always be higher than a conventional system, since it takes up less land and requires smaller tanks, which can amount to considerable savings for land acquisition and materials. (EPA, 2007)

Advantages and Disadvantages

Some advantages and disadvantages are summarized below (EPA, 2007):

Advantages:

- Better effluent quality, smaller spatial requirements than other secondary treatments.

- Treated effluent is better suited for high-level disinfection.
- Treated effluent is suitable for discharge or may be re-used.

Disadvantages:

- Typically higher capital and operating costs than conventional systems for the same through-put. Energy requirements, membrane cleaning and fouling control, and eventual membrane replacement are among some of the higher costs of the system. Operating costs are typically higher than those of comparable capacities.
- Waste sludge from such a system might have a low settling rate, resulting in the need for chemicals (flocculation) to produce biosolids acceptable for disposal.
- The amount of air needed for the scouring has been reported to be twice that needed to maintain aeration in a conventional activated sludge system

5.6 Anaerobic Digesters

Anaerobic digesters are a type of bioreactor where anaerobic bacteria break down organic material in a high-temperature environment with little or no oxygen. The process reduces the volume and mass of the influent faster and more effectively than aerobic processes. This comes at a premium as anaerobic systems are costly to setup compared to aerobic systems (Monsal, 2008).

The anaerobic digestion consists of four main processes that operate in sequence: hydrolysis, acidogenesis, acetogenesis and methanogenesis. Treatment starts with hydrolysis breaking down insoluble organics into simpler components that are easier for bacteria for consume. During acidogenesis, sugars and amino acids are converted into hydrogen, ammonia, carbon dioxide and organic acids, which are then converted by acetogenic bacteria into acetic acid and additional ammonia, hydrogen and carbon dioxide. During methanogenesis, all products are converted to methane and additional carbon dioxide. (DOE, 2003)

As with all treatment systems, construction and operational costs depend largely on site specifics such as wastewater volumes, desired effluent quality, etc. Capital costs may include digester tanks, pumps, mixers, piping, etc. Anaerobic digester systems can be upgraded to multi-stage systems for a variety of end-benefits such as higher quality solids, capitalizing on biogas capture and distribution, reducing offensive odours, etc. (DOE, 2003)

Reclaimed water from the anaerobic bioreactor process, called digestate, contains minerals and a portion of the carbon existent in the original material. It can then be stored in a pond or tank for future use. Methane, a by-product of the process, can be captured and used to generate electricity. Some operations using anaerobic digesters also use the excess heat for building heating, refrigeration and heating processes. (OMOA, 2008)

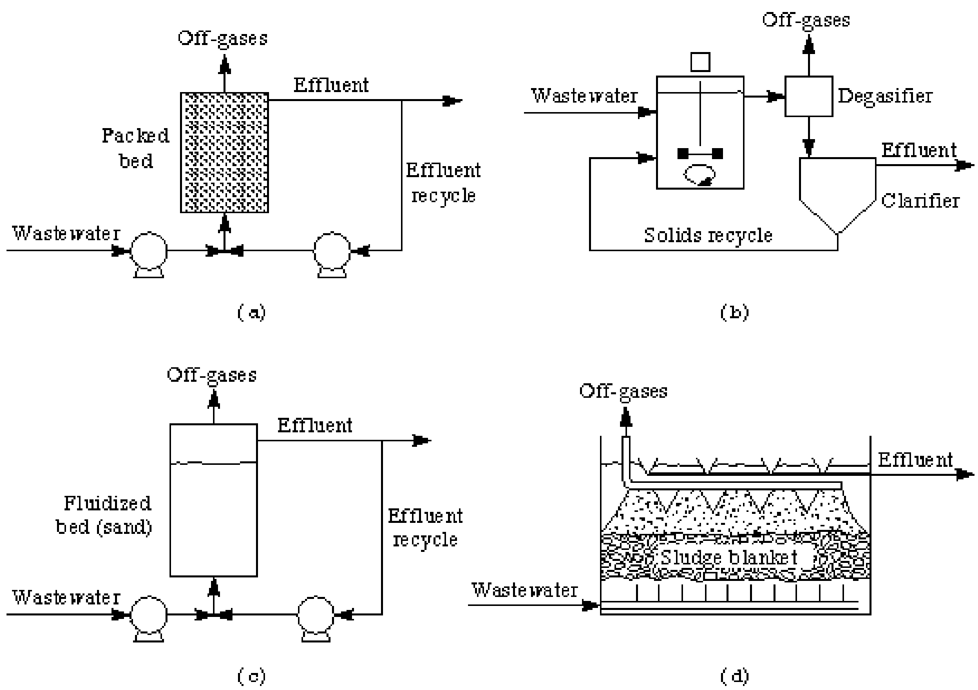

Figure 5: Four types of anaerobic wastewater treatment systems: (a) anaerobic filter reactor; (b) anaerobic contact reactor; (c) fluidized-bed reactor; (d) upflow anaerobic sludge blanket. (Source: http://biomine.skelleftea.se/html/BioMine/Reactors/Bioreractors/page_18.htm)

Advantages and Disadvantages

Some of the advantages and disadvantages of anaerobic digesters are included below: (OMOA, 2008)

Advantages:

- Anaerobic digestion systems often pay for themselves through the combination of reduced costs for biosolids disposal (owing to a reduction in biosolids volume through the digestion process), the potential marketing of good quality biosolids.
- Reduced cost and emissions associated with transport of waste offsite.
- Energy savings due if biogas is used for producing own power.
- Digestate liquid (liquor) can be used as a fertilizer and solid digestate as an organic soil enhancer.
- Reduction in cost of chemical fertilizers due to use of liquid and solid digestate.

Disadvantages:

- The high and constant temperatures needed during the thermophilic stage require a significant input of energy that may not be recovered through biogas reuse.
- Anaerobic digesters may not be as effective as an aerobic treatment in reducing BOD levels. Additional treatment may be required depending on the desired end-use.

5.7 Disinfection

Disinfection of the effluent is carried out when microorganism concentrations need to be reduced or when pathogenic microorganisms are suspected. High turbidity and suspended particles can diminish the effectiveness of the following disinfection methods.

5.7.1 Chlorination

Chlorination remains the most commonly used method as it has been proven effective for decades. Chlorine breaks down the cell walls of organisms and its contents. A major drawback is that it may produce harmful compounds if it reacts with organic matter remaining in the effluent. Storage of the chemical is also an issue as a spill could have serious consequences due to its high toxicity to humans and the environment. (EPA, 1999b)

Advantages and Disadvantages

Some advantages and disadvantages of chlorination are summarized below (EPA, 1999b):

Advantages:

- Chlorine is reliable and effective against a wide spectrum of pathogenic organisms.
- Chlorine is more cost-effective than UV or ozone disinfection.
- The chlorine residual that remains in the wastewater effluent can prolong disinfection even after initial treatment and can be measured to evaluate the effectiveness.
- Dosing rates are flexible and can be controlled easily.

Disadvantages:

- The chlorine residual is toxic to aquatic life and the system may require dechlorination, even when low concentrations of chlorine are used.
- All forms of chlorine are highly corrosive and toxic. Thus, storage, shipping, and handling chlorine pose a risk and requires increased safety precautions.
- Chlorine reacts with certain types of organic matter in wastewater, creating hazardous compounds (e.g., trihalomethanes).
- Chlorine residuals are unstable in the presence of high concentrations of chlorine demanding materials. Thus, wastewater with high BOD may require higher chlorine doses for adequate disinfection.

5.7.2 Ozonation

Ozonation is another common method used for disinfection. Ozone works similarly to chlorine by destroying the cells of microorganisms. Ozone is typically generated on site, so the need for storage of dangerous chemicals is eliminated. It also produces fewer by-products than chlorination. Ozone disinfection, however, is more costly and more complex than chlorination. Chlorination and ozonation work by mixing the disinfectant with effluent, and allowing sufficient contact-time to allow for optimal disinfection. Compared to other disinfection processes, ozonation costs are usually higher. (EPA, 1999c)

Advantages and Disadvantages

Some advantages and disadvantages of ozonation are summarized below (EPA, 1999c):

Advantages:
- Ozone is more effective than chlorine in destroying viruses and bacteria.
- Short contact time (approximately 10 to 30 minutes).
- No harmful residuals that need to be removed after ozonation.
- No resurgence of microorganisms after treatment, except those protected by particulate.
- No safety problems associated with storage of chemicals.
- Ozonation elevates the dissolved oxygen concentration of the effluent eliminating the need for supplemental aeration.

Disadvantages:
- Some viruses, spores, and cysts may require higher dosages.
- Requires complicated equipment and efficient contacting systems. More complex than Chlorination and UV Irradiation.
- Power intensive process.
- Requires corrosion-resistant holding structures (i.e., stainless steel).
- Not economical for wastewater with high levels of suspended solids, BOD, or total organic carbon.
- Ozone is extremely irritating and possibly toxic, so off-gases from the contactor must be destroyed to prevent worker exposure.
- Capital, operation and maintenance costs are relatively high.

5.7.3 Ultraviolet Irradiation

Ultraviolet (UV) light can be used as an alternative to chlorine or ozone. It works by running the effluent through a series of UV lamps at an optimal flow rate. UV light damages the genetic structure of bacteria, viruses and other pathogens, rendering them unable to reproduce. The main advantage is that UV irradiation does not leave unwanted compounds in the effluent, however, UV systems require more maintenance than chlorination or ozonation systems. (EPA, 1999b)

Advantages and Disadvantages

Some advantages and disadvantages of UV irradiation are summarized below (NESC, 2000):

Advantages:

- Effective against most viruses, bacteria, and spores.
- No chemical storage or production required.
- No harmful residual by-products.
- Smaller footprint than other methods.

Disadvantages:

- Some types of viruses, spores, and cysts may require higher dosage.
- Turbidity and suspended solids can render UV disinfection ineffective.
- May require a large number of lamps.

5.8 Advanced Treatment

Residual chemicals, heavy metals and nutrients may pass through the previously mentioned treatment and disinfection processes. Advanced treatment includes methods designed to process effluent following secondary or tertiary treatment, or disinfection that can produce a high-quality effluent fit for reuse in sensitive applications. The extent of advanced treatment necessary, if any, will vary depending on its end-use.

5.8.1 Media Filtration

Media Filtration involves running treated effluent through a media filter, (i.e., sand or activated carbon) to remove microorganisms, soluble organics, nitrogen, sulfides and heavy metals through the processes of adsorption or ion-exchange. In adsorption, contaminants get ‘stuck’ on the surface or pores of the filtering media as the effluent passes through the filter. In ion-exchange, a benign compound is exchanged for an unwanted contaminant in the effluent, much like a water softener exchanges salts with hard-water ions like Calcium to reduce hardness. (EPA, 2000d)

<u>Advantages and Disadvantages</u>

Some of the advantages and disadvantages of Media Filtration are summarized below (EPA, 2000d):

Advantages:

- Reliable technology can remove dissolved organics.
- Small footprint.
- Easy to incorporate in existing facility.

- In an activated carbon system, media regeneration (recycling of media) is generally reliable and reduces solid waste produced. Regeneration can provide up to 50% savings versus buying new carbon media.

Disadvantages:

- Odour and corrosion problems may arise under certain conditions.
- Spent media may present a land disposal problem if not regenerated.
- Spent media may pose an environmental or human health risk in case of accidental release.
- Wet activated carbon is highly corrosive and abrasive.
- Process requires treated wastewater and effectiveness is sensitive to variations in acidity, temperature and flow.
- Regeneration of activated carbon may produce harmful air emissions from contaminants collected in the carbon. Exhaust from the regeneration process needs to be treated as incomplete combustion may produce carbon monoxide.
- Regeneration can be a very involved and noisy process.

5.8.2 Membrane Filtration

Membrane Filtration involves running treated effluent through a membrane that is permeable to water but not to contaminants using pressure. Figure 6 provides a schematic of a basic Membrane Filtration process. Flat sheets or hollow fibres are configured into membrane modules. These can have pores that from micrometers to nanometers in size. Membrane Filtration is divided into classes depending on the pore size of the membrane: Microfiltration, Ultrafiltration, Nanofiltration and Reverse Osmosis. The type of Membrane Filtration class required will be dependant on the size of the contaminant that is to be removed. (EPA, 2005)

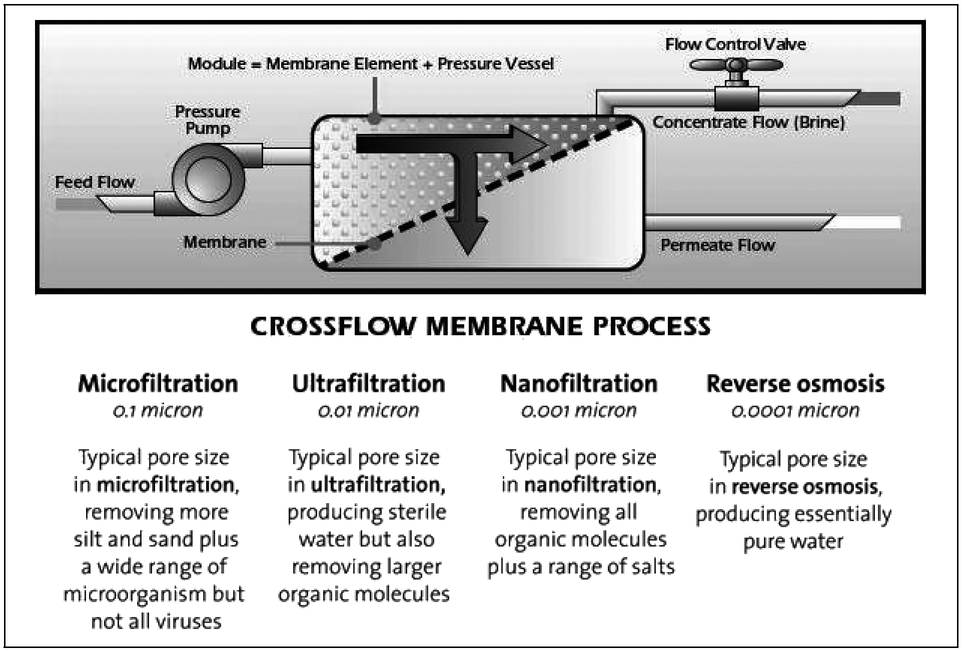

Figure 6: Basic Membrane Filtration Process.
(Adapted from http://www.waterquality.crc.org.au/consumers/Image48.gif and http://www.boostersys.com/stuff/en/technology2.jpg)

Advantages and Disadvantages

Some of the advantages and disadvantages of Membrane Filtration systems are: (Pall, 2007)

Advantages:

- No toxic by-products.
- Prevents bacterial re-growth in water.
- Produces high quality water (suitable for industrial use, groundwater recharge, indirect potable reuse)
- Customizable for different applications can allow for precise contaminant removal.
- Membrane systems typically require 50-70% less space than conventional technologies.
- Minimal operator intervention required and relatively easy to operate.
- Long filter life. Some membranes can last up to 10 years.

Disadvantages:

- Pretreatment of effluent required to prevent membrane fouling.
- High start-up costs and moderate to high operating costs.
- Membrane fouling can affect the rate of filtration. Preventative measures during maintenance required, which may increase cost of operation.
- Backwash may pose risk to the environment and human health in the event of a spill or exposure if it contains pathogens, chemicals or other contaminants of concern.
- Chemicals required for cleaning of equipment.

6.0 RECLAIMED WATER USES

A variety of wastewater treatment options exist that can adequately address the needs of the wine industry. Effective wastewater treatment systems need to be designed to fit the needs of individual operations, taking into account physical, economical, environmental and other limitations. Existing wastewater treatment processes can produce reclaimed water of acceptable quality for a range of non-potable and indirect-potable uses. Depending on the treatment system, useful by-products such as biogas and biosolids (sludge) may also be produced.

The diagram below lists some of the suggested uses as per the Guidelines for Water Reuse developed by the US EPA.

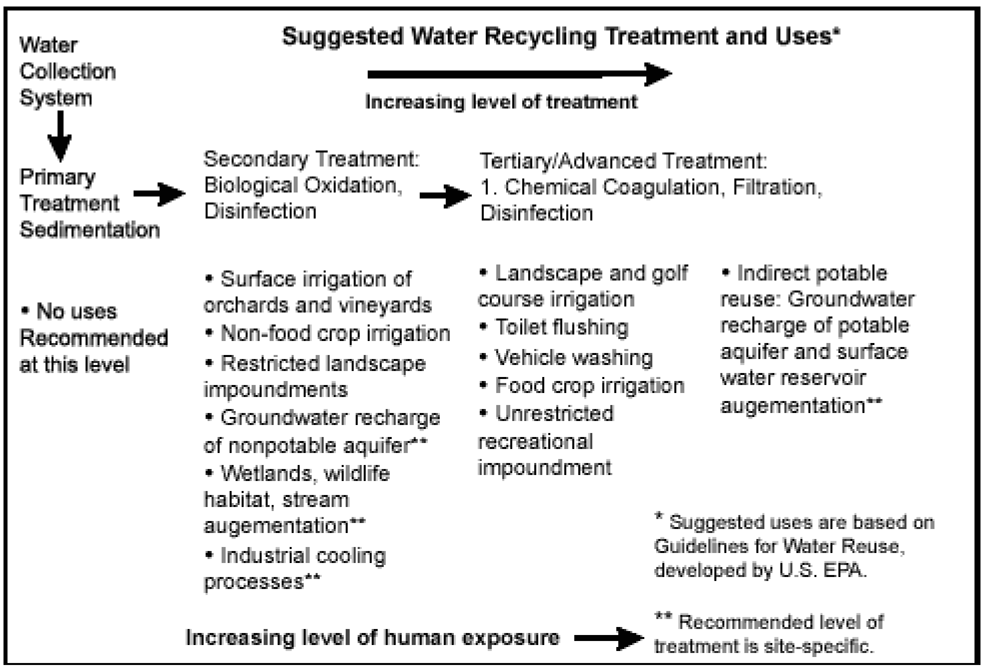

Figure 7: Generalized Overview of Water Recycling and Reuse.
(Source: http://www.epa.gov/region09/water/recycling/index.html)

The water reclaimed from appropriately treated wastewater, can be used for a variety of settings for urban, industrial, agricultural, environmental and recreational applications. Additionally, reclaimed water can be recharged into a local aquifer for future use where groundwater is utilized.

The most popular application for reclaimed water is irrigation, whether in agriculture, landscaping, public parks or golf course irrigation. Other uses may include coolant for industrial processes, water for manufacturing processes, toilet flushing, construction (i.e., concrete mixing), and artificial water features.

The US Environmental Protection Agency document, *Guidelines for Water Reuse* (EPA, 2004 guideline), identifies the following technical issues associated with planning the beneficial reuse of reclaimed water:

- Identification and characterization of potential demands for reclaimed water.
- Identification and characterization of existing sources of reclaimed water to determine their potential for reuse.
- Treatment requirements for producing safe and reliable reclaimed water that is suitable for its intended applications.
- Storage facilities required to balance seasonal fluctuations in supply with fluctuations in demand.
- Supplemental facilities required to operate a water reuse system, such as conveyance and distribution networks, operational storage facilities, alternative supplies, and alternative disposal facilities.
- Potential environmental impacts of implementing water reclamation.
- Identification of knowledge, skills, and abilities necessary to operate and maintain the proposed system.

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Appendix A

Excerpts from the Municipal Sewage Regulation

APPENDIX A – Excerpts from the Municipal Sewage Regulation

Part 4, Section 10, schedule 2, and portions of schedule 7 are most relevant to wastewater reuse.

Part 4 — Standards for Effluent Reuse and Discharges to the Environment

Use of reclaimed water

10 (1) A person must not provide or use reclaimed water unless

(a) the standards for use of reclaimed water as set out in Schedule 2 are met,

(b) use is limited in accordance with Schedule 2 for unrestricted public access and restricted public access,

(c) for systems without seasonal storage, emergency storage is provided so that

(i) if the reclaimed water does not meet the standards required, the flow can be diverted until such time as the standards are met and designated water uses can continue, and

(ii) a minimum 20 days of emergency storage is provided, and

(d) an environmental impact study has been conducted in accordance with condition 8 in Schedule 1.

(2) A person providing or using reclaimed water must, in addition to any seasonal storage for the reclaimed water that is provided,

(a) provide an alternative method of disposing of the reclaimed water and describe that method in the operating plan under section 16, or

(b) satisfy a director that no alternative method described in paragraph (a) is required to assure public health protection and treatment reliability.

(3) Despite subsection (1) (c) (ii), and provided that the treatment processes are built with multiple units capable of meeting the reclaimed water standard with one unit not in operation, emergency storage may be reduced to a minimum of 2 days.

(4) If the required emergency storage required by subsection (1) (c) is temporarily not available, the discharger must

(a) divert the reclaimed water to a disposal method which complies with this regulation, and

(b) if the disposal method is to ground and the reclaimed water meets the unrestricted public access standards, the reclaimed water may be discharged to ground provided the time of subsurface travel before a surface discharge is not less than 2 days.

(5) The discharger must ensure that a provider of reclaimed water is prohibited from using any dual distribution system to convey reclaimed water unless the distribution system incorporates design, construction, maintenance and inspection safeguards to prevent cross connections.

(6) In subsection (5), "dual distribution system" means a water distribution system that distributes 2 grades of water to the same service area; one potable and the other non-potable.

(7) No person may provide for the use of reclaimed water unless specifically authorized
- (a) in writing by the local health authority having jurisdiction, or
- (b) under a local service area bylaw under which the municipality or a private corporation under contract to the municipality assumes the responsibility for ensuring compliance with this regulation and that proper operation and maintenance will be carried out.

(8) For the unrestricted public access category, a person must not be a provider of reclaimed water unless the person
- (a) develops, to the satisfaction of a director, user information and communication materials related to the use of reclaimed water, and
- (b) provides annually to all users copies of the materials required by paragraph (a).

(9) Methods of treatment for reclaimed water other than those included in this regulation and their reliability features may be accepted by a director if the discharger demonstrates to the satisfaction of the director that the methods of treatment and reliability features will assure an equal degree of treatment, public health protection and treatment reliability.

(10) Initial dilution zones are not applicable to reclaimed water used for stream augmentation, creating impoundments, maintaining wetlands or marshes or for emergency disposal to ground unless a standard specified under condition 4 in Schedule 1 makes them applicable.
[am. B.C. Reg. 321/2004, s. 31 (c) and (h).]

Schedule 2
[am. B.C. Reg. 321/2004, s. 31 (z) to (cc).]
Permitted Uses and Standards for Reclaimed Water
(Section 10 of this Regulation)

Reclaimed Water Category and Permitted Uses (1)	Treatment Requirements (2)	Effluent Quality Requirements (3)	Monitoring Requirements (5)
UNRESTRICTED PUBLIC ACCESS			
URBAN - Parks (6) - Playgrounds - Cemeteries - Golf Courses (6) - Road Rights-of-Way - School Grounds (6) - Residential Lawns - Greenbelts - Vehicle and Driveway Washing - Landscaping around Buildings - Toilet Flushing - Outside Landscape Fountains -	Secondary (7) Chemical Addition (8) Filtration (4) Disinfection (9) Emergency Storage	pH = 6 - 9 $\leq$ 10 mg/L BOD_5 $\leq$ 2 NTU (10) number of fecal coliform organisms $\leq$ 2.2/100 mL (11) (12)	pH - weekly BOD - weekly Turbidity - continuous Coliform (16) -

Outside Fire Protection - Street Cleanings AGRICULTURAL - Aquaculture - Food Crops Eaten Raw - Orchards and Vineyards - Pasture (no lag time for animal grazing) - Frost Protection (17), Crop Cooling and Chemical Spraying on crops eaten raw - Seed Crops RECREATIONAL (18) - Stream Augmentation - Impoundments for Boating and Fishing - Snow Making for Skiing and Snowboarding	(2)	General (13) (14) (15)	daily
RESTRICTED PUBLIC ACCESS			
AGRICULTURAL - Commercially processed food crops (19) - Fodder, Fibre - Pasture (20) - Silviculture - Nurseries - Sod Farms - Spring Frost Protection (17) - Chemical Spray - Trickle/Drip Irrigation of Orchards and Vineyards URBAN/RECREATIONAL (18) - Landscape Impoundments - Landscape Waterfalls - Snow Making not for Skiing and Snowboarding CONSTRUCTION - Soil Compaction - Dust Control - Aggregate Washing - Making Concrete - Equipment Washdown INDUSTRIAL (24) - Cooling Towers - Process Water - Stack Scrubbing - Boiler Feed ENVIRONMENTAL (18) - Wetlands (25)	Secondary (7) Disinfection (9)	pH = 6 - 9 $\leq$ 45 mg/L BOD_5 $\leq$ 45 mg/L TSS (26) number of fecal coliform organisms $\leq$ 200/100 mL (11)(21)(22) General (14)(23)	pH - weekly BOD - weekly TSS - daily Coliform - weekly

Numeric values in parentheses refer to numbered explanations in the explanatory notes, Appendix 1 to Schedule 2

$\leq$ means less than or equal to $\geq$ means greater than or equal to > means greater than

Appendix 1 to Schedule 2
Explanatory Notes

1 The type of reclaimed water use permitted must be one of those indicated on this Schedule. Other proposed types of reclaimed water use will be assessed by the director on an individual basis and must, in consultation with the Ministry of Health Services, be approved in writing by the director.

2 Reliability must be provided for all treatment processes as set out in Schedule 7. For the unrestricted public access category, emergency storage must satisfy the requirements of section 10 of this regulation.

3 Effluent quality limits must be calculated as running mean values and apply to the reclaimed water at the point of discharge from the treatment facility or, if storage is provided, at the point of distribution or use.

4 Sixty day storage after secondary treatment is acceptable in lieu of filtration provided the final effluent quality requirements are met and the discharger demonstrates to the satisfaction of a director that no short circuiting is occurring or likely to occur and that no viruses at levels of concern to local health authorities are detected in the reclaimed water.

5 Subject to Note 1 Appendix 1 to Schedule 6, these requirements take precedence over the requirements of Schedule 6.

6 Remote areas of parks, school grounds during vacation periods, and golf courses may be considered under the restricted public access category, provided: a minimum of 60 days storage is provided; the discharger demonstrates to the satisfaction of a director that access is controlled, that environmental concerns are addressed and that any concerns of the local health authorities are resolved; and, the director, in consultation with the local health authorities, approves the use in writing.

7 Secondary treatment as defined by section 1 of this regulation.

8 Chemical addition includes coagulant or polymer prior to filtration. Use is restricted to those coagulants and polymers shown to be non-toxic.

9 For distribution of reclaimed water, the discharger must ensure that minimum total chlorine residual of 0.5 mg/L is maintained at the point of initial use. This requirement may be waived by a director, provided the discharger demonstrates, to the satisfaction of the director and local health authorities, that fecal coliforms remain below levels prescribed by this Schedule at the point of use and that the users are adequately informed regarding appropriate use of the reclaimed water.

10 Turbidity limit must be met prior to disinfection. The average turbidity must be based on a 24-hour time period. The turbidity must not exceed 5 NTU at any time. If TSS is used in lieu of turbidity, the average TSS must not exceed 5 mg/L.

11 The median value, as determined from the bacteriological results of the last 7 samples for which analyses have been completed, must not exceed the coliform limits specified.

12 For unrestricted public access use, the number of fecal coliform organisms must not exceed 14/100 mL in any sample.

13 The reclaimed water provider must demonstrate that reclaimed water does not contain pathogens or parasites at levels which are a concern to local health authorities. Reclaimed water must be clean, odourless, non-irritating to skin and eyes and must contain no substances that are toxic on ingestion.

14 Where available agricultural (crop) limits must govern criteria for metals. High nutrient levels may adversely affect some crops during certain growth stages. Crop limits and season must govern nutrient application.

15 The reclaimed water provider must obtain monitoring results, and confirm that water quality requirements are met, prior to distribution.

16 Based on an initial 60 days of compliance with the quality limit, the discharger must conduct weekly presence or absence testing for coliform monitoring. If presence of any coliform is detected daily fecal coliform testing must be reinstated until the quality limit is in compliance.

Fourteen tests must be conducted to demonstrate that the discharge is back in compliance and then weekly presence/absence testing must be resumed.

17 Discharger must consult with the Ministry of Agriculture, Food and Fisheries regarding the difference between spraying for frost protection and spring frost protection techniques.

18 If chlorine is used as a disinfectant then dechlorination is necessary to protect aquatic species of flora and fauna. The use of alternative disinfection methods is recommended. Possible effects on groundwater must be evaluated. Receiving water quality requirements may necessitate additional treatment. The temperature of the reclaimed water must not adversely affect the ecosystem. Nutrient removal may be necessary to limit algae growth in impoundments.

19 Commercially processed food crops are those that, prior to sale to the public or others, have undergone chemical or physical processing such as, but not limited to, canning, heat treatment, fermentation and pickling, sufficient to destroy pathogens.

20 Milking animals must be prohibited from grazing for 6 days after irrigation ceases. Other cattle must be prohibited from grazing for 3 days after irrigation ceases unless the meat is inspected under the Federal Meat Inspection Program.

21 For restricted public access use, the number of fecal coliform organisms must not exceed 800/100 mL in any sample.

22 Worker contact with reclaimed water must be minimized. A higher level of disinfection to achieve the number of fecal coliform organisms < 14/100 mL must be provided where frequent worker contact with reclaimed water is likely.

23 Setback distance to potable water well must be > 30 m. A provider of reclaimed water must ensure that windblown spray will not exceed the boundaries of the property to which the reclaimed water is being applied and that windblown spray must not reach areas accessible to the public.

24 A provider of reclaimed water must consult specific industry's recommended water quality limits for make-up water.

25 Notwithstanding note 21, for wetlands where no diving, swimming, or wading activities occur, the number of fecal coliform organisms must not exceed 1 000/100 mL as determined in accordance with note 11 to this Appendix and the number of fecal coliform organisms must not exceed 4 000/100 mL in any sample.

26 For lagoon systems, the maximum TSS level must not exceed 60 mg/L.

Schedule 7
[am. B.C. Regs. 321/2004, s. 31 (ll) and (mm); 132/2006, s. 4.]
Design Standards for Sewage Facilities
(Condition 11 in Schedule 1)

1 General

(1) Environmental impact studies must be undertaken for facility siting, as set out in condition 8 of Schedule 1.

(2) The discharger must demonstrate to the satisfaction of a director that any proposed alternative measures:

(a) meet or exceed the requirements of this Schedule;
(b) do not adversely affect the performance of the sewage facility;
(c) do not adversely affect the receiving environment.

(3) Based on any information related to the discharge or the receiving environment, or both, a director may require additional or alternative measures to protect the environment.

2 Treatment Facilities

(1) Treatment facilities must be designed to achieve the applicable effluent quality standards in Schedules 2 to 5 at all times.

(2) Design criteria must ensure that average effluent values are substantially better than the maximum limits specified such that the maximum limits are met at all times.

(3) The design must consider the operation certification level of staff and the availability of professional or specialist advice.

(4) Duplicate or standby facilities are required as described in Appendix 1 to Schedule 7.

(5) Reliability categories must be determined based on the environmental impact study results.

(6) Reliability categories are defined as follows:

(a) Category I - Treatment works for reclaimed water or that discharge to waters or land that could be permanently or unacceptably damaged by effluent that is degraded in quality for even a few hours (for example, discharges near drinking water sources, shellfish waters or waters used for contact sports where "shellfish waters" means water bodies that have or could have sufficient shellfish quantities that recreational or

commercial harvesting would take place or water for which commercial shellfish leases have been issued);
(b) Category II - Treatment works that discharge to waters or land that would not be permanently or unacceptably damaged by short term effluent degradation, but would be damaged by continued (several days) effluent quality degradation (for example discharges to recreational land and waters);
(c) Category III - Treatment works not otherwise designated as Category I or II.

(7) Biosolids or sludge must not be discharged into outfalls.

(8) Disinfectants must be completely mixed with effluent before entering the contact tanks.

(9) Septic tanks must have a hydraulic capacity of at least 2 day minimum detention time at maximum daily flow.

3 Pumping Facilities

(1) A minimum of 2 pumps are required with each pump capable of pumping peak design flows.

(2) For larger pumping stations where multiple pumps are required, the station must have sufficient capacity to pump peak design flow with the largest pump out of service.

(3) Standby power is required as follows:
(a) for a 2 pump station, a receptacle for a portable generator;
(b) for a multiple pump station, an on-site generator.

(4) Provision must be made so that standby power is activated prior to the hydraulic capacity of the pump station being exceeded.

4 Outfalls

(1) Outfall analysis and design must be carried out by a qualified professional.

(2) Outfall design must be according to initial dilution zone specifications (section 5 of this regulation) and incorporate the following minimum standards:
(a) an outfall diffuser must be designed and located
(i) at a sufficient depth to maximize the frequency that trapping of the effluent below the surface of the water body occurs,
(ii) to ensure that the discharge does not cause water quality parameters, outside the initial dilution zone, to exceed known water quality guidelines,

(iii) to intercept the predominant current and avoid small currents that tend to move in toward the shore, and
(iv) in the channel in which most of the water of the river or stream flows to achieve maximum dilution;

(b) an outfall to marine waters, estuaries, or lakes with a surface area greater than 100 ha, must meet the depth, flow and distance standards set out in Appendix 2 to Schedule 7;
(c) subject to the requirements of Schedule 5, the minimum depth below mean low water for any outfall located in marine waters, or lakes with a surface area greater than 100 ha, is 10 m;
(d) a diffuser section that will provide a minimum 10:1 dilution within the initial dilution zone;
(e) the prevention of air entrapment;
(f) protection from wave, boat and marine activity;
(g) adequate weighting to prevent movement from currents, ice or possible entrainment of air;
(h) corrosion protection;
(i) protection from damage during construction.

5 Discharges into Ground

(1) Design must be carried out by qualified professional.

(2) The following standards must apply to exfiltration and rapid infiltration basins:
(a) at least 2 basins must be provided, to allow cleaning of one basin to proceed while the other is in operation, and to act as a safety factor for unusual conditions;
(b) for 2 basin systems, each basin must be capable of accepting all the effluent under annual average rainfall conditions;
(c) setbacks as specified in subsection (3) (h) must be provided.

(3) If disposal is by sub-surface means, the following standards must apply:
(a) the land area must be sufficient to permit application rates as shown in Schedule 4;
(b) percolation rates must be determined by a qualified professional acting within the qualified professional's area of expertise;
(c) examination by a qualified professional is required and if percolation time is greater than 20 minutes, the bed hydraulics must be confirmed by a hydrogeological assessment;
(d) sub-surface fields and a surrounding buffer strip at least as wide as the distance prescribed by Row 2 of the Table H must be kept free of building or hard surfacing of any kind and must not be put to uses which may cause damage to the system or interfere with its operation;

(e) septic tanks have a screen or filter and must be accessible for pumpout, inspected annually and must be pumped out a minimum of once every 3 years or at a frequency sufficient to ensure that sludge accumulation does not exceed 20% of the tank depth. Records of pumpout frequency must be submitted to a director with the annual report;
(f) a pressure distribution system must be used for drainage pipes fed by a dosing syphon or pump;
(g) the drainage pipes must be provided in 2 fields with a third undeveloped field being retained as a standby area. Drainfields must be constructed with trenches on 3 m on-centre spacing. If a qualified professional determines that the performance of the drainfield is not adversely altered by varying the spacing a minimum spacing of 2 m is permissible. In the case where less than 3 m on-centre spacing is used, the standby area must be doubled. Except if reductions in length are allowed, each of the 2 developed fields is to have at least the length of drainage pipe indicated in Table 4 of Schedule 4;
(h) drainfields setback requirements in addition to those specified in Schedule 4:

Table H — Minimum Setback Requirements

	Feature	Minimum Setback Distance	
		Maximum Daily Flow	
		$<37\ m^3/d$	$\geq 37\ m^3/d$
Row 1	property boundary	3 m	6 m
Row 2	building drain(*)	5 m	10 m
Row 3	Christina Lake	**	**
Row 4	surface water	30 m	30 m
Row 5	surface water within Okanagan basin	30 m	150 m
Row 6	water well	60 m	90 m
Row 7	water well within an unconfined aquifer	60 m(***)	300 m(****)

(*) The sewage treatment facility itself is to be considered as a building;

(**) As determined by adherence to Christina Lake Official Community Plan;

(***) Based on a hydrogeological assessment to determine the minimum distance required to protect water quality of the water well distance from water well must be extended accordingly;

(****) Based on a hydrogeological assessment conducted by the discharger to determine the minimum distance required to protect water quality of the water well, the distance from the water well may be reduced or extended as required by a director. In no case shall the distance be less than 90 m;

(i) subsurface visual inspection capability must be provided;
(j) trenches must be a minimum of 0.6 m in width. Trench bottoms must be at least 0.3 m below the pipe invert. Pipe cover must meet local frost protection requirements but must not be less than 0.15 m. The drainage pipe must be no less than 70 mm in diameter, unless a pressure distribution system is utilized;

(k) seepage beds or mounds must be constructed using AMERICAN SOCIETY OF TESTING MATERIALS C33 sand and must receive written approval from a director.

(4) If required, monitoring wells must be installed as determined by a qualified professional in sufficient number and orientation to measure background and receiving environment water quality. Horizontal as well as vertical arrays for sampling must be considered. At least 3 wells per aquifer are necessary and at least one background monitoring well is required.

6 Reclaimed Water Application

(1) Subject to note 1 to Appendix 1 to Schedule 2, the type of reclaimed water use must be one of those indicated in Schedule 2.

(2) The provider of reclaimed water must ensure that the design ensures that the Health and Safety Criteria for use of reclaimed water as set out in Appendix 3 to Schedule 7 are met.

(3) If application of reclaimed water is by irrigation, the following standards must apply:

(a) if application of reclaimed water is not continuous, seasonal storage or an alternative method of disposal that complies with the standards set out in Schedules 3 and 4 is required;

(b) storage ponds must be provided to contain the design average daily effluent flow occurring outside the growing season, plus an allowance from an analysis of the cumulative volumes needed for a reduced irrigation season due to at least 5 years of wet weather equivalent to rainfall or snowmelt events with a 5-year return period. Average rain, seepage and evaporation conditions must be accounted for in the design;

(c) the design area to be used for reclaimed water application must be sufficient so that effluent discharge will not be necessary under the following conditions:

(i) outside the growing season;

(ii) for restricted public access category

(A) during and for 3 days prior to harvesting of crops;

(B) during and for 6 days prior to grazing by dairy cattle;

(C) during and for 3 days prior to pasturing by livestock other than dairy cattle unless the meat is inspected under the Federal Meat Inspection Program;

(d) the restricted public access reclaimed water must be confined to the area designated and approved for use by a director;

(e) maximum ground surface slope must not exceed 20%, unless greater slopes are approved in writing by a director.

(4) For reclaimed water meeting the unrestricted public access category, the constructed drain field length, as specified in Table 4 to Schedule 4, can be reduced provided the requirements set out in condition 8 of Schedule 1 are met. If design flows have been applied for a period of 5 years without hydraulic problems, a director may, subject to recommendation by a suitably qualified professional, allow the area of the fields to be reduced.

Appendix 1 to Schedule 7
Equipment and Process Reliability Category for Treatment Facilities

Component	Reliability Category					
	I		II		III	
	Treatment System	Power Source	Treatment System	Power Source	Treatment System	Power Source
Holding basin	Adequate capacity for all flows		Not applicable		Not applicable	
Degritting		Optional		No		No
Primary sedimentation	Multiple units[a]	Yes	Same as category I	Yes	Two minimum[a]	Yes
Trickling filters	Multiple units[b]	Yes	Same as category I	Optional	No backup	No
Aeration basins	Multiple units[b]	Yes	Same as category I	Optional	Single unit permissible	No
Blowers or mechanical aerators	Multiple units[c]	Yes	Same as category I	Optional	Two minimum[c]	No
Diffusers	Multiple sections[d]		Same as category I		Same as category I	
Final sedimentation	Multiple units[b]	Yes	Multiple units[a]	Optional	Two minimum[a]	No
Chemical flash mixer	Two minimum or backup[e]	Optional	No backup	Optional	Same as category II	No
Chemical sedimentation	Multiple units[b]	Optional	No backup	Optional	Same as category II	No
Flocculation	Two minimum[a]	Optional	No backup	Optional	Same as category II	No
Effluent filters	Two minimum[b]	Yes	Same as category 1	Yes	Same as category I	Yes
Disinfection basins	Multiple units[b]	Yes	Multiple units[a]	Yes	Same as category II	No
Aerobic digesters	Two minimum[a]	Yes	Same as category 1	Optional	Single Unit	No
Anaerobic digesters	Two minimum[a]	Yes	Same as category 1	Optional	Two Minimum	No
Facultative lagoons	Two cells[b]		Two cells		Two cells	
Aerated lagoons	Two cells[b]	Yes	Two cells	Optional	Two cells	No

Package treatment plants	Multiple units[b,f] or ability to repair within 48 hours	Yes	Two units or ability to repair single unit within 48 hours	Yes	Single unit may be permissible	No

a Remaining capacity with largest unit out of service must be for at least 50% of the design maximum flow.
b Remaining capacity with largest unit out of service must be for at least 75% of the design maximum flow.
c Remaining capacity with largest unit out of service must be able to achieve design maximum oxygen transfer; backup unit need not be installed.
d Maximum oxygen transfer capability must not be measurably impaired with largest section out of service.
e If only one basin, backup system must be provided with at least 2 mixing devices (one may be installed).
f Effluent filtration is required in conjunction with ground disposal.

Appendix 2 to Schedule 7
Outfall Depth, Flow and Distance Calculations for Marine, Estuary and Lake Discharges

1 For discharges less than 5000 m3/d,

(a) Qc must be greater than or equal to Qa, where:

Q_a = the maximum daily flow (m^3/d),

Q_c = the calculated critical flow (m^3/d) and is calculated as described below,

D = depth (m) of the shallowest diffuser port below mean low water and must be equal to or greater than 10 m, and

d = distance (m) to the closest port of the diffuser from the mean low water mark and must be equal to or greater than 30 m

and

(b) Qc must be the greater positive value of Qc1 or Qc2, where:

Q_{c1} = (D+0.075d-21) / 0.0029

and

Q_{c2} = (D+0.075d-12.225) / 0.025

2 For outfalls with a diffuser, the terminus, for the purposes of the calculation in note 1, must be considered as the closest and shallowest port.

3 For discharges greater than 5000 m^3/d, depth and distance to be determined by environmental impact study and computer modeling of the discharge.

Appendix 3 to Schedule 7
Health and Safety Criteria for use of Reclaimed Water

1 Construction Criteria

(1) All reclaimed water valves, outlets, quick couplers and sprinkler heads must be of a type or secured in a manner that only permits operation by personnel authorized by the user. All piping, valves and outlets must be marked to differentiate reclaimed water from domestic water. All reclaimed water controllers, valves, etc., must be affixed with reclaimed water warning signs. All piping must be of a distinct colour to differentiate reclaimed water from domestic water.

(2) Use or installation of hose-bibbs on any irrigation system presently operating, or designed to operate with reclaimed water, regardless of the hose-bibb construction or identification, is not permitted unless it can be demonstrated to a director that special circumstances justify their use.

(3) There must be at least a 3 metre horizontal and a 0.3 metre vertical separation (with domestic water above the reclaimed water pipeline) between all pipelines transporting reclaimed water and those transporting domestic water.

(4) There must be no irrigation or impoundment of reclaimed water within 30 metres of any water well or in-ground reservoir used for domestic supply unless it can be demonstrated to a director that special circumstances justify lesser distances to be acceptable.

(5) There must be no connection between a potable water supply, irrigation water or industrial wells and piping containing reclaimed water, except through an air gap separation or reduced pressure principle device.

(6) Impoundments must have perimeter signs indicating that the reclaimed water stored is not safe for drinking (e.g. ATTENTION: RECLAIMED WASTEWATER - DO NOT DRINK, Bliss symbols should be used).

(7) Impoundments must be designed, operated and maintained to minimize fluid leakage. Any leakage must not aggravate or produce soil or bedrock instability or erosion elsewhere or impact ground or surface water quality.

(8) The perimeter of the disposal area must be graded to prevent ponding along public roads or other public areas.

(9) For the restricted public access category of reclaimed water, fencing or other barriers must be installed, where needed, to restrict public access.

(10) At areas irrigated with reclaimed water, warning signs must be posted in sufficient numbers and size and at strategic locations to advise the public that reclaimed water is being used and is not safe for drinking purposes and for the restricted public use category for personal contact as well (e.g., Warning -RECLAIMED WATER - AVOID CONTACT - DO NOT DRINK; Bliss symbols, and the "Mr. Yuck" symbol).

2 Operation Criteria

(1) Restricted public access reclaimed water must be confined to the area designated and approved for use (e.g., windblown spray must be prevented from leaving the property). For use of reclaimed water on parks, playgrounds and school grounds the reclaimed water provider must ensure that no direct contact between the reclaimed water and any person occurs while irrigation is occurring.

(2) Precautions must be taken to ensure that reclaimed water will not have contact with any facility or area not designated for use, such as passing vehicles, buildings, domestic water facilities or food handling facilities.

(3) Drinking water facilities must be protected from direct or windblown reclaimed water spray.

(4) Tank trucks and other equipment which are used to distribute reclaimed water must be clearly identified with warning signs.

(5) Adequate measures must be taken to prevent the breeding of insects and other vectors of health significance, and the creation of odors, slimes or unsightly deposits.

(6) Golf score cards and signage posted at visible locations must indicate that reclaimed water is used.

(7) Irrigation with reclaimed water must not occur within 60 m of areas where food is handled or consumed.

(8) Irrigation must be controlled to prevent ponding and run-off of reclaimed water.

(9) Direct public contact with reclaimed water must be minimized.

(10) A contingency plan including provisions for notification of local health authorities, must be developed outlining the action to be taken in the event effluent quality fails to meet required standards and which identifies alternative methods of disposal during a series of wet years.

3 Notification

(1) The provider of reclaimed water must provide, on request, to a director and to local health authorities reports containing information on:

(a) the quality and quantity of reclaimed water;

(b) the use (method of irrigation and the crop(s) and area(s) irrigated);

(c) the reason for non-compliance with these health criteria, if appropriate, and corrective action taken.

Appendix B

Correspondence with Provincial and Local Governments

APPENDIX B – Correspondence with Provincial and Local Governments

Overview

Municipality/ Regional District	Name and Title of Contact	Email and/or Phone
Interior Health	Mike Adams Senior Drinking Water Officer Okanagan Service Area	mike.adams@interiorhealth.ca 250-549-6348
Ministry of Environment	Neale Waters Environmental Protection Officer Mike Reiner Senior Environmental Protection Officer	Neale.Waters@gov.bc.ca 250-371-6239 Mike.Reiner@gov.bc.ca 250-490-8206
Central Okanagan RD	Michael Noga Engineering Technologist II	michael.noga@cord.bc.ca 250-469-6256
South Okanagan RD	Patrick M. Hickerson Public Works Manager Andrew Reeder Engineering Services Manager	phickerson@rdos.bc.ca 250 490-4103 areeder@rdos.bc.ca 250 490-4142
Osoyoos	Steve Shannon Assistant Planner	sshannon@osoyoos.ca 250-250-495-4608
Oliver	Bruce Hamilton Director of Operations	bhamilton@oliver.ca 250-485-6211
Kelowna	Victoria (last name and title unknown)	250-469-8626
Lake Country	Deb Youngest Customer Service, Engineering	250-766-5650
Vernon	Andrew Marr Manager of Water Reclamation Services	vwrc@vernon.ca 250-550-3627

Interior Health

From: Adams, Mike [mailto:Mike.Adams@interiorhealth.ca]
Sent: Tuesday, December 09, 2008 3:15 PM
To: Kellie Bunting
Subject: RE: Health Acts and Regulations related to reuse of treated winery wastewater

Hi Kellie,
To your questions:

- You are correct, MOE stick handles commercial/industrial waste under the Municipal Sewage Reg., we're strictly domestic sewage and our legislation doesn't allow for surface discharge of domestic sewage (grey water would be considered sewage). If the winery wastewater has strictly domestic components to it (i.e. sinks, showers, etc.) MOE may direct you back to the Health Authority and our legislation would apply.
- The other side of this is possibly food and water supply. If the winery has a food establishment, or tasting/serving area for the public associated with it, the Food Premises Reg. applies including the submission for plans prior to construction. Another requirement for the food establishment is a potable source of drinking water. If the winery had an individual source of water versus being connected to an existing community supply, the full requirements of the DWPA would then also apply. If the winery intended to re-use

wastewater, our interests would include ensuring sufficient cross connection control is in place between the potable water supply and the non potable wastewater. A whole new meaning to recycling/reuse...

Mike Adams, Senior Drinking Water Officer
Okanagan Service Area
Interior Health
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Web: interiorhealth.ca

Ministry of Environment

Telephone conversation November 24, 2008
Between Kellie Bunting and Neale Waters, Environmental Protection Officer, Ministry of Environment, Kamloops (Front Counter BC referral)

- Would not require an Operational Certificate under the *Environmental Management Act*
- Unsure if the Municipal Sewage Regulation would apply because it is not municipal sewage
- Unsure of what Acts and Regulations would apply – no wineries have applied to use reclaimed water
- Contact Mike Reiner at Penticton MOE office – he may have more knowledge because wineries in his area

(Note: Contacted Mike Reiner on November 24 but he is out of the office for a few weeks)

Town of Osoyoos

From: Steve Shannon [mailto:sshannon@osoyoos.ca]
Sent: Thursday, November 20, 2008 3:04 PM
To: 'Kellie Bunting'
Subject: RE: Bylaws related to reuse of treated winery wastewater

Kellie
We have no Bylaws that regulate the reuse of wastewater from wineries; however, we often have developers collect and reuse stormwater for irrigation purposes. They would have to deal with me if they needed subdivision approval or approval of a development permit or rezoning etc. In a case like you have described, I would send their application to our engineering consultant, True Consulting, as a referral, and request comments and recommendations.
I hope this helps.
Steve Shannon, Assistant Planner
Town of Osoyoos
Tele: 250-495-4608
Fax: 250-495-0407

Town of Oliver

From: Bruce Hamilton [mailto:bhamilton@oliver.ca]
Sent: Friday, November 21, 2008 1:13 PM
To: kbunting@insightenv.ca
Cc: Stephanie Johnson; Tom Szalay; Shawn Goodsell; Arvid Bensler; Dave Janzen; Jo Martin
Subject: FW: Bylaws related to reuse of treated winery wastewater

Hi Kellie:
Currently we only have one winery inside our municipal boundaries however, there are many others located in our surrounding rural area. For the most part, the wineries in our rural area are outside our jurisdiction although we do operate an extensive water utility in the rural area and we supply both domestic and irrigation water to many of them. Our main concern would be to ensure that any potential cross connections between the wineries reclaimed water supply and the municipal water supply be properly protected with a back flow preventer. We would want to make sure that there is no possibility of a back flow into one of our water systems. For this purpose the winery would deal either with our Public Works Department or our Building Inspector. We would also hope that their water reuse would meet all MOE and IHA requirements.

Regards
Bruce

Bruce Hamilton, Director of Operations
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Wine Capital of Canada
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Visit our website at: www.oliver.ca

Regional District of Central Okanagan

From: Michael Noga [mailto:michael.noga@cord.bc.ca]
Sent: Friday, November 21, 2008 8:38 AM
To: kbunting@insightenv.ca
Subject: FW: Bylaws related to reuse of treated winery wastewater?

Kellie,
There has to be an application for approval through Ministry of Environment for any waste application to land.

Effluent irrigation isn't that uncommon but it is regulated. Most of the wineries in the service area are hooked up to our sanitary sewer collection system, Mission Hill being the biggest, but the effluent quality has been a constant issue.
One would need to contact the Ministry regarding land application of reused water.

Regards,
Michael Noga, AScT

From: Michael Noga [mailto:michael.noga@cord.bc.ca]
Sent: Friday, November 21, 2008 9:42 AM
To: Kellie Bunting
Cc: Dan Plamondon; Janelle Taylor
Subject: RE: Bylaws related to reuse of treated winery wastewater?

Servicing requirements are triggered at either subdivision or application for building permit (development) and services are required to be constructed and installed in accordance with the Subdivision and Development Servicing Bylaw No. 704. The type and extent of servicing required to be constructed and installed prior to obtaining final approval for a plan of subdivision or development is based on either the parcel zone or land use designation (LUD).

Where the provisions of Bylaw 704 Schedule C.2.2 require the construction of a community sewer system, the Applicant must provide sanitary sewer facilities including gravity sewer mains, pump stations, force mains, manholes, service connections, and all related appurtenances in accordance with the standards and specification set out in Bylaw 704. The Sewer System Regulations are identified in the Sewer Systems Bylaw 1171 which establishes the regulations under which sanitary sewer will be provided (copy attached for your convenience).
Non-residential connection to the sewer system may require among other things, volume control or pre-treatment (as identified in Bylaw 1171) in order to meet the Sewer System Regulations.

If pre-treatment is required for example, Bylaw 1171 S. 5.17 would apply as follows:
5.17 Pre-treatment
Where wastewater, or any component of the wastewater:
a) does not meet the provisions of this bylaw;
b) may damage or increase maintenance costs on the sanitary sewer system; or
c) may detrimentally affect the operation of the sewage treatment plant.

The Owner must retain an engineer to submit a proposal which outlines the method of pre-treatment proposed in order for the wastewater to conform to the provisions of this bylaw. In support of the proposal, the engineer must submit the following information to the District:
i) detailed design of the proposed pre-treatment facility,

ii) detailed list of the wastewater components and the anticipated concentration of each component before and after treatment,
iii) detailed sampling and analysis schedule required to ensure the concentration of the wastewater components remain in compliance to the provisions of this bylaw,
iv) detailed operation and maintenance procedures.

No construction shall take place on the pre-treatment facility until such time as the District Engineer has reviewed the above information and approved construction. Approval to construct the pre-treatment facility by the District Engineer does not imply that the quality of the wastewater discharged after pre-treatment will meet the requirements of this bylaw. It is the Owner's responsibility to ensure that all the components of the wastewater will comply with the provisions of the bylaw after the pre-treatment process is completed.

The design, construction, operation, and maintenance of the pre-treatment facilities shall be the responsibility of the Owner and at the Owner's expense. The Owner shall maintain written records of all cleaning, repair, calibration, maintenance, sampling, and analysis and shall store said records at the facility for a minimum of three (3) years. The Owner shall make these records available for examination by the Regional District Engineer at all reasonable times.

Pls. contact us if you have any further questions or concerns.

Regards,
Michael Noga, AScT
Engineering Technologist II
Regional District of Central Okanagan
Development & Environmental Services
250-469-6256
250-762-7011
*www.regionaldistrict.com

District of Lake Country

Telephone conversation November 21, 2008
Between Kellie Bunting and Deb Youngest, Customer Service, Engineering Department

- No ability to treat wastewater from wineries
- Sewer Regulation and Rates bylaw would apply if pre-treated sewage was discharged to municipal sewage system
- Unsure of where Arrow Leaf and Gray Monk wastewater is discharged

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City of Vernon

Telephone conversation November 20, 2008

Between Kellie Bunting and Andrew Marr, Manager of Water Reclamation Services

- Okanagan Springs brewery discharges to system, very high BOD
- Amendment to Fees and Charges Bylaw enables "Surcharge for High Strength Wastes discharged to the City of Vernon sanitary system"
- Trying to encourage the pre-treatment of wastewater before discharge into municipal system
- Calona Wines and Sun-Rype both pre-treat wastewater before discharging into Kelowna municipal system
- All wineries in California pre-treat because so expensive to pay high-strength surcharge
- City of Vernon uses reclaimed water under a Operating Certificate through Ministry of Environment
- Operating Certificate specifies BOD and TSS levels
- Wastewater is discharged to McKay reservoir, left over winter, and then pumped out into irrigation – no discharges to receiving waters (lake or outfall)

City of Kelowna

Telephone conversation November 21, 2008

Between Jose Garcia and Victoria, City of Kelowna

- No restrictions unless the reuse affects utilities (i.e., wastewater is discharged into municipal system)
- Ministry of Environment would be the one to contact

Regional District Okanagan-Similkameen

From: Jillian Tamblyn [mailto:jtamblyn@rdos.bc.ca]
Sent: Thursday, November 20, 2008 3:27 PM
To: Kellie Bunting; Laura Walton; Andrew Reeder; Patrick Hickerson
Subject: Bylaws related to reuse of treated winery wastewater?

Can any of you assist Kellie Bunting with the request below? My guess is that we don't have anything and this would be a provincial or federal issue. I do know that Ag Can out of Summerland was doing research on reusing water on crops. I also know that there were issues with the solids etc and septics with the wine processing water.

Jillian Tamblyn
Environmental Coordinator
Regional District Okanagan Similkameen