# National Wastewater Source Management Guideline

July 2008

WATER SERVICES ASSOCIATION OF AUSTRALIA

## The Water Services Association of Australia

The Water Services Association of Australia (WSAA) is the peak body of the Australian urban water industry. Its 30 members and 31 associate members provide water and wastewater services to approximately 16 million Australians and to many of our largest industrial and commercial enterprises. WSAA membership also includes two members and one associate member from New Zealand.

Urban water service providers have a critical role in ensuring that Australians have access to adequate and high quality water services. As Australia's population continues to grow, with most of this growth occurring in cities, that role becomes increasingly important.

WSAA's vision is for Australian urban water utilities to be valued as leaders in the innovative, sustainable and cost effective delivery of water services. WSAA strives to achieve this vision by promoting knowledge sharing, networking and cooperation amongst members. WSAA identifies emerging issues and develops industry-wide responses. WSAA is the national voice of the urban water industry, speaking to government, the broader water sector and the Australian community.

## WSAA Wastewater Source Management Network Strategic Advisory Group

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# Foreword

The wastewater systems that provide vital sanitation services to our cities can be considered common pool resources such as air and water. Control is often problematic as individuals feel free to discharge whatever they like to a common pool resource where they do not confront the full marginal cost of their actions. This is why water and air pollution problems are often so insidious to control.

We all know from The Tragedy of the Commons doctrine developed in the 1970's that common pool resources such as air and water will be exploited and degraded if rules applying to discharges are not put in place.

The source control guidelines set the rules which will prevent the wastewater systems in our cities becoming subject to inappropriate discharges.

The guidelines have been developed taking into account the contemporary challenges facing the urban water industry. Traditionally, guidelines covering discharges to wastewater systems concentrated solely on discharges from industrial and commercial premises. Hence, they were commonly referred to as Tradewaste Guidelines.

Now, we understand that the input of substances to the wastewater system from household sources can also be significant. Although, the loads from individual properties may only be tiny, but when multiplied by the millions of households in Australia's largest cities these loads can become significant.

The guidelines also recognise that the water in our wastewater systems can now be source water for advanced water treatment plants to turn into recycled water for a variety of uses which can include being blended with drinking water supplies. Under the principles of the Australian Drinking Water Guidelines the principle of a multi barrier approach is strongly advocated. In this sense, appropriate source control guidelines for industry and households become the first barrier to entry to mitigate risks associated with our drinking water systems.

I am proud that the urban water industry has developed a modern and contemporary set of guidelines to address the risks associated with inputs into our wastewater systems. Managing water resources is much about managing risks and these guidelines put in place a robust risk management framework to protect the integrity of our wastewater systems.

I commend these guidelines to the broader water industry and congratulate the industry Strategic Advisory Committee who worked so diligently and tirelessly to develop these guidelines with many other competing demands on their time.

*Ross Young*
*Executive Director, WSAA*

# Preamble

## WSAA Wastewater Source Management Network Strategic Advisory Group

It has now been nearly twenty years since most water authorities began to appreciate the benefits of managing wastewater inputs at the source. For most of us this awakening came from a series of crises that were either created by an errant trade waste discharger or by a significant change in the way we operated our sewerage system, or a combination of both.

These changes forced water authorities to take a more strategic approach to source management and the realisation that it was better to have formalised systems in place rather than trying to handle issues reactively. This resulted in initiatives such as domestic wastewater quality modelling, infiltration studies, household chemical collections and common law contracts with trade waste dischargers. However, there was very little discussion between water authorities on these matters. This resulted in utilities going through a similar discovery process with very little pooling of knowledge. In 1993 a group of five Trade Waste Managers received funding from the Australian and New Zealand Environment Conservation Council (ANZECC) to develop the first National Trade Waste Guideline and in 1994 the ANZECC Guideline was released.

When the Water Services Association of Australia (WSAA) coordinated the first Source Management Workshop for water authorities in 2005 it was acknowledged that the National Guidelines were in need of updating to reflect modern Waste Water Source Management rather than just Trade Waste. It was necessary to provide utilities with a mechanism to assist them to develop a strategic, process driven approach to source management that complemented water industry practice.

This Guideline is a result of that approach.

This Guideline has a strong emphasis on trade waste management. It is expected that further editions will expand on other areas of source management as knowledge and research increase. This Guideline has been written for staff from water authorities by staff from water authorities. The Strategic Advisory Group would like to acknowledge the contributions from member and associate members of WSAA. In addition we would like to thank Grant Leslie for his persistence in coordinating the publishing of this guideline.

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# Glossary

**BEARPIT** Best Available And Reasonable Pre-treatment Infrastructure Technology

**Biosolids** Organic solids derived from sewage treatment processes that are appropriate for reuse.

**BOD** Biological Oxygen Demand. A measure of the amount of oxygen consumed by micro-organisms in a given sample at a given temperature. It is determined by the amount of organic matter available as food for the organisms to consume.

**Cleaner Production** The integration of sustainability principles to processes, products and services to increase resource efficiency and reduce risks to humans and the environment. In the context of trade waste, Cleaner Production generally encompasses the top tiers of the waste hierarchy, namely avoidance, reduction and reuse within the boundaries of the facility generating the waste, but can also include utilisation of wastes from one industry to another.

**COD** Chemical Oxygen Demand. A measure of the amount of oxygen used in the chemical oxidation of carbonaceous organic matter in wastewater.

**Critical Control Point** A point, step or procedure at which controls can be applied to prevent, eliminate or reduce a hazard to acceptable levels.

**Dissolved oxygen** A relative measure of the amount of oxygen dissolved in a liquid medium.

**Domestic wastewater** Wastewater arising from a dwelling used for primarily domestic purposes. It does not contain trade waste.

**Drinking Water** Water that is intended, and of a quality that is suitable, for drinking. Within the water industry, water of this quality is also referred to as potable water.

**Electrical conductivity** A measure of a material's ability to conduct an electrical current. Usually measured in a solution in siemens per metre (S/m), μS/cm or $ohm^{-1}$ per metre (SI units).

**HACCP** Hazard Analysis and Critical Control Points. A systematic preventive approach to water quality assurance that addresses physical, chemical and biological hazards as a means of prevention.

**Hazardous Waste** A waste that is generated by a commercial, industrial or scientific process and is prescribed to be hazardous by, and required to be managed in accordance with, local legislation.

**Head space** Air space within the sewer.

**Henry's Law** A gas law that states that at a constant temperature, the amount of a given gas dissolved in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid.

**Infiltration** Flow of groundwater or stormwater to the sewer through cracks or gaps within the sewerage network.

**Inflow** Flow of stormwater to the sewer through a direct (including illegal) connection to the sewer.

**ISO** International organisation for establishing standards.

**pH** A measure of the hydrogen-ion concentration in a solution. On the pH scale of 0-14, a value of 7 represents a neutral condition; decreasing values below 7 indicate increasing hydrogen-ion concentration (acidity); and increasing values, above 7, indicate decreasing hydrogen-ion concentration (alkalinity).

**Quality Control Point** A point, step or procedure at which monitoring can be undertaken to determine the presence of a hazard or potential hazard.

**Sewage** Any waste containing human excreta or domestic wastewater. Sewage within a sewerage system may also contain trade waste.

**Sewer mining** Diversion and treatment of raw sewage for on-site purposes such as recycling.

**Tankered Wastes** Wastewater collected, transported and intended to be discharged at a sewage treatment plant or to sewer.

**Trade Waste** Wastewater which is prescribed to be trade waste, according to the criteria of a water utility, and is suitable for discharge into the water utility's sewerage system. Trade Waste includes (but may not be limited to) wastewater discharged from premises as a result of trade, industrial, commercial, medical, dental, veterinary, agricultural, horticultural or scientific research or experimental activities. Wastewater discharged from private residential premises is not trade waste.

**Turbidity** A condition in water or wastewater caused by the presence of suspended matter usually reported in nephelometric turbidity units (NTU) determined by measurements of light scattering.

**Waste Hierarchy** Lists options for the management of waste to drive resource efficiency, in the following order of preference:·
avoidance; ·
minimisation;·
re-use; ·
recycling; ·
recovery of energy; ·
treatment; ·
disposal.

**Wastewater** The used water of a community or industry, containing dissolved or suspended matter. It may or may not contain trade waste, domestic wastewater, groundwater, surface water or stormwater.

**Wastewater system** The wastewater system is defined as the collection, treatment and disposal of wastewater, including all sewers, pumping stations (including pressure mains), storage tanks, wastewater treatment plants (WWTPs), outfalls, treated wastewater and biosolids treatment and recycling / distribution facilities and other related structures operated by the Wastewater Authority (WWA), including its authorised agents responsible for the collection, treatment and disposal of wastewater.

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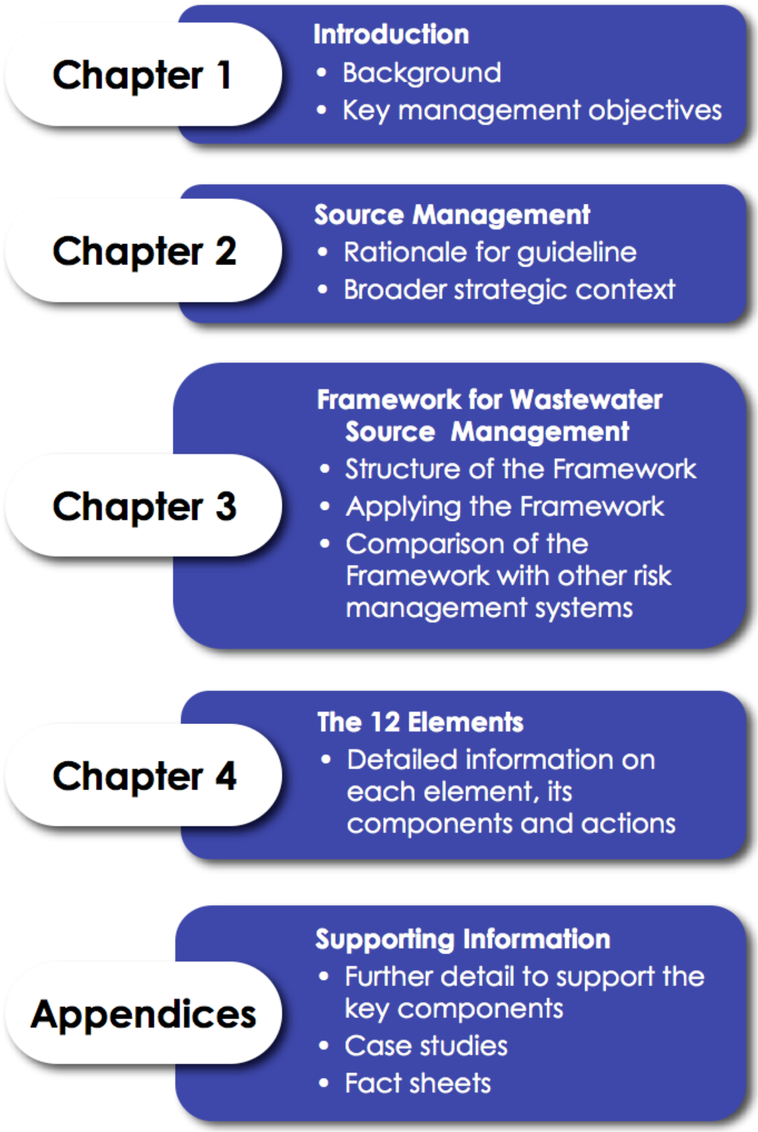
## Boxes

# Chapter 1. Introduction

## 1.1 Structure of this Document

This document is structured as shown in Figure 1.1:

Figure 1.1 Structure of this Wastewater Source Management Guideline.



## 1.2 Overview

This *Wastewater Source Management Guideline* (WSMG) provides a preventive risk management framework for managing risks to the wastewaster system and provides a process for establishing wastewater quality criteria relevant for wastewater collection, transfer, treatment, recycling and disposal.

This document acknowledges the guidelines produced by the Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management council of Australia and New Zealand '*Guidelines for sewerage systems – Acceptance of Trade Waste (Industrial Waste) November 1994*.

This guideline has been developed with specific reference to Australian conditions taking into account:

- The best available elements of existing wastewater source control, and particularly trade waste, management systems; and
- Scientific evidence.

The WSMG has been designed to provide an authoritative reference on what defines best practice in ensuring that the quality and quantities of source inputs to a wastewater system are effectively managed both individually and in aggregate to meet the broad objectives indicated in Section 1.3.

The WSMG is also intended to provide:

- Flexibility in its application recognising the varying circumstances and significance of wastewater impacts, including trade waste, on the wastewater systems of individual utilities; and
- Guidance on how best practice management can be achieved and how implementation of that management can be best assured.

The WSMG is not a mandatory framework and the values for particular substances are not mandatory standards. However the guideline does contain concentrations for substances with occupational health and safety based on an interpolation of mandatory workplace exposure standards. Overall, the WSMG provide a basis for determining the quality and quantities of source inputs to wastewater systems in all parts of Australia.

### Box 1.1 Benefits of implementing the WSMG

Implementing the WSMG will facilitate management of:

- The safety of workers and the public;
- Wastewater system assets;
- Treatment processes;
- Environmental licence and regulatory compliance; and
- Recycling of treated wastewater and biosolids.

### Box 1.2 Applying the WSMG

Implementation of the WSMG will need to encompass locally specific issues including:

- The type of utility;
- Geographical issues;
- Political and legislative environment;
- Economic issues;
- Customer service expectations and obligations; and
- Resourcing capabilities.

It is anticipated that the WSMG will evolve over time as further scientific evidence is gathered and new issues or substances emerge that require specific management, particularly in relation to the issues of source control from the domestic sector and inflow/ infiltration. Evolution of the WSMG will also involve strengthening and integration of the linkages with other risk management systems. Therefore, regular revision of the WSMG is anticipated.

To ensure consistency in approach across the water industry, the development of the WSMG has been harmonised with existing guidelines and frameworks including:

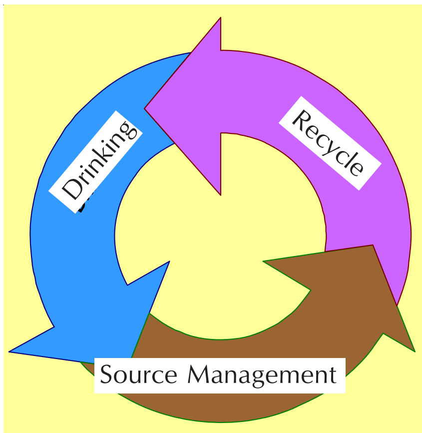
- 'Framework for the Management of Drinking Water Quality' within the Australian Drinking Water Guidelines (ADWG, 2004);
- Framework for Management of Recycled Water Quality and Use' within the Australian Guidelines for Water Recycling (AGWR, 2006; 2007).

## 1.3 Guiding Principles and Objectives

The WSMG is designed to meet five Key Wastewater Source Management Objectives through the management of inputs to the wastewater system that have the potential to impact on wastewater quality. The objectives are outlined in box 1-1.

The guidelines have, as an overarching principle, management of wastewater sources within an 'integrated water cycle management' context. This considers the impacts, opportunities for avoidance, reuse and recycling, and fates of substances in wastewater from an integrated and total water cycle perspective.

### Integrated Total Water Cycle Management




The objectives are defined as preventing, managing or influencing the introduction of substances that enter the wastewater system from trade waste premises, commercial premises, the environment, or households (you can't actively manage what comes in at the household, you can only influence it) or other sources (either individually or in aggregate or in terms of temporal variations) so as to achieve the objectives outlined in Box 1.3.

Box 1.3. The five Key Wastewater Source Management Objectives

**Objective 1 Safety of People**

– protect the safety of water authority personnel and the public, particularly:

- Wastewater system personnel who may be affected by trade waste substances in the wastewater or more generally the overall wastewater quality in the course of their work related to the wastewater system; and
- The general public from the impacts of wastewater system operation (e.g. from unacceptable odour emissions) by conforming to strict health and environmental standards.

**Objective 2 Protection of Assets (Pipes, Plant and Equipment)**

– protect wastewater system infrastructure (all components of it) to ensure that:

- The structural or hydraulic integrity of wastewater system infrastructure will not be adversely impacted (e.g. through unacceptable corrosion) or will not result in an unacceptable level of risk; or
- The achievement of the regulated or reasonable business service objectives for the wastewater system are not unacceptably compromised; or
- The operation of the wastewater system is not unreasonably compromised or interfered with; or
- More generally, the intended lives of all components of wastewater system infrastructure are not unreasonably downgraded.

**Objective 3 Protection of Treatment Processes**

– in particular to ensure that:

- Treatment plant processes are protected to ensure that the ability of the treatment plant processes (biological, physico-chemical) to efficiently treat the wastewater streams and produce treated wastewater or biosolids acceptable for disposal or reuse is not adversely and unacceptably impacted.

**Objective 4 Facilitation of Regulatory and Licence Compliance**

– in particular to:

- Protect the capability to achieve regulatory compliance with reasonable certainty and within acceptable risk, including:The avoidance of operating and/or environmental licence breaches:Meeting requirements for the management of wastewater overflows to the environment; and
- Meeting requirements for treated wastewater and biosolids disposal to the environment (including protecting receiving waters and the land).

**Objective 5 Facilitation of Recycling**

– in particular to:

- Protect the capability to facilitate, either on-site or off-site of water authority land, the recycling and reuse of treatment plant by-product streams in compliance with reuse strategies, applicable statutes and regulations without unreasonable or impracticable further treatment including (with or without the requirement for further treatment depending on the intended use):
  - Recycling treated wastewater;
  - Recycling treatment plant biosolids; and
  - Reuse and sewer mining.

In addition, wastewater source management and control systems must have, and continuously maintain, robust multiple barriers (or physical points of intervention or specific intervention measures) *appropriate to the level of potential contamination and the potential impacts on the wastewater system and achievement of the 5 Key Wastewater Source Management Objectives.*

The multiple barrier approach is now universally recognised as the foundation for effectively managing risks and ensuring protection of the management objectives for wastewater quality and quantities. No single barrier is effective against all conceivable sources of contamination, is effective 100 per cent of the time or constantly functions at maximum efficiency. Robust barriers are those that can handle a relatively wide range of challenges with close to maximum performance and without suffering major failure.

Although it is important to maintain effective operation of all barriers, the advantage of multiple barriers is that short-term reductions in performance of one barrier may be compensated for by performance of other barriers. Prevention of contamination provides greater surety than removal of substances by treatment, so the most effective barrier is protection of source inputs to the maximum extent that is reasonably achievable.

An understanding of the barriers needed to meet the Key Wastewater Source Management Objectives requires a thorough understanding of the wastewater system, from the source of the various inputs (and upstream of them) to the point of disposal or reuse including how the system works and the vulnerabilities to failure.

Finally, a robust system must always include mechanisms and procedures to allow unplanned incidents (such as customer errors, operator errors, illegal discharges, uncertainties in the wastewater quality etc) to be safely and adequately addressed.

# Chapter 2. Source Management

## 2.1 Rationale

A new paradigm of integrated water cycle management that considers a range of water sources, including sewage sources, is becoming established across Australia. The value of sewage as a source of not only water, but also renewable energy, carbon and nutrients is emerging. Moving towards the closing of resources cycles through resource efficiency and recovery can happen at regional, metropolitan, local and on-site scales.

Use of recycled water for a broad range of purposes is occurring in cities across Australia, including irrigation, industrial processes and more recently IPR (indirect potable reuse e.g. AGWR (2007)). Alternative sources such as rainwater and storm water are also being considered to augment supplies. The WSMG has been developed within the current context of increasing effluent reuse.

In the context of recycling and resource efficiency, a wastewater system cannot simultaneously be a stream from which to extract new sources of water while at the same time, being a receiving environment for uncontrolled residues from non-domestic and domestic premises. In addition, uncontrolled inputs to the sewer have the potential to severely damage sewer assets, impact on occupational health and safety of sewer workers, and impact on the environment.

It is now more critical than ever that wastewater sources be measured, controlled and priced accordingly to achieve a balance between the competing demands of:

- Onsite reuse and recycling;
- Extraction of water from wastewater;
- Reuse of treated wastewater;
- Disposal of domestic and non-domestic wastewater; and
- Full cost recovery.

Currently, the management of wastewater source quality resides in trade waste groups within water utilities. Traditionally, this practice has focused on the management of non-domestic premises due to the nature of their discharges. However, given the current resource context, this focus is now broadening to cover:

- Inputs from domestic premises;
- Rainwater;
- Stormwater;
- Groundwater Infiltration; and
- Impacts of redesigning water and sewer systems.

While individual households generate relatively little waste, the sheer number of such residences, means that overall loads of wastes such as prescription medicines, household toiletries and detergents may be significant. It is essential that water utilities understand the very broad scope of source management and resource it adequately.

## 2.2 Key Issues

### 2.2.1 Understanding Wastewater Sources

Addressing the water resource needs of the future requires an understanding of all potential water-borne wastewater sources including:

- Inflow/infiltration to sewers due to asset condition or design (e.g. stormwater, saline groundwater);
- Varying sources of drinking water;
- Household discharges (e.g. endocrine disrupting compounds, pharmaceuticals and detergents);
- Tankered waste;
- Sewer cleaning and management (e.g. root foaming and sewer cleansing agents); and
- Trade waste discharges.

Understanding these sources may require reorganisation of traditional trade waste teams or formal cooperation of multiple teams elsewhere in a water utility to ensure that gaps in understanding and managing source wastewater quality are minimised. In jurisdictions where the management of wastewater systems is fragmented because of institutional arrangements, additional measures and an even stronger focus on a cooperative and coordinated approach to the management of risks (at source, in transfer and for end use) will be necessary. Adopting a wastewater source quality management framework can assist in achieving these aims.

### 2.2.2 Trade Waste Pricing

Through the National Water Initiative (NWI), the role of wastewater as a resource is recognised in the sustainable management of the water in sewers:

- Clause 66. "*In particular, States and Territories agree to the following pricing actions:*
  *iii) review and development of pricing policies for trade wastes that encourage the most cost effective methods of treating non-domestic wastes, whether at the source or at downstream plants, by 2006.*"

This approach requires water utilities to collect sufficient data about the costs and cost drivers of operating their wastewater systems, treating water for discharge and reuse and producing useable biosolids in order to determine appropriate charges. Water utilities should also understand the costs of waste control by companies. Based on this understanding, utility charges should be set to provide the best balance between the onsite treatment of wastes and those treatment systems operated by utilities.

As a result, it is important for utilities to set charges that reflect appropriate cost drivers. The traditional charging basis of flow, organic load (BOD) and solids load (suspended solids) does currently not reflect the requirements of the NWI. In many instances, utilities are now required to manage nutrients, organic toxicants and other substances such as salt. If these substances represent cost drivers, waste charges to industry should be rebalanced to reflect this.

A second important consideration in determining charges is those substances that are not effectively removed or are partitioned between treated wastewater and biosolids. Incentive pricing could be used to minimise the input of these materials at the source particularly where it is not economically feasible to remove such substances at the wastewater treatment plant.

For a wastewater utility, the three fundamental cost categories in relation to the management of trade wastewater are:

Box 2.1 Pricing Principles

Pricing should include the following principles:

- Charges should be consumption-based incorporating pay for use and fee for service.
- Charges should recover the full cost and incorporate a real rate of return on assets (unless services are required to be provided at less than full cost in which case the cost should be fully disclosed and ideally paid as a Community Service Obligation.)
- The tariff approach should be easy to understand especially by customers. The waste producer must be able to clearly identify costs associated with their trade waste discharge.
- Tariffs should be equitable across all customer groups. Cross subsidies should be removed or where cross subsidies continue to exist, they should be made transparent.
- Tariffs should operate to induce customer behaviour that aligns to operating strategies. Pricing policies for trade waste should encourage cleaner production, waste minimisation and the appropriate use of pre-treatment technologies.
- Administration should be streamlined and efficient.

- **Transmission costs** – including the capital, operating and monitoring costs of mains and pump stations must be incorporated into the substance charging structure.
- **Treatment, discharge and downstream monitoring costs** – including both capital and operating costs.
- **Administration costs** – including all costs associated with billing, administration, salaries and overheads.

In addition, some utilities may choose to use incentive charges to encourage compliance, waste minimisation and the introduction of cleaner technology including tiered charges for specific substances, premium charges or asset protection charges for non-installation or maintenance of appropriate pre-treatment equipment. Similarly, some jurisdictions may provide incentive payments or co-payments to encourage the above.

### 2.2.3 Water Conservation and Cleaner Production

The management of wastewater also needs to reflect programs designed to reduce water use. Reducing water use may lead to increased contaminant concentrations in wastewater. There are pressures on water utilities to relax their non-domestic waste acceptance concentration criteria to help ensure water conservation initiatives are provided additional incentives. Any changes need to consider the 5 Key Wastewater Source Management Objectives in this guideline.

Any water conservation program should be combined with a cleaner production program to ensure maximum gains for the water utility and water user. Cleaner production approaches imply working "upstream" of the traditional waste discharge to sewer and often dealing with production staff and the "source" of the contaminant. This augments the traditional "end of pipe" regulatory approach currently taken by most water utilities.

### 2.2.4 Water Sensitive Urban Development

There are a number of proposals aimed at increasing the availability of water suitable for a range of uses that have the potential to impact on the quality of wastewater and the integrity of wastewater assets. For example, sewer mining needs to be managed to ensure residuals returned do not damage assets, generate excessive odours or impact negatively on wastewater quality at the wastewater treatment plant or to the detriment of downstream uses. Greywater reuse and non-domestic on-site reuse can also impact on wastewater quality.

This is a broad issue and systems must be in place to ensure that the water utility has an understanding of planning and development procedures.

### 2.2.5 Industry Clarity

Industry needs clarity on national principles to the management of wastewater to aid their decision-making and planning, and to enable them to proceed with new initiatives with an improved degree of certainty. Competitiveness generally would benefit from the establishment of national product authorisation, national acceptance guidelines and a more national approach to compliance.

However, it needs to be stated that there will always be local conditions and drivers that may require alterations to for example acceptance guidelines in a local environment.

## 2.3 Establishing Wastewater Source Management within a Quality Framework

The most effective means of ensuring wastewater quality that is consistent with the objectives of the water utility is through the adoption of a preventative risk management approach to sewer sources. Examples of such risk management frameworks can be found in contemporary water management guidelines including the Australian Drinking Water Guidelines (ADWG, 2004) and the Australian Guidelines for Water Recycling Phase 1 and 2 (AGWR, 2006; 2007). The WSMG adopt this approach to water quality assurance through source management.

The quality framework introduces a preventative approach, rather than relying solely on the use of a set of acceptance guidelines. This approach is essential in the field of wastewater source management, because systems need to be in place to manage everyday operations as well as incidents – it is too late to correct the problem after it occurs. Also fundamental to the quality framework approach is the role of staff and stakeholders in achieving the 5 Key Wastewater Source Management Objectives.

Establishing a quality framework also provides a goal for water utilities as well as a benchmarking tool for future self-comparison against best practice.

## 2.4 Acceptance criteria for non-domestic wastewater

The acceptance criteria for non-domestic wastewater relates to the quality of the wastewater at the point of discharge into the wastewater system. They define wastewater that, based on current knowledge, is acceptable for discharge to the wastewater system both in the short and long term to ensure that achievement of the 5 Key Wastewater Source Management Objectives is never compromised. For some of the wastewater quality characteristics identified there is a grey area between what is clearly acceptable and what is clearly unacceptable. Often the latter has not been reliably demonstrated and therefore the acceptance criteria have been designed to be conservative which is consistent with the precautionary principle i.e. to err on the side of safety.

This WSMG includes acceptance criteria for non-domestic wastewater for a range of substances. The criteria are intended for use as:

- Action levels for short-term exceedance of substance limits; and
- A means to assess system performance (verification) over the longer term (e.g. over a 12-month or longer period).

Using a guideline value against which to assess acceptability entails assessing whether individual results conform to the requirements of accepting wastewater quality of an acceptable risk in the context of the 5 Key Wastewater Source Management Objectives.

**Short-term exceedance:** Exceedance of a criterion generally requires some form of immediate corrective action (commonly referred to as a 'correction'). For example, if a substance for a health-related characteristic is exceeded, the response should be to take immediate action to reduce the risk to workers, and, as appropriate and necessary, to advise water authority personnel and the relevant health authority of the action taken. If the characteristic affects longer term wastewater system performance, the time frame for action should be commensurate with the risk (e.g. for corrosion of sewers).

**System performance:** When guideline values are used in assessing overall performance (e.g. as presented in an annual report) the aim is to assess whether wastewater source control and management strategies have been, and continue to be, effective. The assessment is generally used to identify any emerging issues and to determine priorities for improvement. The identified gaps and issues can then be scheduled for action through avenues such as Capital/Operational Expenditure or other programs depending on the priority of the issues identified.

Therefore, in most cases, occasional excursions beyond the acceptance criterion may not necessarily pose an immediate risk to the 5 Key Wastewater Source Management Objectives (other than for health-related characteristics where a precautionary approach is advised). The amount by which, and the duration for which, any health-related criterion can be exceeded without raising concerns depends on the particular circumstances. Exceeding a criterion should be a signal to correct the excursion, investigate the cause and, if appropriate, to adjust the system and/or process to prevent a recurrence.

This WSMG provides the basis for best practice management of wastewater sources including their quality and quantity. Utilities should adopt a preventive risk management approach, as stipulated in the WSMG, to maintain their systems as close to best practice as practicable. For specific acceptance criteria for non-domestic wastewater refer to Appendix D.

## 2.5 Future Directions and Knowledge Gaps

### 2.5.1 Domestic Wastewater

In some wastewater catchments, domestic residences are likely to be the main contributors of some key substances including copper, zinc, endocrine disrupters, pharmaceuticals and in some cases, pesticides (e.g. Box 2.2). However, there is currently little focus on managing domestic wastewater quality. The challenge is therefore to gain an improved understanding of domestic wastewater quality to better understand the relative impacts from domestic and non-domestic sources and to understand the ability of utility treatment systems to control those wastes. Some possible actions for managing sewer sources within a domestic context may include:

- National and State Authorities working with consumer goods' suppliers and certifying authorities such as NICNAS (National Industrial

Chemicals Notification and Assessment Scheme) and the APVMA (Australian Pesticides and Veterinary Medicines Authority) to ensure that chemicals used in the domestic context are compatible with wastewater treatment systems.

- Use of education tools to raise awareness of what happens to substances if they are disposed of or used incorrectly (e.g. placed in the toilet or down the sink), especially where the impacts of those actions may be observed locally. An example of such a program is a hazardous household chemical awareness program achieved by distributing pamphlets to home owners.
- Partnerships of water utilities with other agencies for delivering improved waste management outcomes or education programs. For example, the Melbourne metropolitan water industry is working with Sustainability Victoria in supporting and extending a current chemical collection and education program called 'Detox your Home' (www.sustainability.vic.gov.au/www/html/1459-detox-your-home.asp.).

### Box 2.2 Pets, Pests and Pesticides campaign

Sydney Water's effluent sampling revealed increased levels of organophosphorus pesticides at a number of sewage treatment plants. Further analysis showed that two products, chlorpyrifos and diazinon, were at levels of concern. The environmental regulator requested that a Pollution Reduction Program (PRP) commence. The PRP showed that there was a need to reduce chlorpyrifos from sewage effluent and residues of both chemicals were found in ecological and human health risk assessments conducted on the sewage effluent at 15 inland sewage treatment plants.

Chlorpyrifos and diazinon are organophosphorus pesticides found in anti-flea rinses and garden pesticides. They are also used in treatments for termites, spiders, ants and cockroaches. Pest control operators, golf courses and bowling greens have also been found to use these pesticides. There were no product manufacturers within the affected sewage treatment plant catchments and sewage analysis showed that there were minor diffuse sources throughout the catchments which demonstrated that there were no illegal 'dumps' of old product. Later investigations revealed that the sources were households laundering work overalls from Pest Controllers and horticultural sprayers.

In February 2000 Mimi Macpherson, a well known variety show presenter with strong environmental principles, launched Sydney Water's pilot community education program in the Bellambi, Cronulla and Port Kembla sewage catchments. The project involved extensive consultation with many locally based and peak organisations including local government, the Australian Environment Pest Managers Association, the NSW Environment Protection Authority and environment groups such as the Total Environment Centre and the Sutherland Environment Centre.

Project directions and key messages were discussed with a range of manufacturers, industry associations such as the Small Animal Veterinary Association and the Veterinary Manufacturers and Distributors Association, the National Toxics Network, the NSW Environment Protection Authority, the National Registration Authority and the Therapeutic Goods Administration.

Project directions were developed using information gained from focus groups, a literature review, market basket surveys and a telephone survey of a random selection of households in the target sewage catchments.

Choosing key messages for the community education campaign was not easy. Advice from various organisations consulted was conflicting. Initially the messages focused on the disposal of rinse water onto the garden, however the Therapeutic Goods Administration could not recommend that this disposal method around the house was safe. One local council was also concerned about the effect of contaminated rinse water on public health and storm water.

As a result of this consultation Sydney Water's messages changed to advocating the avoidance of using products with chlorpyrifos and diazinon and to choose non-chemical and less hazardous pesticides.

Sydney Water trialled the running of household chemical collections and pesticides only collection for people to dispose of these products. Sydney Water held a launch in each trial area, mailed a brochure to 180,000 households and placed advertisements in local papers and on radio. The subsequent collections received 112 litres diazinon and 14.5 litres chlorpyrifos from mainly domestic users. Overall, 360 litres of non-chlorinated pesticides, 88 litres of organochlorine pesticides and 95 litres of metal-based pesticides were collected.

### 2.5.2 Rainfall Inflow/ Infiltration

Flows can be discharged to sewer from unauthorised stormwater drainage, rain dependent infiltration through soil that enters the sewer from defective pipes and joints or rainfall that enters low lying disconnector traps or leaking manhole covers. These flows may overload the sewerage system which may result in surcharging or overflows to the environment or overloading the treatment plant which may cause deterioration in effluent quality. The additional flows may also result in additional operating expenses such as energy costs for pumping and additional maintenance or premature costs for system augmentation as a result of reduced capacity. It is also possible that during rain events, substances such as metals from brakes and oil on the road would flow into the sewer. Where this poses a risk to the 5 Key Wastewater Source Management Objectives, Water utilities need to conduct research into finding impact of substances received from Rain Dependent Inflow Methods for measuring inflow into the sewer and measurement of contaminant loads need to be investigated to get better understanding of this source.

A possible method for determining rain dependent inflow volumes is:

- Determine the annual dry weather wastewater volume using the average dry weekly wastewater volume factored up to represent 52 weeks; and
- Subtract the calculated annual dry weather wastewater volume from the total annual wastewater volume to determine the component of total annual volume attributable to rainfall dependent infiltration (RDI).

Detailed evaluation of the wastewater system to understand the catchment boundaries, smoke testing, CCTV inspections, night flow investigations will all assist with identifying worst affected areas. The quality of rain dependent inflow could be determined from measuring substances in storm water run off.

### 2.5.3 Ground Water Infiltration

Groundwater infiltration usually occurs where the sewers are laid below the groundwater table. Groundwater can infiltrate the sewer via defective pipes or joints and leaking manholes and can reduce the hydraulic capacity, and increase the costs of, managing the wastewater system.

Generally areas that are near and below sea level are susceptible to increased salt concentrations of wastewater in sewers due to infiltration. This can impact on asset conditions or effluent quality at the treatment plant. Investigations to understand the constituents of groundwater infiltration and the impact on wastewater quality is important in source control. Box 2•2 provides an example of work undertaken by City West Water to determine the extent of groundwater infiltration and the contribution of salt to the treatment plant.

The potential risk from contaminated groundwater infiltration should also be considered for source control. Sewers can act as a preferential pathway for contaminated groundwater flow where groundwater infiltration is significant. Water utilities should work with state based environmental regulators to identify potential sources of contaminated groundwater in areas where groundwater infiltration is identified and considered significant. An example of understanding the sewer catchment is provided in Box 2.3.

### Box 2.3. Altona Catchment Strategy

In order to improve its understanding of the quantity and location of salinity entering the wastewater system via groundwater infiltration, City West Water has conducted a detailed study of 2 catchment areas within its wastewater system. One of these studies was conducted on the wastewater catchment of the Altona Treatment Plant (ATP). The study led to the development of a hydraulic model of the catchment and estimate of the relative contribution of salinity and wastewater volumes from groundwater infiltration.

The ATP catchment is predominately residential and consists of approximately 190 km of sewerage infrastructure, covers an area of 17.8 square kilometres and serves approximately 16,000 properties. The average salinity of the wastewater received at the ATP is 4,700 mg/L. Parts of the sewerage system are located beneath the groundwater table.

Monitoring of the system was conducted over a 26 week program in 2007. The program consisted of 23 flow and 24 salinity monitoring points within the sewerage network, and 6 rain gauges within the catchment. Further sampling was conducted to fill in any data gaps. Some groundwater monitoring was also undertaken to provide hydrogeological information (groundwater level and salinity contours) for development of the hydraulic model. An assessment of the pipe network characteristics was conducted through desk top reviews and CCTV of approximately 15 km of sewer to determine the condition and characteristics of the network.

Accurate measurement of groundwater infiltration can be difficult where there are relatively low flow rates within the sewer. Monitoring sites with higher flows (i.e. significant groundwater infiltration) generally recorded more consistent and accurate results. Collection of salinity data representative of the constantly changing sewage flows also presents a challenge in the field. No specific equipment exists for this purpose and sample probes were fitted with protection (i.e. slotted pipe) for sampling purposes. Probes are also affected by fouling and blockages of the slotted pipe, therefore sufficient sampling points are required to counter these issues and ensure data capture is adequate.

The average TDS concentration from domestic catchments (without influence from groundwater infiltration) was found to be 580mg/L. Whilst this represents an increasing trend in TDS concentrations in domestic sewage due to water conservation efforts the study found that less than 8% of the salt load to ATP was attributed to sewage loads (domestic and non domestic).

Within the ATP catchment where groundwater infiltration represents a relatively high percentage of total flow, a reasonably accurate estimate of groundwater infiltration can be obtained. The outcome of the study was a detailed and comprehensive sewerage system model to assess sewerage flows and volumes and salinity and salt loads within the ATP catchment. The final model was calibrated and verified for both dry weather flows and salinity over the 6 months of monitoring. The model was found to be less accurate for soaking rains within a wet catchment. The model has subsequently been used successfully to assess the effectiveness of a range of augmentation strategies designed to reduce the levels of salinity discharged to the ATP. No feasible options to reduce salt inputs within ATP catchment were identified as part of the study, nor was any catchment identified that could provide a suitable volume of low salinity wastewater for water recycling without further salt reduction treatment. Salt reduction measures to facilitate water recycling will therefore occur at the ATP through treatment.

# Chapter 3 Framework for Wastewater Source Management

## 3.1 Structure of the Framework

The Framework includes 12 elements considered good practice for system management of wastewater source quality, as outlined in Figure 3.1 and detailed in Table 3.1.

Figure 3.1. Framework for Wastewater Source Management (adapted from the AGWR, 2006).

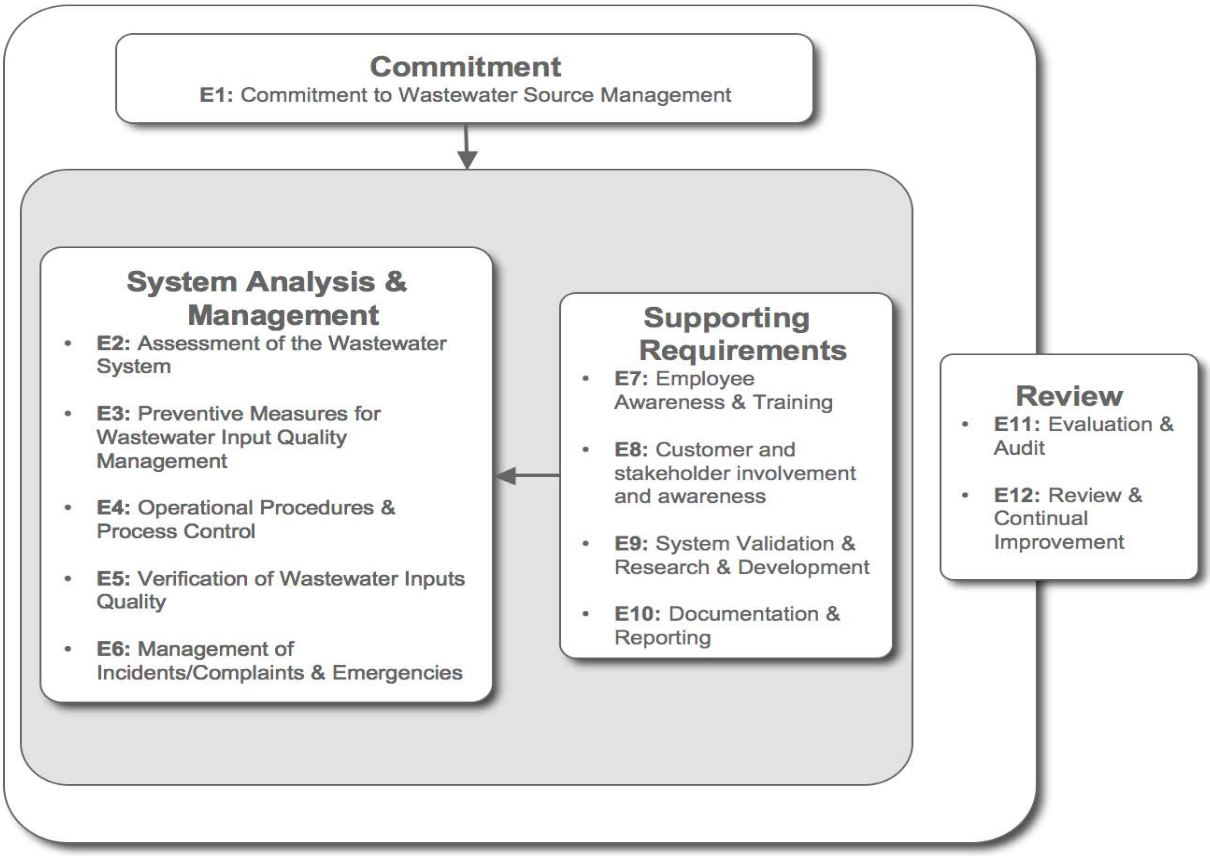


Table 3.1. Framework for Wastewater Source Management.

| Key Elements | Components |
|---|---|
| **COMMITMENT** | |
| ***Element 1*** | |
| Commitment to wastewater source management | Wastewater source management policies and plans<br>Regulatory and formal requirements<br>Engaging stakeholders |
| **SYSTEM ANALYSIS AND MANAGEMENT** | |
| ***Element 2*** | |
| Assessment of the wastewater system | Wastewater system analysis<br>Assessment of wastewater quality and quantity data<br>Hazard identification and risk assessment |
| ***Element 3*** | |
| Preventive measures for wastewater input quality management | Critical control points<br>Quality control points |
| ***Element 4*** | |
| Operational procedures and process control | Operational procedures<br>Operational monitoring<br>Corrective action<br>Equipment capability and maintenance |
| ***Element 5*** | |
| Verification of wastewater inputs quality | Wastewater system and environmental monitoring<br>Short-term evaluation of results<br>Corrective action |
| ***Element 6*** | |
| Management of incidents/complaints and emergencies | Communication<br>Incident and emergency response protocols |
| **SUPPORTING REQUIREMENTS** | |
| ***Element 7*** | |
| Employee awareness and training | Employee awareness and involvement<br>Employee training |
| ***Element 8*** | |
| Customer and stakeholder involvement and awareness | Customer and stakeholder awareness and involvement<br>Communication with customers |
| ***Element 9*** | |
| System validation and research and development | Validation of processes<br>Investigative studies and research monitoring<br>Design of equipment |
| ***Element 10*** | |
| Documentation and reporting | Management of documentation and records<br>Reporting |
| **REVIEW** | |
| ***Element 11*** | |
| Evaluation and audit | Long-term evaluation of results<br>Audit of wastewater quality and source control management<br>Regulatory oversight and surveillance |
| ***Element 12*** | |
| Review and continual improvement | Review by senior executive/managers<br>Wastewater quality and source management improvement plan |

Although listed as discrete components, the 12 elements are interrelated and each supports the effectiveness of the others. These elements need to be addressed holistically because most wastewater quality problems and failure to achieve the five Key Wastewater Source Management Objectives are usually attributable to a combination of factors.

The elements outline principles of management applicable to all wastewater systems regardless of size and system complexity. The framework is intended to be flexible, providing generic guidance, and the content should not be regarded as being prescriptive or exhaustive.

## 3.2 Applying the elements of the Framework

Although the Framework and acceptance criteria for non-domestic wastewater are not intended as standards, it is recognised that some jurisdictions may choose to formalise the Framework and acceptance criteria through legislation, operating licences or other instruments.

Application of the Framework will vary depending on the arrangements for wastewater system operation and management within each jurisdiction, e.g. in some states, wastewater is managed by the one agency, whereas in other states wastewater is managed locally by numerous agencies or as part of connected systems. The variety of systems in operation will affect the manner and degree to which the Framework is implemented and by which entity. However, all wastewater authorities and relevant Government agencies and regulators should consider the Framework as a model for best practice.

How the Framework is applied and implemented will depend on the needs of the organisation, the separation of responsibilities and the institutional arrangements. Each organisation should develop an internal plan for implementing the Framework in a manner that suits its particular circumstances. The Framework can be applied as a stand-alone wastewater quality and source management system or integrated with an existing management system.

## 3.3 Correlations of the Framework with other systems

The Framework is not intended to duplicate or replace adequately working management systems; rather, it is intended to be compatible and complementary. The Framework includes principles of established systems such as HACCP and ISO systems and is sufficiently flexible to allow implementation to be built on programs and systems already present in an organisation. However, the relationships between the Framework and these systems should be understood.

# Chapter 4. The 12 Elements

In this chapter, details of the 12 elements of the Framework are provided. Each element includes an introduction and lists the components that make up that element. The components of each element are then described in further detail. A 'summary of actions' box heads each component and provides an overview of the steps involved in implementation.

## 4.1 Element 1: Commitment to wastewater source management

**Components:**

- Wastewater Source Management Policies and Plans
- Regulatory and Formal Requirements
- Engaging Stakeholders

Organisational support and long-term commitment by senior management is the foundation to implementation of an effective system for wastewater source management. This commitment will ensure that the resources required for executing the management strategy are made available.

Successful implementation requires:

- An awareness, understanding of and commitment to the importance of the 5 Key Wastewater Source Management Objectives (Section 1.3) by all relevant senior management, other key management and operational water utility personnel involved in dealing with trade waste and other wastewater sources. In particular, this applies to the practical application of these objectives in terms of decision-making and implementation at the strategic, tactical and operational levels;
- The development of a continuous improvement culture;
- The ongoing and active involvement of senior management in maintaining, reinforcing and communicating the importance of wastewater source management to all stakeholders;
- Performance monitoring and reporting against defined performance objectives; and
- Measurable indicators for each performance objective.

### 4.1.1 Wastewater Source Management Policies and Plans

**Summary of Actions:**

- Development of a formalised wastewater source management framework that addresses all potential sources and manages the quality of all wastewater.,
- Formulation of specific policies such as trade waste, inflow/infiltration and domestic wastewater,
- Endorsement of these policies by senior executive, to be implemented throughout the organisation, and
- Ensure that these policies are visible and are communicated, understood and implemented by water utility employees.

Development of an overall formalised wastewater source management framework is essential for an organisation to establish the direction and mechanism for providing an increased focus to manage all sources of wastewater.

Within the framework, specific policies should explain the general obligations of customers in discharging to the wastewater system and the overall level of service to be provided to all domestic and non-domestic customers in the context of managing and accepting all potential wastewater sources to the wastewater system.

Other specific policy documents, such as a trade waste policy, should explain the particular level of service to which the organisation is committed to provide. It should also explain the terms and conditions under which the organisation agrees to accept trade waste discharges. These documents should detail the regulatory basis of the service, how dischargers are managed, and the consequences of non-compliance.

These policies provide the basis on which all subsequent actions can be judged. It should define the organisation's commitments and priorities relating to wastewater source management.

The policies should provide a basis from which more detailed policies and implementation strategies can be developed. As such, the documents should be clear and succinct, and should address broad issues and requirements of the organisation's commitment and approach to wastewater source waste management.

The policies should cover issues such as:

- The purpose, measurable objectives, strategies, operations (systems and procedures) and performance measures for wastewater source management;
- The level of service provided and the terms and conditions of providing the service;
- The involvement of water utility employees;
- Compliance with relevant regulations and other requirements;
- Liaison and cooperation with relevant regulators, including the environmental and economic regulator, and external stakeholders;
- Communication with water utility employees and external stakeholders;
- Intention to adopt best practice management and multiple barriers for the management of risk;
- Continual improvement and review for suitability;
- When formulating a source management policy, key considerations are:
  - Any regulatory, statutory and other requirements to be complied with and which must be considered during its formulation, adoption and implementation;
  - Key principles relevant to trade waste and wastewater source management;
  - Expectations of the organisation and key internal and external stakeholders;
  - objectives with measurable indicators to determine whether policy objectives are being met;
  - Full cost recovery and incentive based pricing;
  - Industry assistance where appropriate;
  - Wastewater system capacity and capabilities for the wastewater network – both at a localised level and a system wide level – including consideration of seasonal fluctuations;
  - The impacts on recycled water and biosolids reuse opportunities; and
- How the policy will impact on and interact with other policies and procedures within the organisation.

Information from this process would enable the organisation to establish source management policies, which will ensure that stakeholders have consistent expectations and to provide transparency and directions for decision-making and the establishment of detailed programs.

In developing these policies, the opinions and requirements of employees, customers and other stakeholders should be considered. The document should outline the principal measures to control the quality of all sources of wastewaters. Communication with stakeholder groups at appropriate stages of policy formulation is important and essential to ensure the policy is transparent, understood, accepted and implemented. Effective communication process(es) will enhance the sense of shared ownership and will help during the implementation stage.

Management should ensure that these policies are highly visible, continually communicated, understood and implemented and maintained by all employees of the organisation. It is the responsibility of all employees to support this commitment.

The policies and associated documentation need to be:

- Readily accessible, e.g. through the organisation's website or in hard copy form;
- Reviewed on a regular basis to ensure that the policy continues to reflect current policy directions of the organisation, regulators and government initiatives; and
- Consistent with any other relevant issue-specific policies of the organisation.

### 4.1.2 Regulatory and Formal Requirements

**Summary of Actions:**

- Identify and document relevant regulatory and formal requirements.
- Ensure responsibilities are understood and communicated.
- Ensure review of requirements is carried out periodically.

All water utilities should have a regulated basis for accepting wastewater to sewer such as specific by-laws, customer contracts and plumbing regulations. However such regulations are limited in relation to the quality of wastewater discharged from domestic sources. Any contract should detail the rights and obligation of both the utility and the customer. The majority of these contracts become applicable on connection to services, however it is good practice to review these contracts and include provisions for determining wastewater quality. This fact is particularly relevant for determining what can be accepted from domestic sources.

The ability to develop and implement an effective wastewater management program depends on adequate legal power to enable the organisation to manage wastewater discharges, which include imposing restrictions and/or conditions on wastewater discharges and the application of appropriate fees and charges.

There also may be numerous pieces of legislation that are either directly or indirectly relevant to trade waste management. In addition, there may be other formal requirements with which an organisation may require compliance.

The regulatory and formal requirements may include:

Federal, state, territory legislation and regulation;

- By-laws;
- Operating licences and agreements;
- Contracts, including customer contracts, and agreed levels of service;
- Memoranda of Understanding; and
- Industry standards, code of practice and guide-lines.

It is imperative that all such requirements are identified, documented and complied with.

Generally, legislation is not prescriptive about trade waste management, that is, it provides overarching powers for the organisation to administer trade waste rather than detailed direction. In some cases, the technical regulations for acceptance may be established by an agency other than the utility. Utilities can be empowered to enter into and formulate contracts with its customers through the by-laws for which it has the powers to make or through broad powers where the acceptance criteria for non-domestic wastewater are set initially by a ‘technical regulator’ and revised as required after a review process which is based on evidence and the inputs of all relevant stakeholders.

A water utility’s responsibilities and accountabilities associated with providing wastewater services should be well defined and clearly communicated to all employees. A registry of relevant regulatory and other requirements should be made available to employees. This registry should be regularly reviewed and updated as necessary to reflect any changes. The water utility should also have a formal system in place to routinely track and/or interpret changes to legislation and distribute these changes to the appropriate staff in a timely manner.

New legislation may be required in the future to ensure effective management of other wastewater sources such as inflow/infiltration and domestic wastewater.

### 4.1.3 Engaging Stakeholders

**Summary of Actions**

- Identify all stakeholders who could affect, or be affected by decisions or activities of the water utility.
- Determine appropriate mechanisms and documentation for stakeholder commitment and involvement.
- Prepare, and regularly update, the list of relevant external agencies.

The water utility should ensure that there is an integrated management approach to communication and collaboration with all relevant agencies and stakeholders for effective wastewater source management.

The range of agencies and stakeholders involved in wastewater disposal and recycling systems will vary depending on local organisational and institutional arrangements. Agencies and stakeholders may include:

- Regulators:
    - o Federal and state environmental protection agencies;
    - o Technical;
    - o Health (particularly for effluent and biosolids recycling); and
    - o Economic/pricing;
- Concurrence Authorities (i.e. those with approval or endorsement rights before implementation);
- Government departments (including Workcover);
- Wastewater Wholesaler, Retailers and 3rd party proponents;
- Customers – business customers;
- Industry associations and peak bodies;
- Local government and planning authorities;
- Broader customers and stakeholders;
- Customers, stakeholders and Public Interest Groups;
- Environment NGOs (non-government organisations); and
- Senior management and staff of relevant organizations.

Establishment of an appropriate mechanism and documentation for stakeholder commitments and involvement is important for building trusted relationships with external stakeholders. These mechanisms may include:

- Establishment of working groups, customer councils, customer liaison committees, or taskforces with appropriate representatives;
- Development of partnership agreements, including a signed memorandum of understanding;
- Workshops/seminars/meetings;
- Public exhibition – including advertising for comments – promote and provide adequate notice and attract greater audience by sufficiently advertising in newspapers, posters in public places and special invitations to affected parties; and
- Publications – newsletters, flyers, brochures, posters and stickers.

Continuous communication is essential for the ongoing development of effective partnership between the stakeholders. The list of stakeholders should be reviewed and updated regularly.

## 4.2 Element 2 - Assessment of the wastewater system

**Components:**

- Wastewater System Analysis
- Assessment of Wastewater Quality and Quantity Data
- Hazards Identification and Risk Assessment

Assessment of the wastewater system is an essential prerequisite for the subsequent steps in which effective strategies for prevention and control of hazards and risks are planned and implemented. Assessment includes understanding the characteristics of the wastewater system, what hazards may arise, how these hazards create risks, and the processes and practices that affect wastewater quality.

### 4.2.1 Wastewater System Analysis

**Summary of Actions**

- Ensure assembly of a team for assessment and analysis.
- Ensure responsibilities for the team are understood and communicated.
- Assess the wastewater system components and construct a system flow diagram.
- Assess, assemble and document pertinent information of the wastewater system, both overall and for each system component.
- Ensure that an initial wastewater system analysis is undertaken and that a review is carried out periodically.

Effective system management requires an understanding of the wastewater system. Each component of the system should be characterised with respect to wastewater quality and the factors affecting that quality. This characterisation promotes understanding of the wastewater system and assists with identification of hazards and assessment of risks at each step of the wastewater system including:

- Consideration of the impacts and variability on each infrastructure component;
- Local sub-catchments; and
- The aggregation and contributions of these sub-catchments to the overall wastewater system.

A team with appropriate knowledge and expertise should be assembled to carry out the analysis. The team should include management, planning and operations staff with responsibilities across the entire wastewater system.

In circumstances where the institutional arrangements determine that wastewater sources are managed across a number of entities, arrangements and mechanisms must be established to develop a coordinated approach to the management of all wastewater system risks including a consistent approach on a whole-of-system basis. In all cases, the responsibilities and accountabilities of the team need to be documented, understood and communicated. Communication with other agencies may be required for the analysis of domestic and non-domestic catchments.

A system map or mass model should be developed for the wastewater system that:

- Identifies all system steps including interceptor/main/trunk sewers, pump stations, rising mains, maintenance holes, access chambers, trade waste customer sites and points of discharge, treatment facilities and other relevant system infrastructure and features. The level of detail and the assets split(s), the size of the catchment, the extent of trade waste discharges, the risks and the practicality will depend on the water utility's size and available resources.
- Summarises key flow and quality information including for both the mainstream wastewater flow and trade waste customers including the preparation of mass balances for individual substances and system capacity statements for the network system and the wastewater treatment plants.
- Characterises unique attributes of the wastewater system.
- Identifies the locations where individual discharges or aggregation of discharges result in substance loads or concentrations that may cause significant local as well as systemic impacts or risks.

Wastewater system analysis should be reviewed periodically to incorporate any future changes.

### 4.2.2 Assessment of Wastewater Quality and Quantity Data

**Summary of Actions:**

- Ensure gathering and assembly of historical data from sources into robust information systems e.g. domestic, non-domestic, trade waste, and inflow/infiltration.
- Assess data using tools such as control charts, trend analysis and mass balances – at a local and system level.
- Assess system capacity for acceptance of particular substances in wastewater, based on each of the source management objectives.
- Identify and examine unacceptably high loads or concentrations of particular substances., and
- Ensure review of requirements is carried out periodically.

An assessment should be undertaken to determine the biological, chemical, hydraulic and physical characteristics of the wastewater system. A review of historical wastewater quality data obtained by undertaking catchment wastewater characterisation studies can assist in understanding characteristics and system performance both over time and following specific events, such as heavy rainfall and king tides. This information can aid the identification of hazards and potential sources such as illegal discharges, groundwater, stormwater and seawater ingress. Analysis should be supported by the assessment of the quality of trade waste discharged from individual customers as this trade waste may represent a material risk to achieving the 5 Key Wastewater Source Management Objectives.

In some instances, industries are located in close proximity or are aggregated in a particular location (e.g. non-domestic precincts). This spatial information also needs to be taken into account when assessing the impacts of particular inputs to the system.

Trend analysis and control charts can be valuable tools for recognising potential problems or hazards and the accumulation of any gradual changes or cumulative effects.

Capacity statements should be prepared for each relevant system step and the system overall for each relevant wastewater parameter. The capacity assessment would be based on a comparison of the assessed system performance, the stipulated system capacity limits and the regulatory or business targets to be achieved.

### 4.2.3 Hazard Identification and Risk Assessment

**Summary of Actions:**

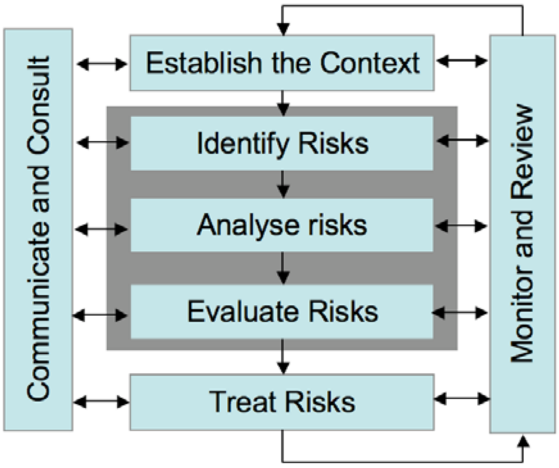
- Define the approach and methodology to be used for hazard identification and risk assessment.
- Identify and document hazards relevant to each component of the wastewater system.
- Estimate the level of risk for each identified hazard.
- Evaluate the major sources of uncertainty associated with each risk and consider the actions to manage this risk.
- Determine the level of risk and document the priorities for risk management.
- Periodically review and update hazard identification and risk assessment to incorporate changes.
- Prepare a contingency plan.

Management of risk should be integrated into the management philosophy of an organization. It is necessary for executive and senior management to take ownership for setting the risk management policy. The policy is usually a brief, high-level document approving a risk management approach as well as creating linkages with other corporate strategies and should be incorporated as part of an organization's overall management policies.

Management of risk is an integral part of good management being an iterative process of continuous improvement that is best embedded into existing practices or business processes. The main elements of the risk management process are as shown in Figure 4-1.

Effective risk management requires identification of all potential hazards, their sources, synergistic effects and hazardous effects and hazardous events, and an assessment of the level of risk presented by each. A structured approach is important to ensure that significant issues are not overlooked and that areas of greatest risk are identified.

Figure 4-1. Risk Management Process – An Overview (Adapted from AS/NZS 4360:2004 Risk management).




### Components of risk[1]

In assessing risk, the following components need to be clearly understood

- **Hazard**:
    - A biological, chemical, physical or radiological agent that has the potential to cause harm;
- **A hazardous event or incident**:
    - An incident or situation that can lead to the presence of a hazard (**what** can happen and **how**);
- **Likelihood:**
    - The **probability** (and/or frequency) of an event (associated with an identified hazard) occurring that causes harm in exposed populations in a specified timeframe;
- **Consequence**:
    - The outcome or impact on a range of stakeholders and assets, e.g. environmental damage, if the event causing harm occurs;
- **Risk:**
    - The product of the likelihood of the hazardous event causing harm and the severity of the consequences of the event if it does occur;
- **Controls** and their level of effectiveness e.g. detection systems, clean up systems, policies, security and training; and
- **When** could the risk occur and **where** could it occur.

These components of risk should not be confused and need to be separately identified. Ideally, a risk should be identified in the following terms – something that happens or has the potential to happen and which leads to outcomes (expressed in terms of impact on objectives).

The distinction between hazard and risk needs to be understood so that attention and resources can be directed to actions based primarily on the level of risk rather than just the existence of a hazard.

Realistic expectations for hazard identification and risk assessment are important. Rarely will enough knowledge be available to complete a detailed quantitative risk assessment. Hazard identification and risk assessment are predictive activities that will often include subjective judgments. These activities will inevitably contain uncertainty and these inherent limitations must be recognised to maintain flexibility and ensure that effective responses are provided when events differ from predictions. A realistic perspective on the limitations of these predictions should be understood by staff.

A consistent methodology should be established for both hazard identification and risk assessment. An example is provided in Appendix Table 1. (based on Brisbane Water's approach). This methodology could also be informed by ISO and other relevant standards and frameworks such as *AS/NZS 4360:2004 Risk Management* and the risk matrices detailed in the AGWR (2006 and 2007). The methodology needs to be transparent and fully understood by everyone involved in the process. Staff should be included and need to be aware of the outcomes of the risk assessment.

#### 4.2.3.1 Hazard Identification

All potential hazards, sources and events that can lead to the presence of hazards (what can happen and how), should be identified and documented at each step of the wastewater collection system. Hazards include point sources of pollution (e.g. domestic and non-domestic waste discharges) as well as diffuse sources (e.g. those arising from illegal discharges, illegal connections, storm water, groundwater and seawater ingress). Continuous, intermittent or seasonal pollution patterns should also be considered, as well as extreme and infrequent events such as droughts, floods or major spills.

[1] Source - Australian Guidelines for Water Recycling (2006)

The hazard identification and risk assessment should be reviewed and updated periodically because changing conditions may introduce important new hazards or modify risks associated with identified hazards. This assessment should give consideration to previous experiences, epidemiological data, and potential upstream and downstream effects.

The aim of hazard identification is to develop a comprehensive list of sources of risks and events that might have an impact on the achievement of each of the Key Objectives.

### 4.2.3.2 Risk Assessment

Once potential hazards and their sources have been identified, the level of risk associated with each hazard or hazardous event should be estimated so that priorities for risk management can be established and documented. Although there are numerous substances in wastewater, not every potential hazard will require the same degree of attention. Further, the risk endpoint (e.g. asset protection, worker safety, indirect potable use etc) will also have a bearing on the level of risk and this information needs to be clearly documented in the risk assessment process.

The level of risk for each hazard or hazardous event can be estimated by:

- Identifying the likelihood of occurrence (e.g. certain, possible, rare);
- Evaluating the severity of consequences if the hazard were to occur (e.g. insignificant, major, catastrophic); and
- Multiplying the likelihood by the severity with the overall objective of being able to distinguish between very high and low risks.

Suitable scales and methods for combining them should be consistent with criteria defined when establishing the context. An example of an approach to estimating the level of risk is provided in Table 4-1 through Table 4-3. These tables have been adapted from *AS/NZS 4360:2004 Risk Management* and the AGWR (2006; 2007) and can be modified to meet the needs of an organisation. Utilities may already have their own risk assessment matrices developed for assessing in house risks such as OH&S issues. It is perfectly acceptable for such matrices to be adapted as required as long as the bases for assessments are clearly documented.

### 4.2.3.3 Risk Evaluation and Prioritisation

**Uncertainty**

There will always be uncertainty associated with hazard identification and risk assessment. Uncertainty can be caused by various factors including a lack of knowledge or by variability in the parameters that affect identification of the hazard. Whereas the extent or imprecise definition of the parameters affecting a hazard or its identification can only be better understood through improved characterisation of the hazard, knowledge uncertainty can be reduced through better measurement and research. Characterising the major sources and types of uncertainty can provide a better understanding of the limitations of the hazard identification and risk assessment and how these limitations can be reduced. Investigative studies and research monitoring can often be used to provide further information to input into the risk assessment process and reduce uncertainty.

Table 4-1. Qualitative measures of likelihood

| Level | Descriptor | Example description |
|---|---|---|
| A | Rare | Have never heard of this happening |
| B | Unlikely | The event does occur somewhere from time to time |
| C | Possible | The event might occur once every 20 years |
| D | Likely | The event has occurred once every 5 years |
| E | Almost certain | The event will occur on an annual basis |

Table 4-2. Qualitative measures of consequence or impact.

| Level | Descriptor | Example description |
|---|---|---|
| 1 | Insignificant | Insignificant impact, little disruption to normal operation, low increase in normal operation costs |
| 2 | Minor | Minor impact for wastewater system, minimal operational disruption, some increase in operating costs |
| 3 | Moderate | Moderate impact for wastewater system, impact to normal operation, operational costs increased, increased monitoring. |
| 4 | Major | Major impact for wastewater system, systems significantly compromised and abnormal operation if at all, high level of monitoring required. |
| 5 | Catastrophic | Major impact, complete failure of systems |

Table 4-3. Qualitative Risk Analysis Matrix: Level of Risk.

| Likelihood Level | Consequences Label | | | | |
|---|---|---|---|---|---|
| | 1 Insignificant | 2 Minor | 3 Moderate | 4 Major | 5 Catastrophic |
| **A [Rare]** | Low | Low | Medium | Medium | High |
| **B [Unlikely** | Low | Low | Medium | Medium | High |
| **C [Possible]** | Low | Medium | High | High | High |
| **D [Likely]** | Medium | Medium | High | High | Very High |
| **E [Almost Certain]** | Medium | High | High | Very High | Very High |

### Risk Prioritisation

Based on the assessment of risks, priorities for risk management and application of preventive measures can be established. Risk should be assessed at two levels:

- **Inherent risk** (sometimes called 'maximum risk') in the absence of preventive measures or controls; and
- **Residual risk** i.e. the risk remaining after consideration of existing preventive measures.

Assessing inherent risk is useful for identifying baseline risks and understanding current management system rationale. Residual risk provides information on how additional preventive measures mitigate inherent risk. There should be an understanding of what is technically and practically reasonable as a risk mitigation measure.

### 4.2.4 Contingency Planning

One way of treating consequences is to undertake planning and preparedness for contingencies so that an organisation can act quickly to take advantage of unexpected gains or stem losses and prevent or limit disruption. This approach requires plans to be well founded in good risk management principles, tested and up-to-date.

When an event occurs, the water utility's management may need to respond quickly to mitigate the impact of the event on the achievement of business objectives such as maintenance of service (including integrity of assets and facilities), revenue stream, product quality, corporate reputation or customer satisfaction.

Plans should detail actions to be undertaken in the event of an emergency to manage discharges that could occur from a site and should include:

- Chain of responsibility, identification of key personnel/positions, contact numbers;
- Steps to be taken dependent upon the seriousness of the event i.e. who to call and their contact information;
- Location of shutoff valves or spill mats, responsibility for shutting valves and the reason for shutting along with the procedure for re-opening; and
- Procedures for getting rid of wastes created on site due to an emergency.

### 4.2.5 Review of Risk Management Effectiveness

Management should ensure that the risk management system aligns well with the organisation's critical performance measures. Undertaking this assessment may lead to a number of questions to the risk management approach such as:

- Are the organisation's objectives valid and measurable?
- Is the risk management approach consistent with the organisation's objectives and context?
- Are risk management reports being taken note of and used in the organisation's decision-making processes including the updating of procedures and information input to CAPEX/OPEX plans?

Risk management provides opportunities for management and staff at every level to continuously improve performance and contributes to improved performance by:

- Providing a structured approach to decision making;
- Promoting the identification of new opportunities;
- Providing an enhanced focus on outcomes;
- Supporting more effective, efficient and appropriate use of resources; and
- Allowing staff members at all levels to have constructive inputs into the risk management system.

Improvements must be able to be measured so that they become tangible and can be communicated to all interested parties.

## 4.3 Element 3 - Preventative measures for wastewater input quality management

**Components:**

- Critical Control Points (CCPs)
- Quality Control Points (QCPs)

Identification and implementation of preventive measures and prerequisite programs requires adopting the multiple barrier approach. The strength of this approach is that a failure of one barrier may be compensated by effective operation of the remaining barriers, minimising the likelihood of wastewater source hazards impacting upon the wastewater system and its end products. Some prerequisite programs may already exist through statutory and regulatory requirements e.g. plumbing regulations, while others may need to be developed by the water utility e.g. maintenance programs and chemical quality controls.

Preventive measures can be directly implemented by the water utility to reduce the risk profile of its wastewater system and may include:

- Trade waste management plan;
- Trade waste policy/management plan (e.g. no connection of bunded areas to sewer and mandatory roofing of trade waste generating areas);
- Detection of new customers;
- Trade waste customer risk assessment system;
- Trade waste customer contracts with quantity and quality limits;
- Trade waste customer monitoring program – quantity, quality and pre-treatment maintenance;
- Trade waste customer chemical usage inventory system;
- Trade waste customer self-monitoring;
- Trade waste customer breach management – cease and desist process;
- Tankered waste disposal management plan;
- Inflow/infiltration management plan;
- Adoption of Wastewater System Design Standards such as the WSAA Sewerage code of Australia (WSA 02);
- Wastewater system asset management plan
- Wastewater system chemical dosing management plan;
- Chemical supplier management plan; and
- Sewer mining and onsite wastewater treatment plant residual wastes policy.

**Box 4.1 Examples of Prerequisite Programs**

- Drinking water catchment management plan
- Drinking water treatment quality management plan
- Water industry legislation
- State and local government economic development plan
- State and local government development approval
- State and local government environmental licensing
- Domestic wastewater quality management plan
    - o Plumbing approval process
    - o Private plumbing and drainage standards
    - o Household hazardous chemical management
    - o New sewer connections
    - o Education and communication
- Trade waste management
    - o Trade waste legislation
    - o Plumbing / hydraulic services design plan approval process
    - o Private plumbing and drainage standards
- Cleaner Production
- Non-sewerable residual waste management plan (hazardous waste)
    - o Hazardous waste tracking system plan
    - o Radioactive waste management plan
- Water restrictions management plan

Assessment of preventive measures involves:

- Identifying existing preventive measures for each hazard;
- Evaluating whether the existing preventive measures, when considered together, are effective in reducing risk to an acceptable level; and
- Evaluating whether additional preventive measures are needed to further reduce risks.

### Box 4.2 Selecting Control Measures

Selection of appropriate barriers and preventative measures will be informed by the hazard identification and risk assessment process.

The types of preventative measures that need to be implemented will be similar for most water utilities, however, the range of preventative measures employed will be system specific. For example, a utility may choose to not accept the discharge of trade waste to the wastewater system where the wastewater treatment capacity is limited. However, when the wastewater treatment plant is upgraded, the utility might revise this policy to allow trade waste discharges to sewer because of the increase in capacity.

When implementing preventative measures, factors such as level of risk, benefits, effectiveness, cost, customer and stakeholder expectations and willingness to pay should be considered. Preventive measures may require considerable resources and expenditure to implement. Decisions regarding wastewater source quality improvements cannot be taken in isolation from other aspects of the management and operation of the wastewater system. Priorities will need to be established and many preventative measures may need to be phased in over time.

Methods to assist resolution of priorities could involve techniques such as a TBL (Triple Bottom Line) or MCA (multi-criteria analysis) approach to addressing and evaluating the competing interests of all parties and assist in establishing priorities. By adopting a TBL framework, which incorporates economic, environmental and social values into strategic or project level decision making processes, a consistent, coordinated and transparent approach is allowed for. Undertaking a TBL assessment can facilitate the selection of balanced options for a given circumstance.

MCA is generally used when environmental and social effects are of medium to high significance and where these significant effects cannot be monetised. MCA is a management tool that allows comparison of monetary and non-monetary data of various options by assigning scores and weights. In practice, the weight given to factors and the identification of relevant distinguishing factors is subjective and cannot be decided by 'experts' in isolation and ideally should incorporate the assessments of stakeholders and the decision-maker in a consultative forum.

All preventative measures are important and should be given on-going attention. However, some can significantly prevent or reduce hazards and are amendable to greater operational control than others.

Prerequisite programs are supporting programs implemented by either the water utility or external organisations that, when implemented successfully, help to reduce the overall risk profile of the wastewater system.

Assessment of prerequisite programs involves:

- Identifying existing prerequisite programs for the wastewater system;
- Evaluating whether the existing prerequisite programs are being effectively implemented and therefore effective in reducing the overall risk of the wastewater system. The evaluation of certain prerequisite programs will require a collaborative approach between the water utility and external organisations – particularly local councils and state government agencies; and
- Evaluating whether additional prerequisite programs are needed to further reduce overall system risks.

This information can be used to build an overall Source Control Improvement Plan with actions being staged for implementation.

### 4.3.1 Critical Control Points (CCPs)

**Summary of Actions:**

- Determine the critical control points within the wastewater system.

A CCP is a point in the system where a preventative measure prevents or eliminates a hazard or reduces a significant hazard to an acceptable level of risk. CCPs will generally be assigned at physical points in the wastewater system where monitoring of critical substances can occur on a continual basis. A critical limit is an exact value which can be measured, which if exceeded, initiates documented corrective action as the hazard is no longer under control. Trigger levels should be set lower than the critical limit so that a corrective action can be taken before the critical limit is exceeded. An example of how a CCP might be assigned is given in Box 4.3.

Box 4.3. Assigning a CCP – an example.

Following the hazard assessment and risk assessment process, a trade waste customer is found to pose a very high risk to the wastewater treatment process due to close proximity of their discharge to the treatment plant and high pH and organic load spikes from time to time.

The water utility and the customer agree that a new preventative measure is needed to reduce the risk of wastewater treatment process failure and a recycled water supply interruption.

It is decided to implement on-line trade waste effluent monitoring of COD and pH and link this data by telemetry to an actuated valve that automatically diverts non-compliant trade waste to a new holding tank when the critical limit (as determined by the water utility) is exceeded. The system will also send an alarm to the customer.

Since this new preventative measure can be measured online and significantly reduces the risk from this source, this new preventative measure in the system is designated as a CCP.

### 4.3.2 Quality Control Points (QCPs)

**Summary of Actions:**

- Determine the quality control points within the wastewater system.

A QCP is a physical point in the wastewater system that while important, is not critical to maintaining product quality, cannot usually be monitored on online, or is not under direct control of the water utility. Its purpose is to alert to a change from the 'normal' but the cause may not be immediately identifiable. Routine monitoring is undertaken at this point and limits can be set such that intervention can occur before the system fails. Example of QCP's include:

- A trade waste effluent monitoring point;
- A wastewater pumping station;
- An in-sewer wastewater monitoring point; or
- A prerequisite program key performance indicator.

When a monitoring event indicates that levels at a QCP have exceeded the set limit and a parameter is out of specification, a breach event is generated that signals a breakdown of the preventative measure or barrier.

A 'breach' management system must be developed to ensure breach events are corrected as soon as possible to return the risk to acceptable levels. This system must be supported by assessment and investigative processes and procedures to establish whether changes to operational procedures, implementation of the strategic policy components and the source management plan are required or whether the policy elements themselves require review and revision.

### 4.3.3 In-sewer Wastewater Quality Monitoring

A wastewater quality monitoring system within the wastewater transportation system should be established that considers the 5 Key Wastewater Source Management Objectives. Key locations where certain hazards need to be identified to allow immediate corrective actions to be undertaken within the wastewater system should be designated as QCPs and/or CCPs.

### 4.3.4 Trade Waste Effluent Monitoring

A trade waste discharge monitoring program should be established to achieve the 5 Key Wastewater Source Management Objectives. The program must be established with the aim of providing a warning that a trade waste discharge is approaching the limits detailed in trade waste control documentation.

### 4.3.5 Wastewater System Incident Monitoring

A wastewater system incident monitoring program must be established and include:

- Blockages:
- Worker safety issues;
- Asset corrosion/erosion;
- High dry weather flows;
- Suspect treatment plant performance; and
- Environmental/regulatory compliance issues.

Such incidents may be caused by 'out of specification' wastewater quality and must be recorded and trended. Limits need to be established to determine when the occurrence of incidents reaches an unacceptable level and corrective action is needed.

Box 4.4 Trade Waste Effluent Monitoring

Monitoring may include routine assessment and reporting of the following elements:

- Trade waste flow – with diurnal/weekly/monthly/seasonal variability (e.g. litres per second, litres per day);
- Contaminant concentration and mass – with diurnal/weekly/monthly/seasonal variability;
- Pre-treatment system maintenance; and
- Flow meter calibration.

## 4.4 Element 4 - Operational procedures and process control

**Components:**

- Operating Procedures
- Operational Monitoring
- Corrective Action
- Equipment Capability and Maintenance

The effectiveness of preventive measures is highly dependent upon the design and implementation of effective operating processes and procedures to manage all aspects of wastewater source and system management planning that contribute to achieving the 5 Key Wastewater Source Management Objectives.

It is vital to ensure that all wastewater management operations are documented as procedures, are optimised and are continuously controlled, and that barriers are functional at all times.

### 4.4.1 Operating procedures

**Summary of Actions:**

- Identify procedures required for processes and activities from wastewater source to the inlet of treatment.
- Document all procedures.

Operating procedures formalise the activities that are essential to manage the impact from wastewater sources upon the wastewater system and of the wastewater quality throughout the system.

Processes and procedures are most effective when asset management, operations, trade waste, customer service and systems planning staff are involved in their development, documentation and verification. This integrated approach also has the added benefit of facilitating an awareness of roles and responsibilities in managing the wastewater system. Therefore, sharing of information across organisational units and integration of all aspects of asset management, customer service, system operations and system planning should be integral to the development of standard operating processes and procedures.

Documentation of procedures should include a description of:

- Overarching preventive measures;
- Processes for relevant activities;
- Monitoring protocols, including substances and criteria;
- Schedules and timelines;
- Data and records' management requirements;
- Corrective actions to be implemented;
- Maintenance procedures;
- Responsibilities and authorities; and
- Internal and external communication and reporting requirements.

### 4.4.2 Operational monitoring

**Summary of Actions:**

- Develop monitoring protocols to identify, evaluate and monitor the risks posed by sources on a routine basis and to determine the contaminant load.
- Document monitoring protocols into an operational monitoring plan.

Operational monitoring includes the planned sequence of measurements and observations to assess and confirm the performance of preventive measures and could include:

- Source quality monitoring;
- Wastewater system monitoring;
- Regular inspections and asset condition assessment;
- Material Safety Data Sheet (MSDS) information;
- Odour monitoring;
- Trade waste monitoring; and
- Product quality (effluent, biosolids, biogas, receiving waters).

In the case of trade waste dischargers, monitoring could include activities such as regular inspections of the customer premises and processes (e.g. for integrity of their risk management systems), on-site plant treatment equipment and discussions with technical personnel.

Operational monitoring consists of those activities, which are critical to ensuring the effective ongoing management of trade waste (see below). Trade waste and wastewater monitoring should be linked with operational monitoring of the performance of the wastewater system at an overall and individual system component level. Operational monitoring is used to:

Select the relevant operational parameters and criteria;

- Support the routine analysis of results;
- Establish compliance with set standards and requirements;
- Provide the basis for trade waste charges;
- Determine the effectiveness of the trade waste management program;
- Identify modification and development requirements for the wastewater system; and
- Identify modifications to the management program.

The frequency and extensiveness of monitoring will depend on the potential impact the waste can have on the wastewater system, reuse activities and the environment. Appendix B gives an example of Water Corporation's approach to developing a monitoring program based on a relative risk algorithm. It should be noted that trade waste monitoring is a useful tool but can not be considered as absolute guarantee of effluent quality. Discrete monitoring should be complemented by comprehensive trend analysis to develop a customer profile.

#### 4.4.2.1 Development of Protocols

Operational monitoring protocols will contain some or all of the following components:

An initial assessment of a proposed discharge and the establishment of appropriate pre-treatment and monitoring facilities;

A program of site visits or inspections to maintain customer relationships, confirm compliance with acceptance criteria for non-domestic wastewater and to confirm the satisfactory operation and maintenance of pre-treatment facilities;

Programs and protocols for sampling and testing of trade waste discharges to confirm compliance with acceptance criteria for non-domestic wastewater and to determine contaminant concentrations for charging purposes;

A meter reading program to determine discharge volumes in order to confirm compliance with acceptance criteria for non-domestic wastewater and to determine waste quantities for charging purposes;

A protocol to manage self monitoring conducted by approved trade waste dischargers; and

A protocol to manage on-line real time monitoring conducted by approved trade waste dischargers.

#### 4.4.2.2 Initial Assessment/Establishment of Facilities

It is critical to accurately determine the impact and hence the potential risk that a new customer will impose on the wastewater system. Where a customer proposes to use a new process or a process that is unfamiliar to the water utility's staff, then additional investigation will be required to determine appropriate pre-treatment and monitoring facilities. Such an initial investigation may include a literature research accompanied by site visits, sample collection and analysis.

#### 4.4.2.3 Site Visits/Inspections

Site visits are used to develop and maintain customer relationships while facilitating an understanding of the roles and responsibilities of key personnel. Consequently, site visits provide the opportunity to ask questions and offer advice regarding trade waste management.

Site visits also provide an opportunity to inform customers on trade waste matters, the constraints imposed by the wastewater system on waste quantity and quality and hence the need to enforce acceptance criteria for non-domestic wastewater. The frequency of site visits and activities to be undertaken during a visit to a customer should be based on the potential risk that the customer's waste has on the wastewater system and the overall risk endpoints and products.

It is useful to calculate the risk that a particular customer might pose to a wastewater system. There are various models that utilities use to calculate risk but the general principles that might be employed include:

- Calculation of a risk factor for the customer using a formula or algorithm that takes into account all the factors and criteria influencing the risk;

- Assigning a weighting mechanism to the type of industry the customer represents (e.g. by ANZSIC Codes); and
- Applying risk ranking or prioritisation rules.

An example of a risk ranking approach that could be used is provided in Appendix Table 1.

When establishing an inspection program, consideration must be given to the hours of operation of a customer to ensure that visits occur throughout all periods of discharge. This often means that visits (sometimes unannounced) need to be made outside normal working hours and on weekends and public holidays and utility arrangements therefore need to be accordingly flexible

#### 4.4.2.4 Sampling

Adequate sampling of the effluent from trade waste customers, coupled with accurate relevant analysis is essential to maintaining efficient operation of the customer's process and pre-treatment, to determine compliance with acceptance criteria for non-domestic wastewater and to determine chargeable loads. In planning a sampling and testing regime, objectives need to be defined and will include one or more of the following:

- Determining compliance with discharge load or concentration limits;
- Providing data for charging purposes;
- Determining the concentration or mass load being discharged; and
- Providing operational data for process management.

Sampling should be undertaken on a random basis using one or more methods, including grab sampling, time proportional sampling, flow proportional sampling or continuous sampling.

Sampling frequency should be determined after consideration of the impact and risk of a particular waste on the wastewater system. The optimum sampling frequency for charging purposes may be determined using a statistical model. An example of a statistical model for optimum sampling frequency is shown in Appendix C.

Sampling techniques and protocols need to be well documented and strictly applied to ensure uniform, consistent and transparent results, which accurately represent the waste being discharged.

#### 4.4.2.5 Meter Reading

Meter reading programs are conducted to enable the determination of the volume of waste discharged by a customer. These programs also provide an opportunity, while on site, to briefly monitor other key aspects of a customer's discharge. The frequency of meter reading should be determined after consideration of the volume of a customer's discharge and the need to integrate with account billing cycles. In some cases it is not practical to install discharge meters. In these circumstances the discharge is expressed in terms of a factor of the incoming water supply.

Where a customer's discharge is in batches, an alternative to the installation and reading of meters is to require the use of a log book to record the details of individual discharges.

For certain high-risk discharges, it is desirable for the utility to require 'locked batch' discharges. In these cases, the utility will sample and test the quality of the batch proposed for discharge and, subject to satisfactory results on its quality, will unlock the storage facility and allow the discharge to occur.

#### 4.4.2.6 Self Monitoring

Self-monitoring of trade waste quality provides a trade waste generator with a number of operational and strategic advantages. Understanding the typical constitution of waste streams provides the opportunity to detect process changes or problems when variances in quality are detected and to reduce or eliminate the loss of valuable resources in the waste stream.

Self-monitoring provides greater control over trade waste agreement compliance issues, the opportunity to benchmark performance against other industries, influence charging by controlling and reducing waste loads and provides assurance that monitoring is truly representative of trade waste quality by providing details on appropriate sampling frequency, location and analytical substances.

Demonstration of ownership of trade waste management issues through self-monitoring of waste streams inevitably leads to trust developing between the waste generator, receiver and regulator, as there is a common understanding of the trade waste management needs. The trade waste generator should never be in a position of being 'caught-out' or surprised by compliance and management issues communicated to them by the wastewater business or a regulator.

Self-monitoring should be the subject of a written protocol agreed with each customer. Any changes to the protocol should first be approved by the water utility. All self-monitoring programs need to be audited to ensure compliance with sampling protocols.

#### 4.4.2.7 On-Line Real Time Monitoring

Whilst initially expensive to establish, on-line real time monitoring of wastewater quality and trade waste quality substances can lead to longer term cost savings in sampling and laboratory expenses as well as benefits in being able to respond to hazardous and other operational events in a timely manner.

Real time monitoring provides a more complete understanding of waste concentrations and loads, and variances in quality with time. The data obtained are integral to developing process improvements, with associated cost savings in tariff reductions, waste minimisation and resource loss, or avoidance of disputes with the waste receiver and/or regulator.

The location of instruments in the sewerage system needs to be carefully considered to take into account both separate and consolidated waste streams, for a more detailed understanding of key waste loads. Care must be taken to calibrate and maintain monitoring equipment to ensure true measurement of substances.

It is important to note that on-line real time monitoring equipment is currently limited to gross quality indicators, such as pH, electrical conductivity, turbidity and dissolved oxygen. Whilst there are developments in the real-time monitoring of specific chemical substances such as nutrients and sulphide, performance of the instruments in the wastewater system may be limited in the short term.

#### 4.4.2.8 Laboratory Accreditation

Generally, only laboratories holding NATA accreditation for the appropriate wastewater substances should be used for analysing wastewater samples, particularly where results of the samples will be used to assign trade waste charges.

When possible, the water utility should, from time to time submit quality assurance samples to laboratories to evaluate their performance. If results on quality assurance samples from a laboratory are not considered acceptable, routine trade waste results should not be accepted from that laboratory until it can demonstrate acceptable performance.

Only in special circumstances should the requirement for NATA registration be waived. In such cases, additional requirements to demonstrate competence should be required. The laboratory would normally be responsible for bearing the cost of these requirements.

### 4.4.3 Corrective action

**Summary of Actions:**

- Establish and document processes and procedures for corrective action to control excursions in operational substances.
- Establish rapid communication systems to deal with unexpected events.

Appropriate processes and procedures should be developed for any immediate corrective action required to promptly re-establish wastewater quality (and process control within the discharger's premises) following failure to meet trigger limits. The processes and procedures should include agreed trigger limits, instructions on required adjustments, process control changes and additional monitoring. Responsibilities and authorities, including communication and notification requirements, should be clearly defined.

Following implementation of a corrective action, effectiveness of the action will need to be verified. This verification will usually require additional monitoring. Secondary impacts of the corrective action and whether adjustments or action may be needed within the wastewater system should also be considered.

Examples of possible corrective actions for trade waste include:

- The discharger altering process operational conditions;
- The discharger installing additional equipment or using particular chemical aids (e.g. coagulant aids, flocculent aids) either temporarily or permanently to treat the trade waste and remedy the concern before further discharge;
- temporary cessation of production and discharge to sewer;
- Altering the trade waste discharge flow rate (e.g. reducing loading);
- Temporarily storing the problem trade waste on-site or diverting the discharge away from the sewer; and
- The water utility temporarily taking other amelioration measures to manage the problems in the wastewater system (for which it would be reimbursed).

Where possible, the underlying cause of the problem should be determined and measures implemented to prevent future occurrences. Analysis of the causes may identify possible solutions, such as modifying the dischargers operating processes or procedure or improving training of its staff. Details of all incidents should be recorded and reported.

While advance planning is important, it will not always be possible to anticipate every type of event. Rapid communication systems should be established to deal with these events.

Incident and emergency responses should be prepared for times when normal corrective actions cannot re-establish operational performance quickly enough to prevent wastewater and trade waste of unacceptable quality causing breaches of the wastewater source control objectives.

### 4.4.4 Equipment capability and maintenance

**Summary of Actions:**

- Ensure programs are in place to ensure equipment performs adequately and provides sufficient flexibility and process control.
- Ensure programs are in place for regular inspection and maintenance of all equipment, including monitoring equipment.

The capability of a trade waste discharger's equipment is an important consideration in maintaining process control and providing confidence to the wastewater authority that it is appropriately managing the wastewater quality risks. The wastewater authority must be assured that the customer has programs in place, commensurate with the risks associated with the quality of its trade waste discharge, to ensure that equipment performs adequately and provides sufficient flexibility and process control.

The discharger's equipment and infrastructure (as well as that in the wastewater authority's wastewater supply system) needs to be adequately designed and of sufficient capacity (size, volume, and detention times) to handle all flow rates (peak and otherwise) without limiting performance. Processes should not be hydraulically overloaded or subjected to rapid changes in hydraulic loading, as these conditions may compromise performance.

Design features that can improve performance and process control include:

- Online measuring devices that monitor operational substances continuously;
- Automated responses to changes in the quality of the final waste stream proposed for discharge and the key contributory streams;
- 24-hour monitored alarm systems that indicate operational failure;
- Back-up equipment, including power generators; and
- Discharger contingency plans for managing variations of unacceptable quality.

When new equipment and processes or increased production capacity are proposed, the trade waste discharger should satisfy the wastewater authority that it has undergone appropriate validation procedures through appropriate research and development or testing to ensure that its trade waste discharge will not deteriorate (see Section 4.9.2).

Equipment used by the trade waste discharger to monitor process performance should also be selected carefully. Monitoring equipment needs to be sufficiently accurate and sensitive to perform at the levels required. Wherever possible, monitoring should be online and continuous, with alarm systems to indicate when operational criteria have been exceeded. Monitoring failures should not compromise the system and in some cases, particularly at critical control points within the customer's premises, backup equipment should be considered.

Both the customer's operating staff and the utility's staff should understand the operation of monitoring equipment so that causes of spurious results can be recognised and rectified.

The utility must also be assured that the customer has established a program for regular inspection and maintenance of all equipment, including monitoring equipment to ensure continuing process capability. The discharger would be expected to have established and documented a competent maintenance program.

### Box 4.5 Components of a maintenance program

- Operational procedures and records for the maintenance of equipment, including the calibration of monitoring equipment;
- Schedules and timelines;
- Responsibilities; and
- Resource requirements.

## 4.5 Element 5 - Verification of wastewater inputs quality

**Components:**

- Wastewater System and Environmental Monitoring
- Short-term Evaluation of Results
- Corrective Action

Verification of the effectiveness of the Wastewater Source Management Program provides an assessment of the *overall* performance of the program and the impact on the wastewater treatment process including:

- Opportunities to determine if the wastewater source risks are being managed effectively or if the wastewater source management program needs any immediate corrective actions or incident and management response; and
- Confidence to the utility and the regulator regarding wastewater source management

There is also a need to undertake activities to verify the efficacy of the management program. These activities include:

- Ensuring that prerequisite programs are implemented
- Hazard analysis is continuously reviewed
- Hazard levels are acceptable, and
- Procedures are being implemented.

### 4.5.1 Wastewater System and environmental monitoring

**Summary of Actions:**

- Determine the substances to be monitored, the frequency of monitoring, the sampling locations and type of sample (grab or composite).
- Establish and document a sampling plan detailing the above information.
- Ensure monitoring data is representative and reliable.

#### 4.5.1.1 Wastewater monitoring

A routine wastewater influent quality monitoring program must be established at wastewater treatment plants to verify that the wastewater source management system is effective at maintaining wastewater treatment plant wastewater influent quality at acceptable levels. Wastewater influent quality upper control limits for both concentration and mass loads must be established for all substances at each wastewater treatment plant based on available treatment capacity, effluent licence conditions and recycled water/biosolids reuse thresholds.

High-risk substances could include:

- Substances that could inhibit or impact on biological processes at the wastewater treatment plant;
- Substances that are not readily biodegradable (if a biological treatment facility is in use) or removed (if an advanced treatment facility is in use) which can result in breaches of effluent quality standards in waterway discharge licences; and
- Substances that restrict the suitability of biosolids for sustainable land application or energy recovery or the suitability of recycled water for sustainable water recycling.

The frequency of wastewater sampling and analysis for individual substances and the type of sample will be system specific and will be influenced by how each contaminant relates to the 5 Key Wastewater Source Management Objectives. Such sampling should be frequent enough to enable the monitoring to provide meaningful information and statistical validity.

#### 4.5.1.2 Environmental Monitoring

In addition to wastewater influent monitoring, there are other indicators and data collected during assessment of source management performance that can be useful in terms of environmental monitoring, examples include:

- **Air Quality Monitoring –** This can either be based on wastewater ventilation points or at wastewater pumping stations. Most wastewater systems will have monitoring in place for condition evaluation for substances such as hydrogen sulphide, methane or lower explosive level (LEL). The monitoring can either be based on discrete results such as confined space entry data from portable gas testing equipment, or fixed equipment on vent shafts or pumping station wet wells.
- **Biosolids Data –** There is generally a requirement for all biosolids to be tested for applicability or grading for varied reuse applications. In addition to this, the data can be used to determine both baseline and exception reporting for substances such as metals and chlorinated compounds.
- **Reject Stream Data –** Streams that are either sent to the head of a treatment works or direct to the environment, such as supernatant, filtrate or reverse osmosis reject, generally represent a concentration of substances. The analysis of these streams may be used to determine disposal options and may also provide information on substances that are difficult to detect in wastewater influent due to concentrations below reporting levels or detection limits.
- **Final Plant Effluent –** While primarily used for discharge licence compliance and assessment of suitability for water recycling, this information can also be a surrogate for determining if the influent contains substances, which might inhibit biological activity.

Once substances and sampling locations have been identified, these should be documented in a consolidated monitoring plan. Monitoring data should be representative, reliable and fully validated. Procedures for sampling and testing should also be documented (Box 4.6).

### 4.5.2 Short-term Evaluation of Results

**Summary of Actions:**

- Establish procedures for assessing monitoring results.
- Develop reporting mechanisms.

Performance evaluation involves assessing monitoring data to verify that quality conforms to established targets and meets performance expectations. In cases of non-conformance, immediate corrective actions or incident and/or emergency responses should be implemented. Control measures should be reassessed if expectations of system performance are not being consistently met.

Box 4.6. Example considerations in ensuring reliability of data.

Monitoring is only as good as the data collected, so every effort should be made to ensure that the data are representative, reliable and fully validated. Appropriate procedures should be in place and the following items need to be considered:

Sampling Plan:

- Substances measured, sampling locations, sampling frequency.
- Qualifications and training of personnel.
- Approved sampling methods and techniques.
- Quality assurance including control samples (field blanks, trip blanks, duplicates, etc) and validation procedures for sampling.
- Statistical validity.

Analytical Testing:

- Qualification and training of personnel.
- Suitability of equipment.
- Use of approved test methods and accredited laboratories.
- Quality assurance and validation procedures (e.g. Positive and negative control samples, inter-laboratory comparisons).

Monitoring Equipment:

- Monitoring and inspection procedures to ensure control of monitoring equipment.
- Ensure equipment is calibrated to standard
- Equipment integrity and security are maintained.

Generally, only laboratories holding NATA accreditation for the appropriate wastewater substances should be used for analysing wastewater samples.

Only in special circumstances (e.g. for research projects) should the requirement for NATA registration be waived. In such cases, additional requirements to demonstrate competence should be required. The laboratory would normally be responsible for bearing the cost of these requirements.

Those responsible for interpreting and recording results should understand clearly how to assess results and communicate them through established reporting mechanisms. Results should be reviewed within appropriate timeframes and should be compared with previous results, established baseline expectations and guideline values. Procedures for performance evaluation and recording of results should be established and documented.

### 4.5.3 Corrective action

**Summary of Actions:**

- Establish and document procedures for corrective actions and responses to non-conformances.
- Establish communication systems to deal with unexpected events.

#### 4.5.3.1 Establish procedure for corrective actions

When monitoring results indicate a non-conformance, pre-determined procedures should be implemented to bring the process back under control. Failure to take immediate or corrective action may lead to situations requiring the activation of incident or emergency protocols.

#### 4.5.3.2 Establish communication systems

It is important to respond immediately to exceedances that compromise meeting the 5 Key Wastewater Source Management Objectives. Corrective action procedures should be clearly documented, responsibilities and authorities should be clearly defined and communicated, and staff should be trained in appropriate procedures.

## Element 6 - Management of incidents/complaints and emergencies

**Components:**

- Communication
- Incident and emergency response protocols

Although preventive strategies are intended to prevent incidents/complaints and emergency situations from occurring, some events cannot be anticipated or controlled, or have such a low probability of occurring that providing preventive measures would be too costly.

For such incidents/complaints, there must be an adaptive capability to respond constructively and efficiently. Wherever possible, emergency scenarios should be identified, assessed, and incident/complaints and emergency protocols, including communication procedures, should be planned and documented. Establishing procedures 'on the run' is likely to lead to inefficiency, lack of coordination, poor response times and potential loss of public confidence.

A risk assessment and review of the hazards and events that can lead to emergency situations should be carried out. Examples of events could include:

- Non-conformance with trade waste quality requirements (the customer) or regulatory and other obligations and requirements (the utility);
- Unauthorised or illegal discharges;
- Accidents within the customer's premises that increase levels of substances (e.g. due to blockages and overflows);
- Changes in the raw materials that could affect processes or treatment effectiveness;
- Equipment breakdown and mechanical failure within the customer's premises;
- Prolonged power outages within the customer's premises and in the wastewater system;
- Extreme weather events (e.g. flash flooding, cyclones);
- Natural disasters (e.g. fire, earthquakes, lightning damage to electrical equipment); and
- Human actions (e.g. serious error, sabotage, strikes).

The development and implementation of appropriate protocols to manage these events is necessary to avoid an incident and could include:

- Bunding around tanks and equipment or isolate areas of site where risk of spill to sewer is too great;
- Automatic shutoff valves;
- Additional storage for holding off-specification effluent or partially treated wastewater; and
- Alarms and automatic notification to appropriate staff when key substances exceed predetermined trigger levels.

### 4.6.1 Communication

**Summary of Actions:**

- Define communication protocols with the involvement of relevant agencies and prepare a contact list of key people, agencies and businesses.
- Develop a public and media communications strategy.

Effective communication is vital in managing incidents/complaints and emergencies. Clearly defined protocols for both internal and external communications should be established in advance, with the involvement of relevant agencies, including health and other regulatory agencies, and customers as appropriate.

These protocols should include a contact list of key people, agencies and businesses, detailed notification forms, procedures for internal and external notification, and definitions of responsibilities and authorities. Contact lists should be regularly updated (e.g. six-monthly) to ensure that they are accurate.

Maintaining customer and public confidence and trust during and after an incident/complaint or emergency is essential and is largely affected by how incidents/complaints and emergencies are handled.

A public and media communication strategy should be developed before any incident or emergency situation occurs. Draft public and media notifications should be prepared in advance and formatted for the target audience. An appropriately trained and authoritative contact should be designated to handle all communications in the event of an incident or emergency. All employees should be kept informed during any incident, because they provide informal points of contact for customer and stakeholders.

Customers and the public should be told when an incident has ended and be provided with information on the cause and actions taken to minimise future occurrences. This type of communication will help allay customer and stakeholders concerns and restore confidence.

### 4.6.2 Incident and emergency response protocols

**Summary of Actions:**

- Define potential incidents and emergencies and document procedures and response plans with the involvement of relevant agencies.
- Train employees and regularly test emergency response plans.
- Investigate any incidents or emergencies and revise protocols as necessary.

Incident and emergency response protocols should be regarded as a priority. Potential incidents and emergencies should be defined and response plans should be developed and documented in advance to respond to these events.

Plans should be developed in communication with relevant regulatory authorities and other key agencies, and should be consistent with existing government emergency response arrangements. In an emergency situation there will not be time to establish confidence and goodwill if these have not been established during normal operation.

An investment in advance for building trust and understanding with parties who will be partners in responding to an emergency will pay important dividends in the form of more effective action when an emergency arises.

Employees should be trained in emergency response to ensure that they can manage any potential incidents or emergencies effectively. Incident and emergency response plans should be regularly reviewed and practiced. Practice and review improve preparedness and provide opportunities to improve the effectiveness of plans before an emergency occurs.

Box 4.7 Emergency Response Plans

Key areas to be addressed:

- Response actions, including increased monitoring;
- Authorities and responsibilities internal and external to the organization; and
- Communication protocols and strategies, including notification procedures (internal, regulatory body, media and public).

Following any incident or emergency situation, an investigation of the incident or emergency should be undertaken and all involved staff should be debriefed to discuss performance and address any issues or concerns.

Appropriate documentation and reporting of the incident or emergency should also be established. The organisation should learn as much as possible from the incident to improve preparedness and planning for future incidents and to ensure that it doesn't recur.  Review of the incident may indicate necessary amendments to existing protocols.

Response to complaints from site neighbours and members of the public is an integral part of system operation. It is important that reports of complaints and/or incidents are dealt with correctly. They can be categorised into:

- Incident/complaints communication response and notification protocols;
- Responsibilities;
- Investigation and action; and
- Incidents' overview.

An incident that requires reporting may be categorised into one of the following types:

- Network incidents; and
- Company/organisation incidents.

Box 4.8 Analysing an Incident

Factors to consider in investigating an incident:

- What was the initiating cause of the problem?
- How was the problem first identified or recognised?
- What were the most critical actions required?
- What communication problems arose and how were they addressed?
- What were the immediate and longer-term consequences?
- How well did the protocol function?

4.6.2.1 Incident Notification and Response

Incidents such as unusual discharges or sewer overflows in the wastewater system are sometimes identified during normal wastewater field operations' activities. An incident may include excessive fumes (sometimes, but not always, registering gas alarms), unusual odours or discolouration of the wastewater. As part of the incident response:

- The wastewater source management staff should be notified as soon as possible, so that further investigation can be carried out.
- The asset management staff should manage the incident and return the sewer to normal conditions while the wastewater source management staff will investigate possible causes.

Incident protocols should contain a list of 24-hour contacts of all agencies and should be updated and reissued every six months. Specifically, internal and external emergency contacts should be identified.

## 4.7 Element 7 - Employee awareness and training

**Components:**

- Employee awareness and involvement
- Employee training

The successful implementation and ongoing performance of a wastewater source control management program relies on the knowledge, skills and motivation of employees. It is vital that awareness, understanding and commitment to performance optimisation and continuous improvement are developed and maintained within the organisation.

### 4.7.1 Employee awareness and involvement

**Summary of Actions:**

- Develop mechanisms and communication procedures to increase employees' awareness of and participation in wastewater source management.

An understanding of wastewater source management is essential for empowering and motivating employees to make effective decisions. All employees in the water utility should be aware of:

- The organisation's wastewater source management policy;
- The procedures, protocols and methods used to meet the policy objectives;
- Regulatory and legislative requirements;
- Roles and responsibilities of employees and departments, including links between departments and other authorities;
- Responsibilities of the wastewater dischargers;
- The characteristics of the wastewater system and associated contingency plans; and
- How their actions can impact on the wastewater system and wastewater source management objectives.

Mechanisms and communication procedures should be developed to ensure awareness of, and commitment to, wastewater source management throughout the organisation. Methods to increase employee awareness can include employee education and induction programs, newsletters, guidelines, manuals, notice boards, seminars, briefings and meetings.

Adequate procedures should also be in place to ensure that any changes to standards, regulation or prerequisite programs that could potentially impact on the guideline are communicated.

Employee participation and involvement in decision making is an important part of establishing the commitment necessary for the continuous improvement of wastewater source management. Employees should be encouraged to participate in decisions that affect their jobs and areas of responsibility. Such participation provides a sense of ownership for decisions made and their implications. Open and positive communication is a foundation to creating a participatory culture, and employees should be encouraged to discuss issues and actions with management.

### 4.7.2 Employee training

**Summary of Actions:**

- Ensure that employees, including contractors, maintain the appropriate experience and qualifications.
- Identify training needs and ensure resources are available to support training programs.
- Document training and maintain records of all employees training.

Employees and contractors must be appropriately skilled and trained in order to effectively implement a wastewater source management program. Training also reinforces the potential risks that wastewater sources can present to the 5 Key Wastewater Source Management Objectives.

Employees should have a sound knowledge base from which to make effective decisions. This requires training in the methods and skills required to perform their tasks efficiently and competently, as well as knowledge and understanding of the impact of their activities.

Training needs should be identified and adequate resources made available to support appropriate programs. Examples of relevant areas to address are:

- The importance of risk assessment and management;
- Understanding the impacts of trade waste, and other sources, on wastewater quality and achievement of the 5 Key Wastewater Source Management Objectives;
- Waste minimisation;
- Wastewater biology and chemistry;
- Sampling, monitoring and analysis;
- Interpretation, recording and reporting of results;
- Legislation;
- Customer service;
- Negotiation and conflict resolution;
- Incident and emergency response; and
- Trade waste charging.

Commonly used training techniques and methods include accredited training courses, in-house training, on-the-job experience, mentor programs, workshops, demonstrations, seminars, courses and conferences. Training programs should encourage employees to communicate and think critically about the operational aspects of their work.

Records of all employees who have participated in training should be maintained. Mechanisms for evaluating the effectiveness of training should also be established and documented. Training is an ongoing process and requirements should be regularly reviewed to ensure that employees maintain the appropriate experience and qualifications.

## 4.8 Element 8 - Customer and stakeholder involvement and awareness

**Components:**

- Customer and stakeholder awareness and involvementCommunication with customers

An external communication program is a long-term commitment, including education, and should be designed to provide an active, two-way exchange of information. This approach will help to ensure that customers' and stakeholders' needs and expectations are understood and are being satisfied.

A clearly defined responsibility for managing this process should be documented.

### 4.8.1 Customer and Stakeholder Awareness and Involvement

**Summary of Actions:**

- Develop an effective strategy for customer and stakeholder communication

Decisions on wastewater source management made by a water utility and the relevant regulatory authorities must be made in the context of achieving the 5 Key Wastewater Source Management Objectives. Customers and stakeholders should be consulted during decision-making processes.

The development of customer communication strategies requires:

- Definition of the scope of the issue and the potential links with wider issues or problems. This approach will provide an indication of the extent of communication or education required;

- Identification of specific customer, industry, interest and stakeholder groups that may be affected, such as suppliers, contractors, statutory and regulatory authorities, customer and stakeholder groups and their representatives. All groups should be able to participate in the communication process irrespective of barriers of language, distance, technical knowledge or lack of resources;
- Analysis of these groups needs, expectations, preferences and concerns need to be considered;
- Presentation of factual information to the customers and stakeholder groups in a form that is accessible, understandable and suitable as a basis for informed discussion;
- Provision of adequate time for communication. The customer and stakeholders should be included in the process proposed for the communication; and
- Inclusion of measures to evaluate the effectiveness of the customer and stakeholder communication process.

Effective customer and stakeholder communication includes:

- Briefings targeted to specific customers or industry groups who are potentially impacted or who have particular interests responsibilities;
- Workshops or seminars on key issues or for special industry groups;
- Focus groups and market research or surveys to determine customer and/or stakeholder views, knowledge and attitudes;
- Customer councils or customer panels;
- Informative media programs targeting print media, radio and television;
- Customer and stakeholder education or information exchange programs;
- Preparation of technical issues' papers;
- Public hearings for major and controversial initiatives; and
- School programs and informative media programs.

While this communication can be conducted on a one-on-one basis with individual industry firms, it has been demonstrated that an effective mechanism for communication and feedback is by way of a formalised process through an advisory council or 'customer forum'. This mechanism has the added advantage of direct access to significant major customer groupings in order that some form of major customer management can be facilitated. Records should be kept of all customer and stakeholder communication.

### 4.8.2 Communication with customers

**Summary of Actions:**

- Develop an effective communication program to inform customers and promote awareness of wastewater source management.

Effective communication to increase customer and stakeholder awareness and knowledge of wastewater source management and the various areas of responsibility is essential. Communication helps customers and stakeholders to understand the decisions about the service provided by the water utility and the impacts of the quality of discharges to the wastewater system.

Procedures for disseminating information to promote awareness of wastewater and source issues to all customers and stakeholders should be established. Possible methods include annual or other periodic wastewater and source quality reports, newsletters, workshops, seminars or briefings, media programs, websites, wastewater system and treatment plant tours and school education programs.

Additional mechanisms such as a service line or complaint handling system should be established to provide opportunities for customers to communicate their needs and expectations.

## 4.9 Element 9 - System validation, research and development

**Components:**

- Validation of Processes
- Investigative Studies and Research Monitoring
- Design of Equipment

### 4.9.1 Validation of processes

**Summary of Actions:**

- Validate processes and procedures to ensure that they are effective at controlling the risks associated with the quality of wastewater discharges.
- Revalidate processes periodically or when variations in conditions occur.

Validation involves evaluating scientific and technical information available on the potential impacts of the overall wastewater quality and the individual substances in particular discharges on the organisation's ability to manage wastewater system risks and reasonably meet the 5 Key Wastewater Source Management Objectives. This evaluation would be supported by undertaking investigations, where necessary, to validate system-specific operational procedures, critical limits and target criteria. The aim of process validation is to ensure effective operation and control.

Historical data, operational experience and benchmarking against other utility's management systems can also be useful sources of information. Processes should be revalidated on a regular basis or when variations occur (e.g. seasonal variations). Any new processes should be tested using bench-top, pilot-scale or full-scale experimental studies to confirm that the process and operational criteria produce the required results under the conditions specific to the individual wastewater system.

A corporate commitment to conduct and participate in research and development on wastewater sources issues is important in terms of ensuring continual improvement and ongoing capability to meet 5 Key Wastewater Source Management Objectives. Any research conducted needs to be communicated to customers and stakeholders and can form part of the requirements of Element 8 (Section 4.8).

**Box 4.9 Applied R&D for Source Management**

Applied research and development may be directed towards:

- Understanding the wastewater system;
- Identifying, understanding and providing actions for addressing the barriers to facilitating water and biosolids recycling;
- Investigating improvements, new processes, emerging effluent quality and environmental constraints, emerging issues with particular substances in wastewater (e.g. endocrine disruptors), emerging issues on asset integrity impacts and new analytical methods;
- Validation of operational effectiveness of new products and processes; and
- Increasing understanding of the relationship between the 5 key wastewater source management objectives and system wastewater quality and source input quality of discharges to the wastewater system.

Research can be performed at various levels. At the local level, this could include increasing the understanding of the quality of discharges from individual trade waste customers and the impact on system performance and more broadly, of the quality and impacts of wastes specific to a particular industry or of the quality and impacts of the wastes from the aggregation of industries in a particular catchment or to a wastewater system overall.

Research at both a local wastewater catchment level and also at an overall wastewater system, increases understanding of the specific characteristics of individual trade waste and domestic discharges and their impacts on system performance. Local wastewater catchment and overall system research could include, for example, detailed analysis of temporal and spatial variations in source water substances. Research and development activities should also investigate mechanisms to improve and optimise system performance, evaluate treatment processes, evaluate environmental impacts of effluent discharged, facilitate increased water and biosolids recycling (including the validation of critical limits and target criteria) and design new policies, programs or infrastructure to achieve these. These activities should be carried out under controlled conditions by qualified staff, and all protocols and results should be documented and recorded.

A cost effective means of undertaking research is through collaboration across water authorities, partnerships with other organisations and industry-wide cooperation. This approach particularly helps to address the broader issues associated with wastewater characterisation, evaluating wastewater quality impacts, treatment processes, environmental impacts and barriers to and means of facilitating recycling including the development and evaluation of new guidelines, evaluation processes and technologies. Opportunities for collaboration and initiation of joint research and development projects should be identified. Partner organisations may include water authorities, peak organisations (e.g. WSAA), Cooperative Research Centres, environmental agencies, specific industry associations, particular customers and stakeholders and universities (see Box 4.10 and Box 4.11 for examples of source research and development and their outcomes).

Box 4.10 Example of research and development (Source: Sydney Water).

In early 2002, Sydney Water experienced an unexpected and significant structural sewer collapse of a 600mm diameter main sewer at a critical location in the downstream end of the Smithfield Carrier. The location of this failure was unusual in that the Smithfield catchment is at the most upstream end of the Malabar wastewater system where residence times are quite short and significant sulphide generation and corrosion was not expected to occur.

An initial investigation and monitoring revealed that:

- The wastewater pH levels varied typically from 4 to 7 (often at the lower end of this range) and the BOD load of wastewater in this catchment was predominantly from trade waste sources (> 90%);
- The aggregation of industries in this catchment and their type was the source of these concerns and ultimately the cause of the accelerated corrosion and sewer failure; and
- The key influencing industries were a paper manufacturer, a dairy food manufacturer, drink manufacturer, a vegetable processor and a food manufacturer.

This investigation resulted in the Smithfield catchment being declared *"corrosion impacted"* and therefore, more stringent acceptance standards and additional charges could be applied.

The second stage of the investigation demonstrated that certain wastes:

- Had significant and very high concentrations of soluble and readily biodegradable BOD and COD (noting that the acceptance standards for discharge had historically been focussed on minimising solids discharged to sewer as ultimately the Malabar system wastewater is treated at an ocean plant not an inland plant); and
- Were not pH stable when mixed with domestic wastewater (resulting in the observed lowered pH throughout this system).

Through research and assessment of the causes and impacts of these two factors, a protocol was developed that allowed the most significant trade wastes to be classified and categorised into low, medium, high and very high corrosion risk. The two criteria key to the corrosion risk classification being pH stability and the concentration of soluble BOD/COD. Sydney Water has developed a revised pH stability test that establishes the variability/stability in pH over time when a particular trade waste is mixed with purely domestic wastewater.

The third stage of the investigation demonstrated, through further testing and assessment, that with appropriate biological treatment the level of soluble BOD could be materially reduced and the pH stability restored to an acceptable level. This approach would allow all the key dischargers currently assessed as being very high and high corrosion risk to be reclassified as low corrosion risk with the adoption of appropriate further treatment before discharge.

The outcomes of this research and development are that new standards (and charges if not compliant) are to be applied to catchments declared as "corrosion impacted". These network protection acceptance standards to protect the network assets in the Smithfield and Malabar systems are:

- Total BOD $\leq$ 600 mg/L;
- Soluble BOD $\leq$ 100 mg/L; and
- pH stable (and $\leq$ 7) after a 24 hour period based on Sydney Water's test procedure; and
- Temperature $\leq$ 30°C.

Through a lengthy process of consultation, the relevant customers have developed EIPs (effluent improvement plans) focussed on waste minimisation and improved on-site treatment and have a plan to actively implement them.

Box 4.11 Example of characterising domestic wastewater quality.

The Melbourne water utilities have undertaken a collaborative project to establish the quality of wastewater from purely domestic catchments.

The value of this work is to establish a baseline from which more robust system mass balances for various substances can be obtained, to identify those substances originating from domestic sources that cause difficulties in achievement of the 5 Key Wastewater Source Management Objectives; to establish the relative contributions of domestic waste and trade waste to the concentrations and loads of a range of wastewater constituent (particularly those considered to be critical substances).

This has involved identification of appropriate catchments for assessment. This project is an ongoing study and the findings of the research have not yet been published. It is likely that further information will be available at the next revision of this document

### 4.9.2 Investigative Studies and Research Monitoring

**Summary of Actions:**

- Establish programs to increase understanding of the wastewater system and the impacts of trade waste discharges.
- Use information to improve management of the wastewater system and the quality of trade waste and other wastewater sources.

Investigative studies and research monitoring include strategic programs designed to increase understanding of a wastewater system and the impacts of wastewater quality generally, and trade waste quality in particular, on each component of the wastewater system and the risks to achievement of the 5 Key Wastewater Source Management Objectives. The purpose of such studies is to establish baseline information or specific catchment characteristics (e.g. wastewater quality), identify and characterise potential hazards and to fill gaps in knowledge. Improved understanding of the factors affecting wastewater quality characteristics allows trade waste dischargers and customers to be kept abreast of emerging issues and of future changes in wastewater quality requirements and respond to them in an effective and timely way.

Examples of investigative studies could include:

- Baseline monitoring of substances or testing of potential new or newly identified wastewater and trade waste sources to identify wastewater quality problems (e.g. impacts of discharge of brine stream to sewers from sewer mining either within or across catchments);
- Wastewater and trade waste quality monitoring to understand the temporal and spatial variability of wastewater and trade waste substances;
- Developing early warning systems to improve the management of poor trade waste or wastewater quality;
- Event-based monitoring to determine the magnitude of impacts (duration and maximum concentrations);
- Examining the effects of a combination of discharges in a particular catchment that may create local (as well as systemic) problems; and
- Evaluating characteristics of groundwater infiltration.

In addition, monitoring could provide input into predictive modelling of wastewater quality impacts on wastewater system performance or assist in the selection of management and treatment approaches. Careful consideration should be given to the selection of wastewater and wastewater quality characteristics to be analysed, use of statistical techniques, collection of samples (frequency and location), use of appropriate sampling and testing procedures, evaluation and management of results.

Tracing the cause of the impacts of odours from the wastewater system and of wastewater quality on the structural integrity of wastewater infrastructure often initiates investigations in its own right.

### 4.9.3 Design of equipment

**Summary of Actions:**

- Validate the selection and design of new equipment and infrastructure to ensure continuing reliability.

Research and development should be undertaken to validate the selection and design of new equipment and infrastructure, or to confirm design changes necessary to meet the 5 key wastewater source management objectives. New technologies require pilot-scale research and evaluation before full-scale implementation. Procedures and processes should be established to ensure that new equipment will be able to meet the intended requirements and provide necessary process flexibility and controllability (see Section 4.4.4).

Similarly, appropriate measures should be designed into system facilities to enable wastewater sources which pose material risks to be appropriately stored and managed before discharge and to ensure that the potential for illegal discharges directly into the system is minimised.

## 4.10 - Element 10 - Documentation and reporting

**Components:**

- Management of documentation and records-Reporting

Appropriate documentation provides the foundation for the establishment and maintenance of effective systems for management of wastewater sources to a wastewater system. Documentation provides a basis for effective communication within the organisation, with the customer and stakeholder.

A system of regular reporting, both internal and external, is important to ensure that the relevant people receive the information needed to make informed decisions about the management of wastewater source quality and the effectiveness of the systems for ensuring that the 5 Key Wastewater Source Management Objectives, and regulatory objectives, are met.

### 4.10.1 Management of Documentation and Records

**Summary of Actions:**

- Document information pertinent to all aspects of wastewater source quality management.
- Develop a document control system to ensure current versions are in use.
- Establish a records management system and ensure that employees are trained to fill out records.
- Periodically review documentation and revise as necessary.

Documentation pertinent to all aspects of wastewater source quality management is required. Documentation should:

- Demonstrate that a systematic approach is established and is implemented effectively;
- Provide for developing and protecting the organisation's knowledge base;
- Provide an accountability mechanism and tool;
- Include a process for facilitating review and audits of the management systems and information by providing written evidence of the system;
- Establish due diligence and credibility;
- Be a basis for effective communication;

Documentation should include detailed information on:

- Preventive measures;
- Critical control points, including specific operational procedures and criteria, monitoring and corrective actions;
- Incident and emergency response plans;
- Training programs;
- Procedures for evaluating results and reporting;
- Consultation and communication protocols; and
- Performance evaluations, audits and reviews.

Documentation should be visible and readily available to employees. Mechanisms should be established to ensure that employees read, understand and adhere to the documents and current versions are used while obsolete documents are discarded.

Operation of systems and processes leads to the generation of large amounts of data that need to be recorded and stored. A records management system for efficient record keeping and data storage, management and retrieval is essential for indicating and forewarning of potential problems, providing evidence that the system is operating effectively, and reporting to stakeholders.

All the above listed activities will generate records that must be managed.

Documentation and records systems should be kept as simple and focused as possible. The level of detail in the documentation of procedures should be sufficient to provide assurance of operational control when coupled with a suitably qualified and competent wastewater system operator. Retention of corporate memory should also be considered in documentation of procedures.

Storage should provide protection against damage, deterioration or loss. A system should be in place to ensure that employees are properly trained to fill out records, and that records are regularly reviewed by a supervisor, signed and dated.

Documents and records can be stored in a variety of forms, such as written documents, electronic files and databases, video and audiotapes, and visual specifications (flow charts, posters etc). Computer-based documentation should be considered to allow for faster and easier access as well as to facilitate updating.

Mechanisms should be established to periodically review and, where necessary, revise documents to reflect changing circumstances. Documents should be assembled in a manner that will facilitate any necessary modifications.

### 4.10.2 Reporting

**Summary of Actions:**

- Establish procedures for effective internal and external reporting.
- Produce an annual report to be made available to consumers, regulatory authorities and stakeholders consistent with individual water authority commitments and obligations.

Reporting includes the internal and external reporting of activities pertinent to the implementation and performance of wastewater source control management. The level of reporting will depend on the importance of the wastewater source quality, trade waste in particular, in achieving the 5 Key Wastewater Source Management Objectives and any reporting obligations.

Internal reporting supports effective decision making at the various levels of the organisation, including operations' staff and management, senior management and the board of directors. Internal reporting also provides a way to communicate information between the various levels and functions of the organisation, particularly between the asset managers and operators and wastewater/trade waste source and customer service personnel and to employees throughout the organisation. Documented procedures (including definition of responsibilities and authorities) should be established for regular reporting (daily, weekly, monthly etc).

These reports should include summaries of monitoring data, performance evaluation and significant operational problems and incidents that occurred during the reporting period and with corrective actions identified. Results from audit and management reviews should also be communicated to those within the organisation responsible for performance.

External reporting ensures that wastewater source quality management is open and transparent. It includes reporting to regulatory bodies, customers and other stakeholders in accordance with requirements. External reporting requirements should be established in consultation with customers, stakeholders and the relevant regulatory authorities. Procedures for information dissemination should also be developed.

Agreement should be reached with the environmental and other relevant regulators on the requirements for:

- Regular reports summarising compliance performance against specified objectives and targets and the wastewater source quality data as relevant; and
- Reports on significant system failures that may pose a risk to achieving the 5 Key Wastewater Source Management Objectives.

Reports should be provided to the environment and other regulatory authorities at least for incidents defined in agreed incident and emergency response protocols.

An annual report should be produced and made available to customers, stakeholder and regulatory authorities. The annual report will vary considerably between wastewater utilities and as a guide for best practice the annual report should include:

- Summarised wastewater source quality management performance, particularly with regard to trade waste sources, and wastewater system performance over the preceding year against numerical guideline values, regulatory requirements or agreed levels of service and the 5 Key Wastewater Source Management Objectives and the identification of any wastewater quality trends and problems;
- A summary of any system failures due to shortcomings in wastewater source control management and the action taken to resolve them;

- Clear articulation of whom the wastewater source control manager is accountable to, statutory or legislative requirements, and minimum reporting requirements; and
- An indication of whether monitoring was carried out in accordance with the principles of risk management set out in the organisation's standard operating procedures and practices, this Wastewater Source Management Guideline, standards set by the regulator and any requirements contained in agreed levels of service reflected in customer contracts or documented business policies.

Annual reports should contain sufficient information to enable individuals or groups to make informed judgments about the quality of wastewater discharged into the wastewater system and the impacts on the 5 Key Wastewater Source Management Objectives and provide a basis for discussions about the priorities that will be given to improving wastewater source control. The annual report represents an opportunity to canvas feedback, and it should therefore encourage customers and stakeholders to provide comment.

## 4.11 Element 11 - Evaluation and Audit

**Components:**

- Long term evaluation of results
- Audit of the wastewater quality and source control management
- Regulatory oversight and surveillance

Long-term evaluation of wastewater quality results and audit of wastewater source management are required to determine whether management strategies are effective and whether they are being implemented appropriately. These reviews enable performance to be measured against the 5 Key Wastewater Source Management Objectives and assist in identifying opportunities for improvement.

### 4.11.1 Long-term evaluation of results

**Summary of Actions:**

- Collect and evaluate long-term data and other relevant information to assess performance and identify trends.
- Document and report results.

The systematic review of monitoring results and other relevant information over an extended period (typically the preceding 12 months or longer) is needed to:

- Assess overall performance against acceptance criteria for non-domestic wastewater, regulatory requirements or obligations in customer contracts, service agreements between internal stakeholders and/or between relevant water authorities and/or agreed levels of service;
- Identify emerging trends; and
- Assist in determining priorities for improving wastewater source management.

There will inevitably be occasions of non-conformance with operational criteria or acceptance criteria for non-domestic wastewater or other obligations in contracts or service agreements. Each event will need to be assessed and appropriate responses determined.

Mechanisms for evaluation should be documented, with responsibilities, accountabilities and reporting requirements defined. Useful tools to enhance the interpretation of data sets include statistical evaluation of results and graphs or trend charts using a ‘control chart’ format.

Evaluation of results should be reported internally to senior management, and externally to customers, stakeholders and regulatory authorities in accordance with water utility requirements (see Section 4.10.2). Providing assurance that data and relevant information are reviewed regularly and that improvements are made in response to identified issues will contribute to regulatory, customer and stakeholder confidence.

### 4.11.2 Audit of the wastewater quality and source control management

**Summary of Actions:**

- Establish processes for internal and external audits.
- Document and communicate audit results.

Auditing is the systematic evaluation of activities and processes to confirm that objectives are being met, including assessment of the implementation and capability of management systems. Auditing provides valuable information on those aspects of the system that is effective, as well as identifying opportunities for improvement of policy and operational practices.

Effective internal audits are important for maintaining a functional wastewater source management system and for identifying areas for improvement. Internal audits will involve trained staff and should include a review of the management system and associated operational procedures, monitoring programs, and the records generated in order to ensure that the system is being implemented correctly and is effective.

The frequency and schedule of audits as well as the responsibilities, requirements, procedures and reporting mechanisms should be defined. A plan to undertake comprehensive audits of all aspects of an organisation’s wastewater source management system over a reasonable time period should be in place. This approach should also span across organisations in circumstances where the responsibilities for wastewater source management and achievement of the 5 Key Wastewater Source Management Objectives is disaggregated.

Water utilities should consider mechanisms for establishing external auditing. Such auditing can be useful in establishing credibility and maintaining customer, regulator and other stakeholder confidence. External auditing could be achieved by peer review or be undertaken by an independent third party. External audits should focus on confirming implementation and results of internal audits.

Audit results should be appropriately documented and communicated to management and personnel responsible for the department or function being audited. Results of audits should also be considered as part of the review by senior management.

**Box 4.12 External Audits**

External audits could be conducted on:

- The management system;
- Operational activities;
- Wastewater quality and source quality performance;
- The effectiveness of incident and emergency response or other specific aspects of wastewater system management and wastewater source management; and
- Quality systems management.

### 4.11.3 Regulatory oversight and surveillance

**Summary of Actions:**

- Establish mechanisms for communication with regulators as part of regulatory oversight and surveillance.

Regulators should be consulted and advised of system evaluations and audits undertaken by the water utility with their outcomes and given the opportunity to provide feedback. Informal mechanisms should be established to achieve this outcome as part of meeting broader regulatory oversight and surveillance objectives consistent with the more formal compliance and reporting obligations.

## 4.12 Element 12 - Review and continual improvement

**Components:**

Review by Senior Executive/ManagersWastewater Quality and Source Management Improvement Plan

Senior executive support, commitment and ongoing involvement is essential to the continual improvement of the water utility's activities. The senior executive should regularly review its approach to wastewater source management, develop action plans and commit the resources necessary to improve operational processes and overall wastewater source management performance.

### 4.12.1 Review by Senior Executives/ Management

**Summary of Actions:**

- Senior management to review the effectiveness of the management system and evaluate the need for change.

In order to ensure continual improvement, the highest levels of the organisation should maintain oversight of the effectiveness of the wastewater source management system and evaluate needs for change, by:

- Reviewing reports from audits, previous management reviews, evaluation of verification results, validation of control measure combinations, corrective actions, research and development and review of the wastewater source management plan (Section 4.12.2);
- Considering the concerns of customers, regulators and other stakeholders;
- Evaluating the suitability of the wastewater source management policy, objectives and preventive strategies in relation to changing internal and external conditions such as:

- o Changes to legislation, expectations and requirements;
- o Changes in the activities of the organisation;
- o Advances in science and technology;
- o Outcomes of wastewater source incidents and emergencies and continuing assessment of the impacts of wastewater system performance, particularly in relation to the achievement of the **5** Key Wastewater Source Management Objectives; and
- o Reporting and communication.

The review by senior management should be documented.

### 4.12.2 Wastewater Quality and Source Management Improvement Plan

**Summary of Actions:**

- Develop a wastewater source management improvement plan.
- Ensure that the plan is communicated and implemented, and that improvements are monitored for effectiveness.

An improvement plan should be developed to address identified needs for the maintenance and enhancement of wastewater source management. The improvement plan should be endorsed by senior management. Improvement plans may encompass a wide range of issues such as:

- Capital works;
- Training;
- Enhanced operational procedures and processes;
- Communication programs;
- Research and development opportunities;
- Incident protocols;
- Enhancements to policy and wastewater source management objectives; and
- Communication and reporting.

Actions in improvement plans should be prioritised relative to the risk that has been identified. For instance, short-term improvements might include actions such as increased monitoring of targeted sources of high-risk waste, waste conservation measures, increased staffing and the development of customer awareness programs. Long-term actions could include upgrading of the organisation's treatment facilities, improved on-site treatment by firms before discharge including the development of effluent improvement plans for improved management of specific problematic substances or newly identified risks, review of influent standards and development of cleaner production programs.

Improvement plans should include objectives, actions to be taken, accountability, timelines and reporting. They should be communicated throughout the organisation and to customers and stakeholders.

Implementation of improvement plans will often have significant budgetary, regulatory and pricing implications and therefore may require detailed cost-benefit analysis and careful prioritisation in accord with the outcomes of risk assessment (see Section 4.2.3). Implementation of plans should be monitored to confirm that improvements have been made and are effective.

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# Appendix A

## Example of a Wastewater Source Management Hazard Analysis and Risk Assessment Methodology

*Note that the information in this appendix is provided for information only and is not intended to be prescriptive.*

The following example is based on Brisbane Water's risk assessment of wastewater sources to the Oxley Creek Water Reclamation Plant (WRP) conducted in January 2008. This risk assessment does not address the key wastewater objectives relating to wastewater transportation systems (e.g. Worker safety or asset protection), however, it does address the objectives of environmental flows and manufacturing recycled water for indirect potable re-use.

The risk assessment methodology detailed in Section 4.2.3 was amended to reflect the multiple products produced at the Oxley Creek WRP. Appendix Table 1 details the revised risk assessment methodology. With respect to the 'Likelihood' rating, an 'event' occurs when a substance in a product is expected to exceed the agreed product quality specification.

A risk team with extensive knowledge of liquid industrial waste management and the Oxley Creek WRP catchment conducted the hazard analysis and risk.

Appendix Table 1. Risk assessment methodology.

| Risk Level Calculator | Consequence | | | | |
|---|---|---|---|---|---|
| Likelihood | Insignificant | Minor | Moderate | Major | Catastrophic |
| Almost certain | Low | Medium | High | Very High | Very High |
| Likely | Low | Medium | Medium | High | Very High |
| Infrequent | Negligible | Low | Medium | High | Very High |
| Unlikely | Negligible | Low | Low | High | Very High |
| Rare | Negligible | Negligible | Low | Medium | High |

| Likelihood of an Event Occuring | | |
|---|---|---|
| Almost Certain | - | Expect to occur on a daily basis |
| Likely | - | Expect to occur on a weekly basis |
| Infrequent | - | Expect to occur on a monthly basis |
| Unlikely | - | Expect to occur on a yearly basis |
| Rare | - | Expect to occur once in 7 years |

| Consequence | | |
|---|---|---|
| Insignificant | - | No WRP upset |
| Minor | - | Minor WRP upset with no supply interruption |
| Moderate | - | Moderate WRP upset with less than 1 day supply interruption |
| Major | - | Major WRP upset with up to one week supply interruption |
| Catastrophic | - | Any exceedance above an established chronic risk limit and/or major WRP upset with more than one week supply interruption |

The risk assessment process identified two sources with a risk assessment above "Low" risk. Additional preventative measures (corrective actions) will need to be implemented for these two sources to reduce the risk to acceptable levels.

Table 2 details the corrective actions and the likely residual risk after successful implementation of such corrective actions.

## Appendix Table 2. Corrective Actions and Residual Risks

| Source | Hazard | Risk Assessment | Corrective Actions | Likely Residual Risk |
|---|---|---|---|---|
| Trade waste | Chemicals and physical | Medium | Conduct chemical surveys in catchment.<br><br>Implement cleaner production and BEARPIT where appropriate | Low |
| Hazardous waste | Chemicals and physical | High | Consult with State EPA with the aim to improve the hazardous waste management system. Implement agreed actions. | Low |

# Appendix B

## Example of Relative Risk Algorithm – Calculating a Monitoring Program for Industrial Waste Dischargers

The following example is based on the Western Australian Water Corporation's current approach for allocating inspection frequencies for its large and high-risk businesses.

### Introduction

This procedure describes the methodology for determining the Risk Index for industrial waste customers. The risk index is used to categorise businesses into groups to which different surveillance regimes are applied, according to the level of risk posed to the Water Corporation's wastewater system

The inspection frequency established by using the Risk Index is a minimum frequency, when the business is operating in compliance with its industrial waste permit. If non-compliances are observed or suspected then follow-up inspections may be required at a higher frequency until compliance is confirmed.

Individual businesses may also have specific characteristics which mean that the risk index model does not generate a suitable inspection frequency, and a different frequency may be more appropriate. If it is considered that the risk index is not generating an appropriate inspection frequency this should be reviewed in consultation with the relevant manager.

The risk index is not an absolute measure of risk. It is a relative measure, which ranks different industries in order of potential risk to the system. The procedure for determining risk index for an industrial customer is shown in overview in Appendix Box 1 and described in more detail below.

Appendix Box 1. Determining a risk index – an overview.

**Step 1 – Determine a Risk Score:**

A risk score for the customer is determined, using specific characteristics of the business, which are assigned individual scores and applied in the following formula:

Risk Score = A + V + S + P

Where:
A = Activity score
V = Volume score
S = Special substances score
P = Pre-treatment equipment complexity score

Assessment of the specific characteristics and determination of the scores is described in the following sections of this procedure.

**Step 2 – Determine a Risk Index:**

From the risk score, the risk index is determined. This step provides a ranking between 1 and 6 (1 being the highest risk). This ranking can then be used to set inspection frequencies, or other uses as required.

## Methodology for Determining the Risk Score

Reasons for the inclusion of each characteristic in the risk assessment and the relative weighting for each score are described below.

### Industry Activity Score (A)

The industry activity score is based on a general assessment of the process producing the waste stream.  Factors considered include the organic and chemical strength of the waste stream, and the robustness and degree of control of the process producing the waste stream. Categories and typical industries in each are listed below.

It is considered that the ranking below may be underweighted with respect to asset protection. Users setting up a risk index model should consider modifying the model to better accommodate asset protection risks.

***Category 100*:**
Waste streams which may contain a wide and undefined range of chemicals Chemical manufacturing or formulation: toxic chemicals, or varied and unpredictable range of chemicals-Wastewater receival and treatment - domestic or industrial

***Category 75*:**
Waste streams containing a consistent and well-defined range of chemicals, some of which may be of concernMetal finishingMetal refining

***Category 20*:**
Waste streams that have variable organic or solid strengths.Manufacture of animal-based products, including slaughtering, processing-Dairy productsMetal products manufacturing-Wood products manufacturing

***Category 0:***
Waste streams which have consistent strengths of organic and solids.Manufacture of soft drinks or fruit juicesManufacture of pulp, paper or cardboard productsWholesale butchering-Smallgoods manufacturingIndustrial and commercial laundries

***Category -1*:**
Waste streams which have generally low and consistent strengths of organics and solids. These premises present a minor risk to the system and include large and complex industries which are best managed by site audits rather than regular final effluent inspections. Examples includeVehicle washesUniversities-HospitalsSmall laundries & Food Manufacturers-LaundriesPrisons

Activity categories and scores are listed in Appendix Table 3.

Scores for industries not listed should be interpolated from the guidelines above.

### Appendix Table 3. Activity scores.

| **Activity** | **Score** |
|---|---|
| **Potentially many variable chemicals of concern** | |
| Waste water treatment | 100 |
| Organic chemical manufacture/formulation | 100 |
| Inorganic chemical manufacture/formulation | 100 |
| Drum and Tank washing | 100 |
| **Consistent and well defined chemicals of concern** | |
| Anodising | 75 |
| Metal Refining | 75 |
| Metal Finishing | 75 |
| Mineral Processing | 75 |
| Resins and polymer manufacture | 75 |
| Laboratory (large) / (Small) | 75 / 55 |
| Ground Water Treatment | 75 |
| Oil Separation (Large process amounts) | 75 |
| **Organic or solids variable strengths** | |
| Chemical handling | 20 |
| Abattoir | 20 |
| Small Laboratory – Lab room exploratory | 20 |
| Tannery | 20 |
| Metal/Wood products manufacturing | 20 |
| Paint Manufacturing | 20 |

Powder Coating (Only) .......... 20
Photography .......... 20
Cement products manufacture .......... 20
Pulp, paper & cardboard manufacture .......... 20
Wool Scouring .......... 20
Dairy products .......... 20
Edible oils manufacturing .......... 20
Yeast manufacture .......... 20
Portable toilet waste .......... 20
Solid Waste Transfer, Recycling & Treatment (Leachate) .......... 20

**Consistent strengths of organic and solids**

Textiles manufacturing .......... 0
Glass manufacture .......... 0
Egg Processing .......... 0
Livestock .......... 0
Smallgoods manufacture .......... 0
Butchering .......... 0
Seafood Processing .......... 0
Warehousing .......... 0
Malting .......... 0
Brewery .......... 0
Soft drink/fruit juice manufacturing .......... 0
Laundries and Dry cleaning .......... 0
Washing (Trucks, Trains, Crates and bins) .......... 0
Printing .......... 0
Fruit or vegetable processing .......... 0
Mechanical servicing .......... 0
Meal Preparation .......... 0

**Consistent low strengths of organics & solids, large & complex sites**

Vehicle Washers .......... -1
Universities .......... -1
Laundries .......... -1
Hospitals .......... -1
Small Laundries & Food Manufacturers .......... -1
Prisons .......... -1
Large complex premises .......... -1
Swimming Pools .......... -1
Cooling Towers (Air Conditioners) .......... -1

## Volume Score (V)

A higher daily discharge of industrial waste from a site will have a greater potential impact on a wastewater treatment plant (WWTP) than a low daily discharge; consequently the score increases with volume. Industrial Waste volumes, expressed as a percentage of the total inflow to the receiving WWTP, with their corresponding scores, are provided in Appendix Table 4.

### Appendix Table 4. Volume scores.

| Maximum Daily Discharge Percentage of receiving WWTP inflow | Volume Score |
|---|---|
| <0.001 | 0 |
| 0.001 - ≤ 0.006 | 5 |
| 0.006 - ≤ 0.02 | 10 |
| 0.02 - ≤ 0.06 | 25 |
| 0.06 - ≤ 0.15 | 50 |
| >0.15 | 100 |

## Substance Score (S)

The substance score applies both to substances used in the processes generating liquid waste and which may potentially be present in the effluent, as well as those substances regularly discharged.

“Domestic” substances (BOD, COD & suspended solids) attract a relative score of 0. Non-domestic substances are grouped according to the risk they pose to the following:

- The environment (Objective 4 of the Key Wastewater Source Management Objectives);
- Occupational health and safety (Objective 1);
- Wastewater assets (Objective 2)
- Wastewater treatment processes (Objective 3); and
- Contamination of effluent and biosolids produced by Water Corporation WWTPs (Objectives 4 and 5).

Non-domestic substances are grouped into three categories and attract scores as shown in Appendix Table with the following explanation of scoring:

**Score 10:**

- Substances which may cause sewer blockages
- Substances which may cause undesirable elevation of effluent or sludge concentrations, but only if discharged in large amounts
- Substances which may cause damage to sewer fabric under some conditions
- Substances of some OH&S concern

**Score 40:**

- Substances which are of moderate OH&S concern, including those which are likely to be rendered harmless on contact with wastewater
- Substances of moderate concern with respect to accumulation in effluent or sludge

**Score 70:**

- Substances of high OH&S concern
- Substances of high concern with respect to accumulation in effluent or sludge
- Substances which may upset wastewater treatment processes if discharged in moderate quantities
- Substances of high concern with respect to damage to sewer fabric

Some judgement is needed in determining assessing which substances to include when determining scores. For example, a discharge which would only contain trivial quantities of a non-domestic substance should not attract a score for that substance. Similarly, a discharge which contains a substance such as ammonia nitrogen or sulphate, but only at domestic wastewater levels, should also not attract a score for that substance.

If there are multiple non- domestic substances present, **only** the **highest** score is applied, for example, a waste containing aluminium, zinc and silver would attract a substance score of 70. Scores for substances that are not included in the table should be interpolated from the guidelines above. If in doubt, such substances should be referred to the relevant manager.

Appendix Table 5. Substance scores.

| Substance Score | | |
|---|---|---|
| **10** | **40** | **70** |
| Acids or alkalis (bulk quantities) | | |
| Aluminium | Ammonia | Chlorinated hydrocarbons |
| Barium | Arsenic | Flammables/explosives |
| Boron | Bromine | Copper |
| Calcium | Cadmium | Cyanide |
| Chloride | Chlorine | Hydrofluoric acid |
| Cobalt | Chromium | Mercury |
| Fluoride | Gluteraldehyde | Silver |
| Iron | Iodine | Petroleum hydrocarbons |
| Manganese | Lead | (Process Amounts) |
| Nitrogen (Kjeldahl) | Molybdenum Nickel | pH (unstable) |
| Oil & Grease<br>pH (stable) | Zinc | |
| Petroleum hydrocarbons | Styrene | |
| (Wash down amounts) | Selenium | |
| Phosphorus | Molybdenum | |
| Silica (Si) | High BOD Formaldehyde | |
| Strontium (Sr)<br>Sulphate<br>Sulphide<br>Temperature<br>Thiosulphate<br>Tin<br>TDS | | |

## Pre-treatment Complexity Score (P)

The degree of complexity of the pre-treatment equipment will affect the frequency of inspections required. Each item of pre-treatment has a score based on its perceived complexity, susceptibility to failure and the difficulty of maintaining it in a satisfactory condition. Items of pre-treatment attract a score between 5 and 30. Where more than one type of pre-treatment device is involved, only the **highest** score is applied.

## Appendix Table 6. Pre-treatment scores.

| Number | Fixture | Score |
|---|---|---|
| 1 | Dissolved air flotation (DAF) unit | 30 |
| 2 | Chemical process (including precipitation) | 30 |
| 3 | pH control – manual dosing | 30 |
| 4 | pH control – auto dosing | 30 |
| 5 | Silver recovery unit | 25 |
| 6 | Oil arrester – plate separator, VGS, triple double etc | 20 |
| 7 | Re-use recycling facility | 20 |
| 8 | Dilution unit / Neutraliser unit | 15 |
| 10 | Grease arrester | 15 |
| 11 | Screen – rotary | 15 |
| 12 | Screen – static | 10 |
| 13 | Gravity separator - settling trap | 10 |
| 14 | Plaster trap | 10 |
| 15 | Bucket trap | 10 |
| 16 | Holding tank / Balancing facility | 5 |
| 17 | Bunding – bulk storage of chemicals | 5 |
| 18 | Washdown area | 5 |
| 19 | Cooling facility | 0 |

## Determining the Risk Score and Risk Index for a business

This section describes the procedure for determining the risk score for a business. Once the risk score is available, the risk index can be determined, and from this, the inspection frequency.

**Step 1:**
**Enter the following data into the Water Corporation's calculation spreadsheet**

- Business name of Industry
- Permit number
- Receiving WWTP
- Activity performed by industry
- Discharge volume, expressed as a percentage of the receiving WWTP inflow
- Pre-treatment fixture/s on site
- Special substances which may present a risk
- Non-compliance comments

**Step 2:**
**Enter relevant scores into the spreadsheet.**

The risk score and risk index will be calculated automatically by the Water Corporation's spreadsheet. Note risk index can also be determined from Appendix Table .

**Step 3:**
**Refer to Appendix Table to determine inspection frequency.**

This information can then be entered into the inspection program scheduling system.

## Appendix Table 7. Risk groupings.

| Risk Score | Risk Index |
|---|---|
| ≥ 150 | 1 |
| < 150 and ≥120 | 2 |
| < 120 and ≥ 100 | 3 |
| < 100 and ≥ 85 | 4 |
| < 85 | 5 |
| < 46 | 6 |

## Appendix Table 8. Inspection frequency.

| Risk Index | Inspection Frequency |
|---|---|
| 1 | 12 per year / 30 days |
| 2 | 6 per year / 60 days |
| 3 | 4 per year / 90 days |
| 4 | 2 per year / 180 days |
| 5 | 1 per year / 360 days |

## Worksheet for Calculation of risk score, risk index and inspection frequency

A manual calculation of the Risk Factor can be performed from an assessment of the individual scores described previously, and risk index and inspection frequency determined accordingly.

**Step 1:**
List the individual scores below to calculate the Risk Score and refer to Appendix Table  and Appendix Table  to determine the Risk Index and Inspection frequency.

Activity _______ Score A = __________

Volume _______ Score V= __________

Substance _______ Score S = __________

Pre-treatment ______ Score P = __________

**Step 2:**
Calculate the risk factor using the formula substitute each factor below:

Risk Factor = A + V + S + P

Risk Factor =
______+______+______+______ = _____

**Step 3:**
Determine the risk index from Appendix Table .

Risk Index = ________

**Step 4:**
Determine the inspection frequency from Appendix Table

No. Inspections = ________ per year

**Step 5:**
Update the Risk Index List spreadsheet or other appropriate data storage system accordingly.

**Step 6:**
Enter the Risk Index, Frequency & next Inspection date into the data management and scheduling systems.

Note that the frequency determined above is that for compliance inspections. The sampling frequency for characterising industrial waste loading is determined using the methodology in

# Appendix C

## Example of a statistical model for calculating optimum sampling frequency for determination of industrial loading

The following example is from the Western Australian Water Corporation's sampling frequency model.

### Sampling Frequency Model

The optimum sampling frequency may be determined using a statistical model (as described below), which balances the cost of sampling against the estimated charge. This optimum frequency is then used as a guide to set an appropriate sampling program for the industry. This model only uses two substances, usually biochemical oxygen demand and suspended solids, although any two could be used. In applying the model, the two substances generating the highest quality charges should be used. These will usually be biochemical oxygen demand and suspended solids.

The nature of the model is such that the number of samples required to achieve the desired precision will increase with the size of the monetary charge and the variability of effluent quality.

The optimum sampling frequency is determined using the following formula:

**Equation 1:** $n^* = (usF/2c)^{2/3}$

Where:

$n^*$ = the optimum (cost-effective) sampling frequency to avoid an abnormally low estimate of net revenue (this frequency also is the optimum to avoid an unusually high charge for the customer).

u = the standard normal deviate corresponding to the desired confidence interval for the charge estimate (for 90% confidence, u=1.645).

s = the standard deviation of the charge rate, calculated as described below.

F = the chargeable flow, expressed in kL.

c = the cost of collecting and analysing one sample, expressed in dollars. This will be the current charge for the particular type of sample as set by the utility.

Once $n^*$ is determined, the precision of the charge (P) achieved at this sampling frequency is calculated using the following formula.

**Equation 2:** $P = 100usF/An^{1/2}$

Where:

P = the desired precision in the charge estimate, expressed in percent.

u = same as defined for Equation 1.

s = same as defined for Equation 1.

F = same as defined for Equation 1.

A = the annual Quality and Quantity charges, expressed in dollars.

n = the annual number of samples to achieve the desired charge precision.

In determining the sampling frequency, a level of pragmatism should be used. The aim is to sample at appropriate intervals that give a reasonable confidence in the precision of the charge. The confidence intervals are statistically based, and do not provide absolute certainty, and so it is inappropriate to slavishly apply frequencies calculated from the formula.

It is important to note that the output of any model is limited by the quality of the data used. Small, variable data sets may generate impracticably high sampling frequencies. In cases where there is insufficient data to determine a sampling frequency on a statistical basis, an initial frequency should be established based on typical frequencies for similar size and/or types of industries.

The cost to the customer (sampling costs should not exceed say 5% of total quality/quantity charges) and the personnel available for sampling, especially if the sampling is done by the water utility, should also be considered in setting the sampling frequency.

Note also that the precision of the charge estimate does not improve linearly with the number of samples taken. Equation 2 shows that the precision of the charge estimate is inversely proportional to the square root of the number of samples. This fact means, for example, that if a 10% precision was achieved with 4 samples per year, to improve precision by a factor of two to 5% would require 16 samples per year, four times as many as needed to achieve 10% precision.

### Standard Deviation of the Charge Rate

The standard deviation of the charge rate is dependent on the variability of the BOD and suspended solids expressed as their standard deviations, and on the correlation between BOD and suspended solids for the waste. The variance, $s^2$, of the charge rate is expressed as follows:

$$\mathbf{s^2 = (c_{BOD})^2(s^2_{BOD}) + (c_{SS})^2(s^2_{SS}) + 2.c_{BOD}.c_{SS}.r.s_{BOD}.s_{SS}}$$

Where:

$c_{BOD}$ = charge rate in $/gram for BOD

$c_{SS}$ = charge rate in $/gram for SS

$s_{BOD}$ = standard deviation of the BOD data

$s_{SS}$ = standard deviation of the SS data

r = correlation coefficient for the BOD and SS data

# Appendix D
## - Non-domestic Wastewater Acceptance Criteria

### Introduction and philosophy

Each substance listed in the acceptance criteria for non-domestic wastewater with a Guideline Concentration is a priority contaminant for meeting the 5 key wastewater source management objectives. As further research and understanding of emerging substances of concern linked to:

- the augmentation of drinking water supplies with recycled water
- Revisions of workplace exposure standards;
- Revisions of environmental and ecological standards; and
- Better knowledge or information on substance impacts

Guideline concentrations will be developed and updated as information becomes available.

The acceptance criteria for non-domestic wastewater is divided into two parts to align with the 5 key wastewater source management objectives. The first section assesses impacts of substances to general wastewater collection systems and details recommended Guideline Concentrations for these substances. The second section provides the methodology to assess the local impacts of substances that impact upon the specific wastewater treatment system so water utilities can determine their site based Local Guideline Concentrations and mass load limits for these substances.

### Impact Assessment on the Wastewater Collection System

Substances listed in Appendix Table 9 are known to impact on the wastewater collection system. The primary basis for determining the Guideline Concentration relates to one of the following objectives-

- Objective 1 – safety of people, and
- Objective 2 – protection of assets.

### Objective 1 – Safety of People

A hierarchy of approaches exists to manage OH&S risk in order of preference (most preferred to least preferred):

- Elimination
- Engineering Control
- Administration
- Training and Education
- Personal Protection.

The preferred way to maintain safety is to eliminate the hazard where practicable, and other approaches can be used as listed in the hierarchy. The Guideline concentrations are based on a number of assumptions which give conservative (low) concentrations but set the requirements to ensure that a hazard is eliminated in a wastewater system. The least preferred approach is personal protection involving cessation of discharge, confined space entry procedures, training and education and use of personal protective equipment. All these approaches are being used satisfactorily by various water utilities around Australia.

The substances listed in Appendix Table 9 are known to require management in order to provide a safe working environment within the wastewater system. These are not the only substances that can pose a risk, and in all systems, a process for identifying and managing substances that can compromise objectives 1 & 2 is required. The Guideline provides a methodology for establishing trade waste acceptance criteria that can be applied to all wastewater systems, while other mechanisms for establishing risk controls can be considered on a case by case basis, provided that the risk can be managed and appropriate verification and validation processes exist within the context of these Guidelines.

The Guideline Concentration for many substances is based on maintaining a safe work environment for wastewater system workers. Appendix Table 9 details priority substances marked with an asterisk, where the 'Primary Basis' for establishing the Guideline Concentration, is sewer worker / public health and safety. These substances are volatile and cause harm to humans above a certain gaseous concentration with the key route of exposure by inhalation. Inhalation was chosen as the primary pathway due to skin exposure and ingestion generally requiring higher concentrations to be toxic to humans. It should be noted that this is not an exhaustive list and other utilities may have other priority substances that will require Henry's Law assessment. Many of these substances also pose a potential for explosion within a wastewater asset. Therefore, the concerns to a water utility are when the gaseous phase contaminant concentration in the sewer atmosphere exceeds the Workplace Exposure Standard, or the lower explosive level (LEL) is exceeded for that contaminant.

Since Guideline Concentrations in Appendix Table 9 are expressed as an aqueous phase concentration, the Workplace Exposure Standard needs to be converted from a gaseous phase concentration to an aqueous phase concentration. This conversion process is undertaken by applying Henry's Law. Henry's Law states that at a constant temperature, the amount of a given gas dissolved in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid

Using the Workplace Exposure Standard for the substances listed in Appendix Table 9, the partial pressure can be determined for that contaminant. By applying Henry's Law, the maximum aqueous phase concentration that will maintain the gaseous phase concentration at the Workplace Exposure Standard can be determined – this concentration is the Guideline Concentration detailed in Appendix Table 9. It should be noted that the calculations in Appendix Table 9 are based on the Short Term Workplace Exposure Limit (STEL). Extended entry scenarios may also need to be considered by water utilities, such as through confined space entry procedures. However some conservatism is built into the calculation as it is based on no dilution in the wastewater system at the point of discharge (i.e. sewer pipe only 100% trade waste effluent at the Guideline Concentration) and assumes liquid-gaseous phase equilibrium. In most wastewater systems, instantaneous dilution of trade waste effluent will occur and equilibrium will seldom be reached.

The development of acceptance standards for safety related substances are usually due to immediate safety concerns. These substances can either create flammable environments or cause harm to human health (or both). In many cases, the key route of exposure is through inhalation therefore the main concern is when the substance is in the vapour phase. As a result most Workplace Exposure Standards are listed as concentration in the atmosphere. Wastewater acceptance standards are expressed as concentration of the substance in the aqueous phase hence Workplace Exposure Standards must be converted to a concentration in the aqueous phase.

Henry's Law and its coefficient for individual substances (available in literature) is used to determine the concentration in the aqueous phase. It is important to note that concentration of substances in the vapour phase is temperature dependent.

Henry's Law states that for a dilute solution, the concentration of the substance in the vapour phase is proportional to the concentration of the substance in the liquid phase.

$$x_B = p_B \, kH$$

Where:

$p_B$ Concentration of the substance in the vapour phase

$X_B$ Concentration of the substance in the liquid phase

$kH$ Henry's Law coefficient for the substance (Available in literature at $25^0$C standard temperature)

As Henry's Law coefficient is temperature dependent, the relationship between the coefficient for the same substance at a different temperature must be determined, it is defined as:

$$kH_T = kH_{25} \times \exp\left(\frac{-\Delta H_{soln}}{R}\left(\frac{1}{T} - \frac{1}{T_{25}}\right)\right)$$

Where

$kH_T$ Henry's Law coefficient at temperature, T

$\Delta H_{soln}/R$ temperature dependence constant (available in literature)

$kH_{25}$ Henry's Law coefficient at $25^0$C or 298.15K

$T_{25}$ Temperature at $25^0$C

Using the above equations and data from literature, $kH_T$ can be calculated for a particular operating temperature, usually a worst case acceptance standard temperature of $38^0$C. Then by using Henry's Law, and the Workplace Exposure Standard set by the National Industrial Chemicals Notification and Assessment Scheme (NICNAS), the concentration of the substance in the liquid phase can be determined.

In order to simplify unit conversions, the following formula can be used to calculate the concentration of the substance in the liquid phase

$$C = kH_T * E * M$$

Where

C trade waste limiting concentration (mg/L)

$kH_T$ Henry's Law coefficient at temperature, T

E Exposure limit (atm) = exposure limit (ppm)/(1,000,000 ppm/atm)

M Molecular weight (mg/Mole) = molecular weight (grams/mole) * 1000 (mg/gram)

Note that Henry's Law calculations *(refer Appendix Example 1 - Derivation of a Local Guideline Concentration for Formaldehyde)* are very complicated and numerous assumptions have been made to calculate the Guideline Concentrations in Table 3 as detailed below-

- If not specifically detailed in literature, it is assumed that the contaminant does not hydrate, dimerize or change to another form when in the aqueous phase. This assumption is conservative and errs on the side of caution. Potential synergistic effects have not been taken into account as they are difficult to quantify. Where literature sources confirm that the contaminant converts to "other" aqueous forms in a significant proportion, adjustments have been made to the Henry's Law determinations (for example, formaldehyde and ammonia).
- A temperature of 38°C (or closest literature source to 38°C) is used as the basis for the temperature since this is the Guideline Concentration for Temperature.
- Where several Henry's Law coefficients are documented in literature sources, outliers are removed and the lowest coefficient is then used to set the Guideline Concentration. Where the lowest coefficient is significantly lower than other coefficients, the most recent literature source is used.
- Workplace Exposure Standards based on Short Term Exposure Limits [STEL] are used to determine the partial pressure (P). Odour thresholds are also examined but have not been used.

Substances assessed for sewer worker / public health and safety have associated flammability risks since they are volatile. Flammability or explosive limits for the substances listed in Table 3 have also been reviewed for lower explosive limits. In most cases, the concentration where the contaminant becomes a flammability risk is significantly higher than the sewer worker / public health and safety based concentration determined using Henry's Law. Other substances with Guideline Concentrations established based on flammability risk are detailed in Appendix Table 9.

### Objective 2 – Protection of Assets

Trade waste discharges generally contain substances at a concentration or temperature higher than domestic wastewater. These higher levels either alone or by increased interaction with other wastewater substances can form new problematic substances which can lead to accelerated corrosion of erosion of sewers leading to sewer collapse and shortened asset life. Substances with Guideline Concentrations are detailed in Appendix Table 3.

## Appendix Table 9 – Objective 1 and 2 priority substances

| Parameter | Primary Basis for Guideline Concentration | Guideline Concentration (mg/L) | Typical Wastewater Concentration - Influent Value (mg/L) | Analytical Method Reference APHA Method |
|---|---|---|---|---|
| Acetaldehyde * | Worker Safety | 5 | <0.001 | SW method TC006 HPLC |
| Acetone * | Worker Safety | 400 | <0.001 | SW method TC006 HPLC |
| Ammonia | Worker Safety | 200 | 50 | 4500-NH3-B |
| Benzene * | Worker Safety | 0.04 | <0.001 | 6200 |
| Biochemical Oxygen Demand - Soluble | Asset Protection | 100 (To be considered if sewers are | 100 | 5210-B |
| Chloroform * | Worker Safety | 0.1 | <0.001 | 6200B |
| Dimethyl Sulphide | Odour | 1 | 0.01 | 2150 |
| Ethylbenzene * | Worker Safety | 1 | <0.001 | 6200 |
| Sulphide - Dissolved | Asset Protection | 1 | 1 | 4500S2--C&D or E |
| Flammable / Explosive Substances | Flammability | 5% LEL | N/A | N/A |
| Formaldehyde * | Worker Safety | 30 | <DL | SW method TC006 HPLC |
| Gross Solids - Non-faecal | Asset Protection | 13 mm QSV<3m/hr | N/A | N/A |
| Halogenated Volatile Organic Compounds – Total * | Worker Safety | 1[1] | <0.001 | 6200B |
| Methyl Ethyl Ketone (MEK) * | Worker Safety | 100 | <0.001 | SW method TC006 HPLC |
| Perchloroethylene * | Worker Safety | 0.01 | <.001 | 6200B |
| Petroleum Hydrocarbons C6-C9 | Flammability | 5 | 0.05 | USEPA 8015B USEPA 8260B |
| Propionaldehyde * | Worker Safety | 5 | <0.001 | SW method TC006 HPLC |
| pH | Asset Protection | 6 to 10 | 7.5 | Recorded on-site using a calibrated pH meter or 4500H+ |
| Radioactive Isotopes | Worker Safety | State radiation safety legislation specific | State radiation safety legislation | 7120 (gamma) |
| | | | | 7110 (alpha and beta) |
| Sulphite | Asset Protection | 100 | 15 | 4500BSO3B |
| Sulphate | Asset Protection | 2000 | 350 | 4500BSO4D |
| Suspended solids | Asset Protection | 600 (applies if there is a potential for settled solids to cause corrosion, odour or deposition) | 250 | 2540D |
| Total Dissolved Solids | Asset protection | 10000 | 700 | 2510B |
| Total oxidised sulphur | Asset Protection | 600 | 50 | 4500 |
| Toluene * | Worker Safety | 0.5 | 0.01 | 6200 |
| Trichloroethylene * | Worker Safety | 0.1 | <0.001 | 6200B |
| Xylene (total) * | Worker Safety | 1 | 0.05 | 6200 |

## Appendix Example 1 - Derivation of a Local Guideline Concentration for Formaldehyde

This example details how the Guideline Concentration detailed in Table 3 has been derived for the contaminant Formaldehyde by assessing occupational health and safety impacts within the wastewater collection system.

Data for Formaldehyde:

1. Workplace Exposure Standard (WES) for formaldehyde (gaseous phase) = 0.3 ppm [2] (ie. 1 part of vapour or gas per million parts of contaminated air by volume)
2. Henry's Law coefficient for formaldehyde @ 25$^0$C ($kH_{25}$) = 8500 M/atm [3].
3. Temperature dependence constant ($DH_{soln}$/ R) = 7200 K [2] (temperature dependence constant including hydration).
4. Molecular Weight (MW) = 30 (grams/mole)
5. Temperature (T) = 38$^0$C or 311.15K
6. Temperature ($T_{25}$) = 25$^0$C or 298.15K

**Step 1:**
Calculate the Henry's Law coefficient ($kH_T$ ) for the maximum allowable wastewater temperature (T) of 38$^0$C (or 311.15K) by inputting the above data into Equation 1 as follows-

$$kH_T = kH_{25} \times \exp(\frac{-\Delta H_{soln}}{R}(\frac{1}{T} - \frac{1}{T_{25}}))$$

$KH_{38}$ = 8500 x exp (7200 (1/311.15 – 1/298.15))

= 3099.1 M/atm

**Step 2:**
Calculate the Guideline Concentration for Formaldehyde in the liquid phase using the Henry's Law coefficient ($kH_T$ ) calculated in Step 1 and Equation 2 as follows-

GC = $kH_{38}$ * WES / 1,000,000 * MW * 1000

= 3099.1 * (0.3 / 1,000,000) * (30 * 1000)

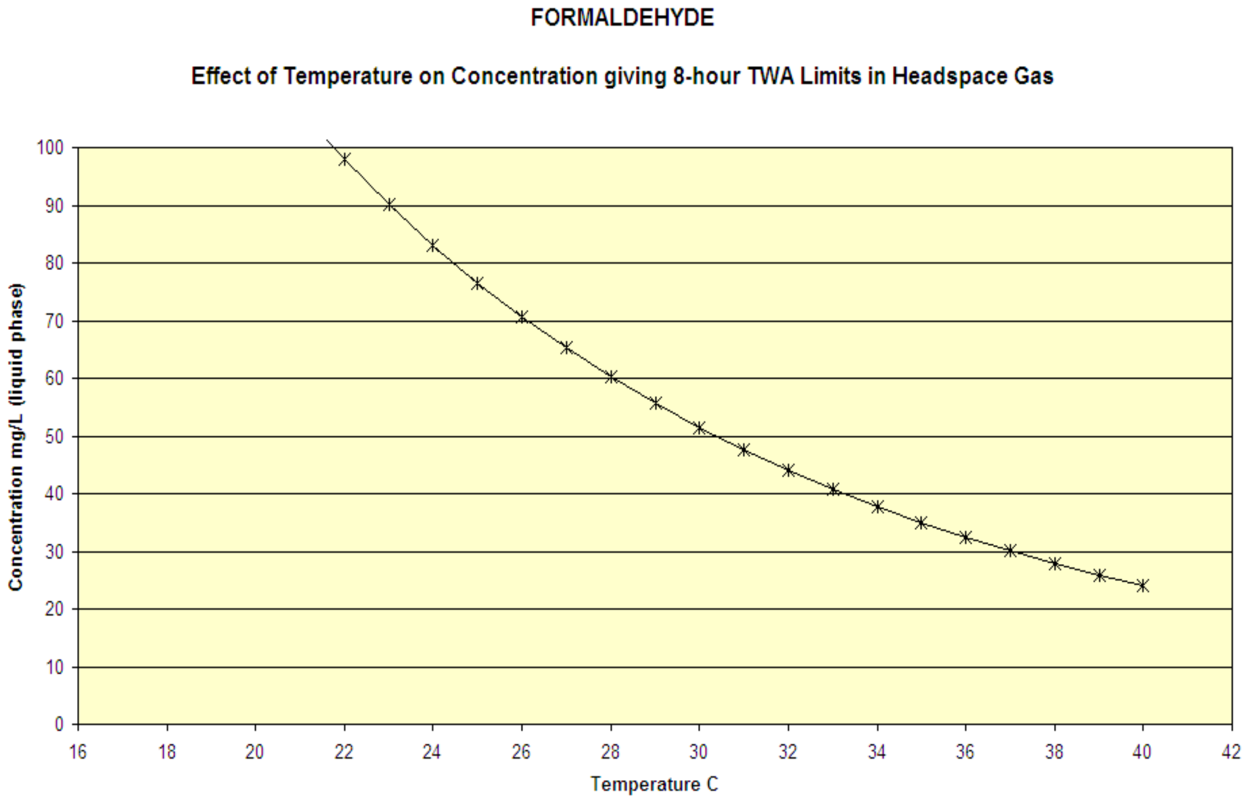
= 27.9 ppm (or mg/L)

Therefore the concentration of Formaldehyde in the liquid phase that is equivalent to the workplace exposure standard of 0.3ppm is 27.9 ppm.

**Guideline Concentration for Formaldehyde is 30ppm.**

**Step 3:**
Repeat Step 1 and Step 2 to calculate the concentration of formaldehyde in the liquid phase for various wastewater temperatures and develop a chart for easy reference - see over page.

[2] NOHSC – Time Weighted Average
[3] Betterton, EA and Hoffmann, MR (1988) Henry's Law Constants for some environmentally important aldehydes. Environ. Sci Technol Vol. 22, No. 12, pages 1415-1418.
Dong, S and Dasgupta, PG (1986) Solubility of gaseous formaldehyde in liquid water and generation of trace standard gaseous formaldehyde. Environ. Sci. Technol. Vol 20. Page 637-640.




## Impact Assessment on the Wastewater Treatment System

Substances listed in Appendix Table 54 impact on the wastewater treatment system. The primary basis for determining the Guideline Concentration relates to one of the following objectives-

- Objective 3 – protection of treatment processes;
- Objective 4 - facilitation of regulatory and licence compliance.
- Objective 5 – facilitation of recycling.

For these substances, it is imperative that the guideline concentration should not be considered to represent a definite line of division between safe and unsafe acceptance of trade waste to a wastewater system. This is because these objectives must be assessed for each individual wastewater treatment system due to the highly variable nature of wastewater systems in Australia. As such, mandatory Guideline Concentrations cannot be set for these substances based on assessment of general risks and impacts related to such objectives.

It is generally accepted that the majority of these substances should be managed by determining the capability of the system to handle the load of substances and continue to meet the objectives. This will vary from system to system based on treatment plant capacity, biosolids limits, licence limits or other limitations. Therefore it is essential that system capability is determined by a mass model or similar mechanism. This will allow the establishment of baseline information for the determination of trigger limits and critical limits for each system.

In the absence of a mass model, it is essential to develop reasonable parameters in determining Guideline Concentrations.

To provide a baseline reference point for these substances, Guideline Concentrations have been established using the following principles:

1. Implementation of site specific cleaner production work processes; and
2. Best Economic and Reasonable Pre-treatment Infrastructure Technology (**BEARPIT**).

Cleaner Production, as a preventative measure, was highlighted in the body of this document as the first multiple barrier that should be used to help reduce the overall operational risk of managing a wastewater system. Cleaner production involves working with individual organisations on a holistic approach to site water management.

BEARPIT generally applies to substances that are not specifically designed for significant removal in conventional wastewater treatment systems and therefore should be significantly removed by pretreatment prior to discharge to the wastewater system. BEARPIT, as a preventative measure, is the second barrier in the multiple barrier system. BEARPIT is a contaminant based minimum standard of pre-treatment infrastructure that a trade waste customer must install that -

- requires a reasonable investment;
- must be operated and maintained in accordance with manufacturer's specifications; and
- will pre-treat trade waste effluent to a reasonable standard prior to discharge to the wastewater system.

The 'reasonable standard' is based on documented performance data for such BEARPIT for each contaminant such pre-treatment is designed to remove. This verified standard becomes the Guideline Concentration for that contaminant. BEARPIT and related Guideline Concentrations are detailed in Appendix Table 54.

It is imperative that the Guideline Concentrations detailed for these substances should be a reference point to determine whether the local guideline concentrations determined using a mass model approach are reasonable and justifiable.

When developing Local Guideline Concentrations, the water utility should evaluate each contaminant for its impact on each wastewater system objective (as detailed above) to minimise risks and ensure safe and environmentally sustainable operation of the wastewater system. For each wastewater objective detailed above, an acceptable Guideline Concentration or customer based mass load can be determined and the most stringent criterion becomes the Local Guideline Concentration or mass load.

To assist water utility's to develop Local Guideline Concentrations, the following reference data is provided-

1. Appendix Table 10 details typical threshold concentrations for common substances in wastewater that are known to inhibit activated sludge, nitrification and anaerobic digestion processes. (Appendix Table 10)
2. Appendix Table 1 details typical removal rates through primary settlement and secondary settlement treatment processes for common substances in wastewater (Appendix Table 1) table
3. Appendix Table 12 details typical concentrations for common substances in 'domestic' wastewater.

Appendix Table 10. Typical threshold concentrations (mg/L) for common substances in wastewater that are known to inhibit activated sludge, nitrification and anaerobic digestion processes.

| Pollutant | Activated Sludge | Anaerobic Digestion | Nitrification |
|---|---|---|---|
| Acenaphthene | NI# at 10 | Not Available | Not Available |
| Acrolein | NI at 62 | Not Available | Not Available |
| Acrylonitrile | NI at 152 | 5 | Not Available |
| Ammonia | 480 | 1500-3000 | Not Available |
| Arsenic | 0.04-0.4 | 0.1-1 | Not Available |
| Benzene | 125 | Not Available | Not Available |
| Benzidine | 5 | S | Not Available |
| Boron | 0.05-10 | 2 | Not Available |
| Cadmium | 0.5-10 | 0.02-1 | 5-Sep |
| Calcium | 2500 | Not Available | Not Available |
| Carbon tetrachloride | NI at 10 | 2.9 | Not Available |
| Chlorobenzene | NI at 1 | 0.96 | Not Available |
| 1,2,4-tridilorobenzene | NI at 6 | Not Available | Not Available |
| Hezachlorobenzene | 5 | Not Available | Not Available |
| 1,2-dichloroethane | NI at 258 | 1 | Not Available |
| 1,1,1-trichloroethane | NI at 10 | Not Available | Not Available |
| Hexachloroethane | NI at 10 | Not Available | Not Available |
| 1,1-dichloroethane | NI at 10 | Not Available | Not Available |
| 1,1,2-trichloroethane | NI at 5 | Not Available | Not Available |
| 1,1,2,2-tetrachloroethane | NI at 201 | 20 | Not Available |
| Bis-(2-chloroethyl)ether | NI at 10 | Not Available | Not Available |
| 2-chloroethyl vinyl ether | NI at 10 | Not Available | Not Available |
| 2-chloranaphthalene | NI at 10 | Not Available | Not Available |
| 2,4,6-trichlorophenol | 50 | Not Available | Not Available |
| Pata-chloro-meta-cresol | NI at 10 | Not Available | Not Available |
| Chloroform | NI at 10 | 1 | 10 |
| 2-chlorophenol | NI at 10 | Not Available | Not Available |
| 1,2-dichlorobenzene | 5 | 0.23 | Not Available |
| 1,3-dichlorobenzene | 5 | Not Available | Not Available |
| 1,4-dichlorobenzene | 5 | 1.4 | Not Available |
| 1,1 -dichloroethylene | NI at 10 | Not Available | Not Available |
| 1,2-trans-dichloroethylene | NI at 10 | Not Available | Not Available |
| 2,4-dichlorophenol | NI at 75 | Not Available | Not Available |
| 1,2-dichloropropane | NI at 182 | Not Available | Not Available |
| 1,3-dichloropropylene | NI at 10 | Not Available | Not Available |
| 2,4-dimethylphenol | NI at 10 | Not Available | Not Available |
| 2,4-dinitrotoluene | 5 | Not Available | Not Available |
| 2,6-dinitrotoluene | 5 | Not Available | Not Available |
| 1,2-diphenylhydrazine | 5 | Not Available | Not Available |
| Ethylbenzene | NI at 10 | Not Available | Not Available |
| Fluoroanthene | NI at 5 | Not Available | Not Available |
| bis-(2-chloroisopropyl)ether | NI at 10 | Not Available | Not Available |
| Chloride | Not Available | 20000 | 180 |
| Chloromethane | NI at 180 | 3..3 | Not Available |
| Methylene chloride | Not Available | 100 | Not Available |
| Chloroform | NI at 10 | Not Available | Not Available |
| Dichlorobromomethane | NI at 10 | Not Available | Not Available |
| Trichlorofluoromethane | NI at 10 | 0.7 | Not Available |
| Chlorodibramomethane | NI at 10 | Not Available | Not Available |

## Appendix Table 10 (continued)

| Pollutant | Activated Sludge | Anaerobic Digestion | Nitrification |
|---|---|---|---|
| Hexachlorobutadiene | NI at 10 | Not Available | Not Available |
| Hexachlorocyclopentadiene | NI at 10 | Not Available | Not Available |
| Chromium (Tot.) | 0.1-20 | 1.5-50 | 0.25-1 |
| Chromium (Hex.) | 1 | 50 | Not Available |
| Copper | 0.1-1 | 0.5-100 | 0.05-0.5 |
| Iodine | 10 | Not Available | Not Available |
| Iron | 5-500 | 5 | Not Available |
| Isophorone | NI at 15.4 | Not Available | Not Available |
| Lead | 0.1-10 | 50-250 | 0.5-1.7 |
| Manganese | 10 | Not Available | Not Available |
| Magnesium | Not Available | 1000 | 50 |
| Mercury | 0.1-5 | 1400 | 2-12.5 |
| Napthalene | 500 | Not Available | Not Available |
| Nickel | 1-May | 2-200 | 0.25-5 |
| Nitrobenzene | 500 | Not Available | Not Available |
| 2-nitrophenol | NI at 10 | Not Available | Not Available |
| 4-nitrophenol | NI at 10 | Not Available | Not Available |
| 2,4-dinitrophenol | 1 | Not Available | Not Available |
| N-nitrosodiphenylamine | NI at 10 | Not Available | Not Available |
| N-nitraso-di-N-propylamine | NI at 10 | Not Available | Not Available |
| Pentachlorophenol | 0.95 | 0.2 | Not Available |
| Phenol | 200 | Not Available | 4 |
| Bis-(2-ethyl hexyl)phthalate | NI at 10 | Not Available | Not Available |
| Butyl benzyl phthalate | NI at 10 | Not Available | Not Available |
| Di-n-butyl phthalate | NI at 10 | Not Available | Not Available |
| Di-N-octyl phthalate | NI at 16..3 | Not Available | Not Available |
| Diethyl phthalate | NI at 10 | Not Available | Not Available |
| Dimethyl phthalate | NI at 10 | Not Available | Not Available |
| Chrysene | NI at 5 | Not Available | Not Available |
| Acenaphthylene | NI at 10 | Not Available | Not Available |
| Anthracene | 500 | Not Available | Not Available |
| Fluotene | NI at 10 | Not Available | Not Available |
| Phenanthrene | 500 | Not Available | Not Available |
| Pyrene | NI at 5 | Not Available | Not Available |
| Tetrachloroethylene | NI at 10 | 20 | Not Available |
| Toluene | NI at 35 | Not Available | Not Available |
| Trichloroethylene | NI at 10 | 20 | Not Available |
| Aroclor-1242 | NI at 1 | Not Available | Not Available |
| Aroclor-1254 | NI at 1 | Not Available | Not Available |
| Aroclor-1221 | NI at 1 | Not Available | Not Available |
| Aroclor-1232 | NI at 10 | Not Available | Not Available |
| Aroclor-1016 | NI at 1 | Not Available | Not Available |
| Silver | 0.03-5 | Not Available | 0.25 |
| Sodium | Not Available | 3500 | Not Available |
| Sulphide | 50 | 50-100 | Not Available |
| Tin | Not Available | 9 | Not Available |
| Vanadium | 20 | Not Available | Not Available |
| Zinc | 0.3-20 | 1-Oct | 0.01-1 |

Key: NI – No Inhibition at the nominated concentrations

Appendix Table 11. Typical substance removal rates through an extended aeration activated sludge treatment plant.

| Substances | Removal Efficiency | Type |
|---|---|---|
| Alkalinity | 52% | Inorganic |
| Aluminium | 99% | Inorganic |
| Ammonia | 100% | Inorganic |
| Arsenic | 77% | Inorganic |
| Barium | 91% | Inorganic |
| Biochemical Oxygen Demand | 99.90% | |
| Cadmium | 84% | Inorganic |
| Calcium | 18% | Inorganic |
| Chromium | 65% | Inorganic |
| Copper | 93% | Inorganic |
| Iron | 96% | Inorganic |
| Lead | 85% | Inorganic |
| Magnesium | 18% | Inorganic |
| Manganese | 68% | Inorganic |
| Mercury | 87% | Inorganic |
| Methylene Blue Anionic Surfactants | 87% | |
| Nickel | 52% | Inorganic |
| Ortho-Phosphorus | 54% | Inorganic |
| pH | No Reduction | |
| Potassium | 9% | Inorganic |
| Sodium | No Reduction | Inorganic |
| Suspended Solids | 99% | |
| Total Nitrogen | 95% | Inorganic |
| Total Phosphorus | 65% | Inorganic |
| Zinc | 69% | Inorganic |
| Acrylonitrile | 99% | Volatile Organic Carbon |
| Benzene | 100% | Volatile Organic Carbon |
| Bromomethane | 100% | Volatile Organic Carbon |
| Bromodichloromethane | 100% | Volatile Organic Carbon |
| Carbon Tetrachloride | 100% | Volatile Organic Carbon |
| Chlorobenzene | 56% | Volatile Organic Carbon |
| Chloroethane | 91% | Volatile Organic Carbon |
| Chloroform | 99% | Volatile Organic Carbon |
| Dibromochloromethane | 100% | Volatile Organic Carbon |
| 1,1 Dichloroethane | 79% | Volatile Organic Carbon |
| 1,2 Dichloroethane | 99% | Volatile Organic Carbon |
| 1,1 Dichloroethene | 100% | Volatile Organic Carbon |
| 1,2 Dichloroethene | 98% | Volatile Organic Carbon |
| 1,2 Dichloropropane | 97% | Volatile Organic Carbon |
| 1,3 Dichloropropane | 98% | Volatile Organic Carbon |
| Ethyl acetate | 98% | Volatile Organic Carbon |
| Ethylbenzene | 99% | Volatile Organic Carbon |
| Methylene Chloride | 75% | Volatile Organic Carbon |
| 1,1,2,2 Tetrachloroethane | 93% | Volatile Organic Carbon |
| 1,1,2,2 Tetrachloroethene | 27% | Volatile Organic Carbon |
| 1,1,1 Trichloroethane | 38% | Volatile Organic Carbon |
| 1,1,2 Trichloroethane | 72% | Volatile Organic Carbon |
| Trichloroethene | 40% | Volatile Organic Carbon |
| Toluene | 100% | Volatile Organic Carbon |
| Vinyl Chloride | 100% | Volatile Organic Carbon |

## Appendix Table 11 (continued)

| Substances | Removal Efficiency | Type |
|---|---|---|
| Acenaphthene | 95% | Base / Neutral Compounds |
| Acenaphthylene | 93% | Base / Neutral Compounds |
| Anthracene | 97% | Base / Neutral Compounds |
| Benzo (a) anthracene | 56% | Base / Neutral Compounds |
| Bis (2-ethylhexyl) phthalates | 64% | Base / Neutral Compounds |
| Di-n-butylphthalate | 99% | Base / Neutral Compounds |
| 1,3 Dichlorobenzene | 100% | Base / Neutral Compounds |
| 1,2 Dichlorobenzene | 94% | Base / Neutral Compounds |
| Diethylphthalate | 99% | Base / Neutral Compounds |
| Dimethylphthalate | 99% | Base / Neutral Compounds |
| Dioctylphthalate | 90% | Base / Neutral Compounds |
| Fluoranthene | 83% | Base / Neutral Compounds |
| Isophorone | 100% | Base / Neutral Compounds |
| Naphthalene | 100% | Base / Neutral Compounds |
| Nitrobenzene | 98% | Base / Neutral Compounds |
| Phananthrene | 98% | Base / Neutral Compounds |
| Pyrene | 84% | Base / Neutral Compounds |
| 1,2,4 Trichlorobenzene | 82% | Acid Compounds |
| 2 Chlorophenol | 41% | Acid Compounds |
| 2,4 Dichlorophenol | 91% | Acid Compounds |
| 2,4 Dimethylphenol | 100% | Acid Compounds |
| 2,4 Dinitrophenol | 84% | Acid Compounds |
| 2 Nitrophenol | 77% | Acid Compounds |
| Pentachlorophenol | 36% | Acid Compounds |
| Phenol | 98% | Acid Compounds |
| 2,4,6 Trichlorophenol | 45% | Acid Compounds |

Sewage quality within a typical domestic catchment in City West Water's service area is provided in Appendix Table 12. The sewer services predominantly domestic and commercial catchments within a growth area in Melbourne's Western suburbs. Water restrictions were in place during the sampling. Samples were obtained over 2 x 14 day periods in 2006 and 2007. The data is representative of the daily composite samples taken over 2 x 14 day periods.

Appendix Table 12. Typical concentrations for common substances in 'domestic' wastewater (Source: City West Water).

| Parameter | Average Concentration (mg/L) | Parameter | Average Concentration (mg/L) |
|---|---|---|---|
| Antimony | ND | Magnesium | 3.890 |
| Barium | 0.027 | Potassium | 17.907 |
| Beryllium | ND | Sodium | 78.018 |
| Boron | 0.134 | Biological Oxygen Demand | 287.286 |
| Chromium | 0.006* | chemical Oxygen Demand | 657.024 |
| Cobalt | ND | Cyanide | 0.010* |
| Copper | 0.118 | Electrical Conductivity | 842.393 |
| Manganese | 0.038 | pH | 7.275 |
| Molybdenum | ND | Bicarbonate Alkalinity | 300.500 |
| Nickel | 0.006* | Ammonia Nitrogen | 45.324 |
| Selenium | 0.008* | Grease & Oil | 60.357 |
| Silver | ND | Chloride | 44.348 |
| Strontium | 0.041 | fluoride | 0.62* |
| Thallium | ND | Phosphate | 25.229 |
| Tin | 0.007 | Sulphate | 31.919 |
| Titanium | 0.023 | Total Kjeldahl Nitrogen | 53.500 |
| Vanadium | ND | Total Nitrogen | 59.802 |
| Zinc | 0.120 | Organic Total Dissolved Solids | 121.536 |
| Arsenic | 0.002* | Total Suspended solids | 326.010 |
| Cadmium | ND | Sulphide | 0.147 |
| Lead | 0.003* | Total organic carbon | 176.495 |
| Mercury | ND | Total Phenols | 0.107 |
| Calcium | 11.493 | Total Solids | 646.167 |
| Iron | 0.486 | Silica | 11.786 |

ND – Not detected

* – Represents the maximum result obtained from a measured concentration during one of the composite sampling programs and a non detect during the other program, rather than an average

## Example 2 – Derivation of a Local Guideline Concentration and mass load limit for Nickel.

In this example, the Wastewater Influent Trigger Limit and local guideline concentration specific to a particular wastewater treatment plant are derived using a mass model approach for the contaminant Nickel by assessing impacts upon-

- Objective 3 – protection of treatment processes;
- Objective 4 - facilitation of regulatory and licence compliance.
- Objective 5 – facilitation of recycling.

Once established, a comparison with BEARPIT is undertaken to test reasonableness of determined concentration.

The most critical of the objectives will determine the maximum allowable influent concentration for nickel that the Wastewater Source Management Plan will need to deliver to ensure low risk operation of the wastewater treatment plant and product quality compliance.

### Appendix Table 13. Wastewater Treatment Plant & Trade Waste Customer Characteristics (Activated Sludge – BNR – No Primary Tank – No Sludge Digestion).

| Parameter | Value |
|---|---|
| Average Dry Weather Flow | 37,500 kl/day |
| Average Trade Waste Flow – Nickel Dischargers | 730 kl/day |
| Planned Maximum Number of Nickel Dischargers | 6 |
| Domestic Wastewater Concentration – Nickel (Appendix Table 12) | 0.015 mg/L |
| Biosolids Production Rate (objective 5) | 6,500 kg/day dry solids |
| Nickel Removal (Appendix Table 1) (objective 4) | 72% |
| Nitrification Process Inhibition Threshold Appendix Table 10 (objective 3) | 0.25 mg/L |
| Discharge to Environment Condition – Nickel (objective 4) | 0.075 mg/L |
| Biosolids Beneficial Reuse Threshold - Nickel (objective 5) | 105 mg/L |
| Recycled Water Reuse Threshold - Nickel (objective 5) | 0.01mg/L |
| BEARPIT Threshold – Nickel (Appendix Table 14) | 1.0 mg/L |

## Phase 1. Determine Allowable Influent Concentration to Comply with objectives

**Step 1.**
**Avoid inhibition of nitrifying bacteria (objective 3)**

Maximum Influent Concentration = 0.25 mg/L

**Step 2.**
**Licensed conditions for discharge to waterways (objective 4)**

Maximum Influent Concentration
= Environmental Authority Condition / (1- Removal Rate)

= 0.075 / (1 – 0.72)

= 0.27 mg/L

**Step 3.**
**Guidelines for the beneficial use of biosolids (objective 5)**

Maximum Nickel Mass in Biosolids = Biosolids Production Rate x Biosolids Beneficial Reuse Threshold

= 6,500 kg/day x 100 mg/kg

= 650,000 mg/day

Since the wastewater treatment process removes 72% of Nickel, the Allowable Daily Mass Load to the wastewater treatment plant = 650,000 mg/day / 0.72 = 903,000 mg/day.

Maximum Influent Concentration = Allowable Daily Mass Load / Average Dry Weather Flow

= 903,000 mg/day / (37,500 kl/day x 1000 L/kl)

= 0.024 mg/L

**Step 4.**
**Guideines for the beneficial use of recycled water (objective 5)**

Maximum Influent Concentration = Environmental Authority Condition / (1- Removal Rate)

= 0.01 / (1 – 0.72)

= 0.036 mg/L

The biosolids beneficial reuse threshold (objective 5 – facilitation of recycling) is the limiter for Nickel in this wastewater system. The Wastewater Treatment Plant Influent Trigger Limit for Nickel = 0.024 mg/L.

Once the wastewater influent trigger limit for Nickel is established, a monitoring program needs to be established. If the trigger limit is exceeded, corrective action is required. The following actions would be considered:

Determine significant sources of nickel i.e. trade waste, domestic, inflow/ infiltration

If the source is trade waste, establish a local guideline concentration for trade waste dischargers (phase 2 of example)

If the source is domestic wastewater, consult with water cycle stakeholders.

If the source is inflow/ infiltration, consult with asset owner to rectify.

The system is validated on an ongoing basis by monitoring the relevant trigger limits (established using the above methodology) for various substances at the wastewater system influent monitoring point.

## Phase 2 - Determine the local trade waste concentration based on Trade Waste Mass Load

From Phase 1 - Step 3, based on a concentration of 0.024 mg/L, the Maximum Allowable Daily Mass Load for Nickel is 903,000 mg.

Domestic Wastewater Mass Load = Average Dry Weather Flow x Domestic Wastewater Concentration

= 37,500 kl/day x 0.015 mg/L x 1000 L/kl

= 562,500 mg

Trade Waste Mass Load Allocation = Maximum Allowable Daily Mass Load - Domestic Wastewater Mass Load

= 903,000 mg/day – 562,500 mg/day

= 340,500 mg/day or 341 gram/day

Local Trade Waste Guideline Concentration = Trade Waste Mass Load Allocation / Average Trade Waste Flow from Nickel Dischargers

= (341 gram/day x 1000 mg/gram) / (730kl/day x 1000 L/kl)

= **0.47 mg/L**

Upper Daily Mass Load = Trade Waste Mass Load Allocation / Maximum Number of Nickel Dischargers

= 341 gram/day / 6 customers = **57 gram/day per customer**

## Implementation

If a trade waste customer is discharging trade waste with a concentration above the local trade waste guideline concentration of 0.47mg/L or with a mass load above the upper daily mass load of 57 grams per day, corrective action is required.

To determine the reasonableness of applicable corrective actions, the local trade waste guideline concentration should be compared with the BEARPIT threshold. If below the BEARPIT threshold of 1.0 mg/L, new and existing trade waste customers will have to install relatively expensive pretreatment infrastructure or significantly improve the efficiency and management of existing trade waste pretreatment infrastructure to ensure compliance with the local trade waste guideline.

If a trade waste customer is discharging trade waste with a concentration below the local trade waste guideline concentration of 0.47mg/L or with a mass load below the upper daily mass load of 57 grams per day, no corrective action is required for that customer.

## Appendix Table 14. – BEARPIT Threshold Values

| Parameter | BEARPIT | Guideline Concentration (mg/L) | Typical Wastewater Concentration – Influent Value (mg/L) | Analytical Method Reference APHA Method |
|---|---|---|---|---|
| Aluminium | Chemical Precipitation (Hydroxide) | 100 | 1.5 | 3120B |
| Arsenic (excluding organoarsenic compounds – see | Chemical Precipitation (Iron and Hydroxide) , Sand Filtration | 1 | 0.002 | 3114B |
| Barium | Chemical Precipitation | 5 | 0.05 | 3120B |
| Biochemical Oxygen Demand | N/A (Designed to be removed via wastewater treatment) | To be Determined – Site Specific | 325 | 5210B |
| Boron | Chemical Precipitation | 5 | 0.3 | 3120B |
| Bromine – Free | Air-stripping | 5 | | DPD-colorimetric Test Kit |
| Cadmium | Chemical Precipitation (Iron - Hydroxide), Sand Filtration | 1 | 0.0005 | 3120B |
| Chemical Oxygen Demand (COD) | N/A (Designed to be removed via wastewater treatment) | To be Determined - Site Specific | 800 | |
| Chlorine - Free | Air-stripping | 10 | <DL | DPD-colorimetric Test Kit |
| Chromium (Total) | Reduction (SMBS) and Chemical Precipitation (Hydroxide) | 3 | 0.03 | 3120B |
| Cobalt | Chemical Precipitation | 5 | 0.002 | 3120B |
| Colour | Chemical Oxidation (Ozone) | 100 (Pt–Co) | 90 | |
| Copper | Chemical Precipitation (Hydroxide) | 5 | 0.13 | 3120B |
| Cyanide - Weak and Dissociable | Alkaline Chlorination | 1 | | 4500-CN-G and E |
| Fluoride | Chemical Precipitation (Calcium) | 30 | 0.3 | 4500-F-C |
| Genetically Engineered/Modified Organisms | Cleaner Production | To be Determined by the Office of the Gene Technology Regulator | | |
| Iron | Chemical Precipitation (hydroxide) | 10 | 1.6 | 3120B |
| Lead | Chemical Precipitation(carbonate or hydroxide), Sand Filtration | 1 | 0.01 | 3120B |
| Lithium | Chemical Precipitation | 10 | | 3120B |
| Manganese | Chemical Oxidation, Precipitation, Clarification | 10 | 0.15 | 3120B |
| Anionic surfactants | Cleaner Production | 100 | 2 | |
| Mercury | Chemical Precipitation (iron) | 0.01 | 0.0001 | 3112B |
| | Ion Exchange | | | |
| | Carbon Adsorption | | | |
| | Mercury Amalgam Trap[1] | ?? | | |

[4] Dental Industry only

## Appendix Table 14. – BEARPIT Threshold Values (cpontinued)

| Parameter | BEARPIT | Guideline Concentration (mg/L) | Typical Wastewater Concentration – Influent Value (mg/L) | Analytical Method Reference APHA Method |
|---|---|---|---|---|
| Molybdenum | Chemical Precipitation | 5 | 0.01 | 3120B |
| Non-ionic Surfactants | Cleaner Production | 100 | 2 | |
| Nickel | Chemical Precipitation (Hydroxide), Sand filtration | 1 | 0.03 | 3120B |
| Total Oil and Grease | Grease Trap | 500 | 60 | USEPA1664 |
| Total Oil and Grease | Dissolved Air flotation with acid cracking | 50 | 60 | USEPA1664 |
| Organic Nitrogen (TKN-Ammonia) | Cleaner Production | Site specific | 20 | 4500-Norg B or C |
| Organoarsenic Compounds | Activated Carbon | 0.1 | | NA |
| Organochlorine Pesticides | N/A (Hazardous Waste) | prohibited | | 6410B |
| Organophosphorous Pesticides | Adsorption (Activated Carbon) and Chemical Oxidation (H2O2) | 0.1 | | 6410B |
| Organotin Compounds | Activated Carbon | 0.1 | | NA |
| Petroleum Hydrocarbons - Total | Coalescing Plate Interceptor, Gravity Separator or Hydrocyclone | 30 | | USEPA 8015B USEPA 8260B |
| Phenolic Compounds – Non-Halogenated | Chemical Oxidation | 1 | | 6410B |
| Phosphorus - Total | Chemical Precipitation for phosphate removal | 30 | 13 | 4500P-I & 4500P-F |
| Polybrominated Biphenyls (PBBs) | N/A<br><br>(Hazardous Waste) | Prohibited Discharge | | 6200B |
| Polychlorinated Biphenyls (PCBs) | N/A<br><br>(Hazardous Waste) | Prohibited Discharge | | 6200B |
| Polynuclear Aromatic Hydrocarbons | Adsorption (Activated Carbon) and Chemical Oxidation (H2O2) | 5 | | 6410B & 6440 |
| Selenium | Chemical Precipitation(Sulphide) and sand filtration | 1 | 0.001 | 3120B |
| Silver | Silver Recovery Unit | 50 | | 3120B |
| Silver | Chemical Precipitation(sulphide) and sand filtration | 1 | | |
| Sulphate(SO4-S) | Chemical Precipitation (Calcium) | 2000 | 100 | 3120B |
| Suspended Solids | N/A (Designed to be removed via wastewater treatment) | To be Determined - Site Specific | 350 | 2540D |
| Temperature | Equalisation<br>Heat Exchange | < 38ºC | 22ºC | |
| Tin(excludes Organotin compounds) | Chemical Precipitation | 5 | 0.004 | 3120B |
| Zinc | Chemical Precipitation (Hydroxide) and sand filtration | 1 | 0.2 | 3120B |

# Appendix E
# Water Utility Guidance for Industry Pollutants

The following tables are an extensive list of Industry processes and the typical trade waste profiles from these processes. The information has been gathered from the major Urban Water Utilities of many years.

The tables act as a guide for water utilities to direct the first sampling program of new industries that may discharge to the sewerage system. Coupled with appendices A – D a water utility can powerfully determine the risk that an industry may pose to water system workers and assets.

While the tables are very comprehensive, there may be some industry processes that do not appear within them. They are included as guide only.

Appendix Table 15 Guidance for Industry Pollutants

**Process**
**Substance**

**Abrasives**
- Biochemical Oxygen Demand*
- Suspended Solids
- Oil & Grease
- Total Dissolved Solids

**Vehicle Manufacture And Assembly**
- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Total Oxidised Sulfur
- Sulfate
- Sulfide
- Oil & Grease
- Nickel
- Cadmium
- Chromium
- Iron
- Copper
- Fluoride
- Phosphorus
- Formaldehyde
- Acetaldehyde
- Acetone
- Methyl Ethyl Ketone
- Methylene Blue Active Substance
- Petroleum Hydrocarbons
- Phenolic Compounds
- BTEX
- PAH
- Total Dissolved Solids

**Acid Pickling**
- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfide
- Total Oxidised Sulfur
- Sulphate
- Oil & Grease
- Chromium
- Copper
- Iron
- Cadmium
- Lead
- Barium
- Arsenic
- Manganese
- Nickel
- Zinc
- Aluminium
- Ammonia
- Acetone
- Chlorinate Hydrocarbons
- Petroleum Hydrocarbons
- Total Dissolved Solids

**Adhesive/Latex**
- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfide
- Total Oxidised Sulfur
- Sulphate
- Oil & Grease
- Ammonia
- Styrene
- Acetone
- Vinyl Chloride
- Petroleum Hydrocarbons
- Total Chlorinated Hydrocarbons
- Trichloroethylene
- Total Dissolved Solids

**Agricultural & Veterinary Drugs**
- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfide
- Total Oxidised Sulfur
- Sulfate
- Mercury
- Arsenic
- Zinc
- Iron
- Nitrogen

Ammonia
Phosphorus
Trichloroethylene
Formaldehyde
Total Dissolved Solids

### Bitumen & Tar

Biochemical Oxygen Demand*
Suspended Solids
Ph
Total Oxidised Sulfur
Sulfate
Sulfide
Oil & Grease
Mercury
Cadmium
Zinc
Petroleum Hydrocarbons
BTEX
Trichloroethylene
Process
Substance

### Chemical Repackaging

Biochemical Oxygen Demand*
Suspended Solids
PH
Total Oxidised Sulfur
Sulfide
Sulphate
Oil & Grease
Aluminium
Arsenic
Iron
Chromium
Zinc
Nitrogen
Ammonia
Phosphorus
Methylene Blue Active Substances (MBAS)
Petroleum Hydrocarbons
Formaldehyde
Total Chlorinated Hydrocarbons
Total Dissolved Solids
Process
Substance

### Cosmetic & Perfumes

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Total Oxidised Sulfur
Sulphate
Ammonia
Petroleum Hydrocarbons
Methylene Blue Active Substances (MBAS)
Formaldehyde
Acetone

### Essential Oils

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Oil & Grease

### Gas Production

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Copper
Cadmium
Zinc
Ammonia
Petroleum Hydrocarbons
Total Chlorinated Hydrocarbons
PAH

### Ink Manufacture

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Oil & Grease
Ammonia
Petroleum Hydrocarbons
Methyl Ethyl Ketone

### Inorganic Liquids/Acid

Biochemical Oxygen Demand*
Suspended Solids
PH
Total Oxidised Sulfur
Sulfide
Sulfate
Aluminium
Arsenic
Zinc
Barium
Nickel
Lead
Iron
Manganese
Ammonia

Phosphorus
Nitrogen
Fluoride
Acetone
Total Dissolved Solids

## Inorganic Powders

Biochemical Oxygen Demand*
Suspended Solids
PH
Total Oxidised Sulfur
Sulfide
Sulfate
Aluminium
Arsenic
Zinc
Barium
Nickel
Lead
Iron
Manganese
Ammonia
Phosphorus
Nitrogen
Fluoride
Acetone
Total Dissolved Solids

## Oil Recycling

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Sulfide
Total Oxidised Sulfur
Sulphite
Iron
Arsenic
Iron
Zinc
Mercury
Aluminium
Cadmium
Boron
Ammonia
Petroleum Hydrocarbons
Total Chlorinated Hydrocarbons
BTEX
Phenolic Compounds
Acetone
Total Dissolved Solids

## Oil Refinery

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Total Oxidised Sulfur
Sulfide
Sulphate
Iron
Arsenic
Zinc
Mercury
Aluminium
Cadmium
Boron
Ammonia
Petroleum Hydrocarbons
Total Chlorinated Hydrocarbons
BTEX
Phenolic Compounds
Dimethyl Sulfide
PAH
Total Dissolved Solids

## Oil Terminal

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphide
Total Oxidised Sulfur
Sulfate
Oil & Grease
Cadmium
Arsenic
Zinc
Lead
Iron
Petroleum Hydrocarbons
BTEX
Phenolic Compounds

## Chloralkali Plant

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Sulfate
Total Oxidised Sulfur
Mercury
Aluminium
Zinc
Copper
Total Dissolved Solids

## Organic Liquids

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfide
- Total Oxidised Sulfur
- Sulphate
- Oil & Grease
- Boron
- Zinc
- Mercury
- Cadmium
- Barium
- Copper
- Ammonia
- Styrene
- Acetone
- Vinyl Chloride
- BTEX
- Total Chlorinated Hydrocarbons
- Petroleum Hydrocarbons
- Total Dissolved Solids

## Paint Mfr

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfide
- Sulphate
- Oil & Grease
- Aluminium
- Lead
- Chromium
- Iron
- Zinc
- Fluoride
- Ammonia
- Nitrogen
- Xylene
- Acetone
- Methyl Ethyl Ketone
- Formaldehyde
- Petroleum Hydrocarbons
- Phenolic Compounds
- Trichloroethylene

## Pharmaceuticals

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfide
- Total Oxidised Sulfur
- Sulphate
- Oil & Grease
- Chromium
- Copper
- Aluminium
- Lithium
- Mercury
- Arsenic
- Zinc
- Nitrogen
- Ammonia
- Phosphorus
- Methyl Ethyl Ketone
- Acetone
- Petroleum Hydrocarbons
- Phenolic Compounds
- Trichloroethylene
- Total Dissolved Solids

## Resins & Polymers

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Total Oxidised Sulfur
- Sulfide
- Sulphate
- Oil & Grease
- Zinc
- Aluminium
- Boron
- Nitrogen
- Ammonia
- Vinyl Chloride
- Chlorinate Hydrocarbons
- Styrene
- BTEX
- Acetaldehyde
- Acetone
- Formaldehyde
- Petroleum Hydrocarbons
- Phenolic Compounds
- Total Dissolved Solids

## Rubber Production

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfide
- Total Oxidised Sulfur
- Sulfate
- Oil & Grease
- Zinc
- Copper
- Iron
- Nitrogen
- Ammonia
- Phosphorus
- Methyl Ethyl Ketone
- Styrene
- Acetone
- Petroleum Hydrocarbons

## Soaps/Detergents

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphite
- Total Oxidised Sulfur
- Sulfide
- Sulphate
- Zinc
- Aluminium
- Copper
- Iron
- Lead
- Nitrogen
- Ammonia
- Phosphorus
- Formaldehyde
- Methylene Blue Active Substances (MBAS)
- Petroleum Hydrocarbons
- Phenolic Compounds
- Total Dissolved Solids

## Pesticide Manufacture

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfide
- Total Oxidised Sulfur
- Sulfate
- Magnesium
- Mercury
- Arsenic
- Cadmium
- Copper
- Ammonia
- Nitrogen
- Phenolic Compounds
- Total Chlorinated Hydrocarbons
- Pesticides Scan
- Dimethyl Sulfide
- Total Dissolved Solids

## Weedkillers/Insecticides

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Total Oxidised Sulfur
- Sulfide
- Sulfate
- Oil & Grease
- Total Herbicides
- Total General Pesticides
- Xylene
- Trichloroethylene
- Total Dissolved Solids

## Aerated Soft Drinks

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Total Oxidised Sulfur
- Sulfide
- Oil & Grease
- Nitrogen
- Colour
- Total Dissolved Solids

## Brewery

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfide
- Ethanol
- Total Dissolved Solids

## Cordials

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfide
- Sulfate
- Petroleum Hydrocarbons
- Chlorine
- Total Dissolved Solids

## Fruit Juices
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Sulphate
Chlorine
Nitrogen
Total Dissolved Solids

## Wine/Spirit Mfr
Biochemical Oxygen Demand*
Suspended Solids
PH
Total Oxidised Sulfur
Sulfide
Sulfate
Ethanol
Total Dissolved Solids

## Cheese/Butter Mfr
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulfide
Oil & Grease
Nitrogen
Ammonia
Phosphorus
Total Dissolved Solids

## Dairy
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Sulphate
Oil & Grease
Nitrogen
Ammonia
Phosphorus
Total Dissolved Solids

## Ice Cream Mfr
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Sulfate
Oil & Grease
Nitrogen
Ammonia
Phosphorus
Total Dissolved Solids

## Cannery
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulfide
Oil & Grease
Copper
Nickel
Zinc
Aluminium
Total Dissolved Solids

## Chip Manufacturers (Small) < 10kl/Day
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphite
Sulfide
Oil & Grease
Total Dissolved Solids

## Condiments/Sauces Mfr
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulfide
Oil & Grease
Iron
Ammonia
Phosphorus
Nitrogen
Formaldehyde
Total Dissolved Solids

## Fruit/Vegetable Washing
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulfide
Ammonia
Chlorine

## Pickles
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulfide
Ammonia
Total Dissolved Solids

### Potato Peeling

Biochemical Oxygen Demand*
Suspended Solids
PH
Total Oxidised Sulfur
Sulfide
Sulphate
Nitrogen
Ammonia
Phosphorus

### Bakery

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulfide
Oil & Grease

### Cereals

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Sulphate
Oil & Grease
Nitrogen

### Edible Oil & Fats

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Sulfide
Sulphite
Sulphate
Phosphorus
Nitrogen
Total Dissolved Solids

### Pies

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Sulfide
Ammonia
Nitrogen
Total Dissolved Solids

### Starch Mfr

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphite
Sulphate
Total Oxidised Sulfur
Nitrogen
Ammonia
Phosphorus
Total Dissolved Solids

### Abattoir/Saleyards

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Sulfide
Total Oxidised Sulfur
Sulfate
Nitrogen
Ammonia
Phosphorus
Barium
Iron
Total Dissolved Solids

### Meat Packing

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Sulfate
Oil & Grease
Ammonia

### Meat Preserving

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Sulfate
Oil & Grease
Nitrogen
Phosphorus
Total Dissolved Solids

### Oyster Preparation

Biochemical Oxygen Demand*
Suspended Solids
PH
Ammonia
Sulfide

## Poultry

Biochemical Oxygen Demand*
Suspended Solids
PH
Total Oxidised Sulfur
Sulphide
Sulphite
Oil & Grease
Aluminium
Ammonia
Phosphorus
Nitrogen
Total Dissolved Solids

## Rendering

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfate
Sulfide
Oil & Grease
Iron
Nitrogen
Ammonia
Phosphorus
Total Oxidised Sulfur

## Small Goods

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphide
Sulphate
Oil & Grease
Nitrogen
Ammonia
Phosphorus
Total Dissolved Solids

## Wholesale Butcher

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Nitrogen
Ammonia

## Confectionary

Biochemical Oxygen Demand*
Suspended Solids
Ph
Sulfide
Total Oxidised Sulfur
Sulfate
Oil & Grease
Copper
Iron
Ethanol
Total Dissolved Solids

## Egg Processing

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Ammonia
Nitrogen
Phosphorus

## Essence & Flavours

Biochemical Oxygen Demand*
Suspended Solids
PH
Total Oxidised Sulfur
Sulphite
Sulphate
Oil & Grease
Nitrogen
Phosphorus
Ethanol
Total Dissolved Solids

## Honey

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide

## Sugar Distillery

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Phosphorus
Total Dissolved Solids

## Yeast Mfr

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate

### Asbestos Cement

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphide
- Total Oxidised Sulfur
- Sulphate

### Cement & Concrete

- Chemical Oxygen Demand
- Suspended Solids
- PH
- Sulphite
- Total Oxidised Sulfur
- Sulfide
- Sulphate
- Copper
- Iron
- Calcium
- Chromium
- Aluminium
- Barium
- Zinc
- Phosphorus
- Acetone
- Total Dissolved Solids

### Ceramic Pottery/Stoneworking (Industrial)

- Chemical Oxygen Demand
- Suspended Solids
- PH
- Total Oxidised Sulfur
- Sulphate
- Sulfide
- Arsenic
- Lead
- Barium
- Nickel
- Zinc
- Aluminium
- Acetone
- Total Dissolved Solids

### Glass Finishing

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Zinc
- Aluminium
- Arsenic
- Boron
- Phosphorus
- Lead
- Nitrogen
- Ammonia
- Total Dissolved Solids

### Glass Mfr

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphate
- Arsenic
- Zinc
- Copper
- Ammonia
- Phosphorus
- Petroleum Hydrocarbons

### Mirrors

- Chemical Oxygen Demand
- Suspended Solids
- PH
- Sulphate
- Sulfide
- Silver
- Arsenic
- Barium
- Chromium
- Copper
- Lead
- Zinc
- Ammonia
- Total Dissolved Solids

### Cardboard & Carton Mfr

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Total Oxidised Sulfur
- Sulphite
- Sulphate
- Copper
- Aluminium
- Arsenic
- Boron
- Barium
- Zinc
- Nitrogen
- Ammonia
- Colour
- Formaldehyde
- Total Dissolved Solids

### Paper Mfr/Pulp Processing
Biochemical Oxygen Demand*
Suspended Solids
PH
Total Oxidised Sulfur
Sulphite
Sulphate
Sulphide
Oil & Grease
Arsenic
Copper
Barium
Aluminium
Colour
Petroleum Hydrocarbons
Acetone
Total Dissolved Solids

### Printing
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphite
Sulphate
Sulfide
Oil & Grease
Ammonia
Silver
Boron
Chromium
Copper
Iron
Zinc
Thiosulphate
Petroleum Hydrocarbons
Total Dissolved Solids

### Extrusion & Mounding
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulphide
Oil & Grease
Zinc
Aluminium
Barium
Cobalt
Chromium
Manganese
Copper
Iron
Nitrogen
Phosphorus
Petroleum Hydrocarbons
Chlorine
Formaldehyde
Acetone

### Fibreglass
Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Copper
Zinc
Iron

### Resin Fabrication
Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Ammonia
Petroleum Hydrocarbons
Acetone

### Plywood/Hardwood
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulphide
Oil & Grease
Arsenic
Chromium
Copper
Formaldehyde
Methyl Ethyl Ketone
Acetone

### Caterer
Biochemical Oxygen Demand*
Suspended Solids
Sulphide
Oil & Grease

### Wet Cell Batteries
Chemical Oxygen Demand
Suspended Solids
PH
Sulphate
Sulphide
Cadmium
Arsenic
Nickel

Lead
Zinc
Total Dissolved Solids

## Foundry

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Aluminium
Arsenic
Lead
Chromium
Copper
Iron
Zinc
Total Phenolic Compounds
Total Dissolved Solids

## Machine Shop

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulphide
Oil & Grease
Arsenic
Aluminium
Barium
Chromium
Copper
Iron
Zinc
Petroleum Hydrocarbons
Acetone
Trichloroethylene

## Sheet Metal & Fabrication

Suspended Solids
PH
Oil & Grease
Fluoride
Iron
Chromium
Arsenic
Aluminium
Manganese
Nickel
Zinc
Petroleum Hydrocarbons
Acetone

## Anodising

Suspended Solids
PH
Sulphate
Sulphide
Oil & Grease
Arsenic
Cadmium
Lead
Nickel
Magnesium
Aluminium
Zinc
Chromium
Ammonia

## Electroplating - Cyanide

Biochemical Oxygen Demand*
Suspended Solids
PH
Cadmium
Sulphate
Sulfide
Oil & Grease
Aluminium
Barium
Arsenic
Chromium
Copper
Iron
Manganese
Nickel
Lead
Selenium
Tin
Zinc
Phosphorus
Ammonia
Petroleum Hydrocarbons
Total Chlorinated Hydrocarbons
Acetone
Total Dissolved Solids

## Electroplating - Non Cyanide

Biochemical Oxygen Demand*
Suspended Solids
PH
Cadmium
Sulphate
Sulfide

- Oil & Grease
- Aluminium
- Barium
- Arsenic
- Chromium
- Copper
- Iron
- Manganese
- Nickel
- Lead
- Selenium
- Tin
- Zinc
- Phosphorus
- Ammonia
- Petroleum Hydrocarbons
- Total Chlorinated Hydrocarbons
- Acetone
- Total Dissolved Solids

## Painting & Coating

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphite
- Sulphate
- Sulfide
- Oil & Grease
- Zinc
- Nickel
- Lead
- Tin
- Cyanide - Labile
- Aluminium
- Chromium
- Copper
- Fluoride
- Iron
- Nitrogen
- Phosphorus
- Trichloroethylene
- Acetone
- Formaldehyde
- Petroleum Hydrocarbons
- Total Dissolved Solids

## Phosphating

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphate
- Zinc
- Manganese
- Nickel
- Aluminium
- Boron
- Cadmium
- Tin
- Chromium
- Copper
- Fluoride
- Iron
- Ammonia
- Phosphorus
- Petroleum Hydrocarbons
- Total Dissolved Solids

## Powder Coating

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphate
- Zinc
- Nickel
- Barium
- Cyanide - Labile
- Chromium
- Fluoride
- Iron
- Aluminium
- Phosphorus
- Ammonia
- Petroleum Hydrocarbons
- Total Dissolved Solids

## Caustic Degreasing

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphate
- Sulfide
- Oil & Grease
- Copper
- Lead
- Zinc
- Boron
- Iron
- Petroleum Hydrocarbons
- Perchloroethylene
- Phenolic Compounds
- Acetone
- Total Dissolved Solids

### Metal Rumbling
Biochemical Oxygen Demand*
Suspended Solids
PH
Zinc
Aluminium
Arsenic
Cadmium
Chromium
Nickel
Boron
Copper
Iron
Lead
Phosphorus

### Non-Cyanide Heat Treatment
Suspended Solids
Sulphate
Chromium
Iron
Nickel
Zinc

### Paint Stripping
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Total Oxidised Sulfur
Sulfide
Lead
Zinc
Total Chlorinated Hydrocarbons
Formaldehyde
Trichloroethylene
Phenolic Compounds
Acetone

### Photo Engraving
Suspended Solids
Silver
Zinc

### Printed Circuit Etching
Suspended Solids
Sulphate
Zinc
Copper
Lead
Tin
Ammonia

### Metal Refining
Suspended Solids
Sulphite
Total Oxidised Sulfur
Sulphate
Sulfide
Full Metal Screen
Nitrogen
Phosphorus
Thiosulphate
Acetone

### Contaminated Ground Water
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulfide
Sulfite
Full Metal Screen
Ammonia
Nitrogen
Chlorine
Total Chlorinated Hydrocarbons
Phosphorus
Total General Pesticides
Petroleum Hydrocarbons
BTEX
PAH
Total Dissolved Solids

### Contaminated Surface Water
Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulfide
Sulfite
Full Metal Screen
Ammonia
Nitrogen
Chlorine
Total Chlorinated Hydrocarbons
Phosphorus
Total General Pesticides
Petroleum Hydrocarbons
BTEX
PAH
Total Dissolved Solids

## Fume Scrubbing

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Mercury
Cadmium
Lead
Barium
Zinc

## Boat Washing Facilities

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Methylene Blue Active Substances (MBAS)
Petroleum Hydrocarbons

## Detergent Degreasing

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulfide
Total Oxidised Sulfur
Sulphate
Oil & Grease
Zinc
Copper
Iron
Lead
Petroleum Hydrocarbons
Acetone
Perchloroethylene
Total Chlorinated Hydrocarbons
BTEX

## Engine/Gearbox Reconditioner

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphite
Sulphate
Oil & Grease
Zinc
Aluminium
Copper
Iron
Nickel
Lead
Chromium
Total Chlorinated Hydrocarbons
Petroleum Hydrocarbons
Phenolic Compounds

## Mechanical Workshop, Auto Recyclers

Suspended Solids
PH
Oil & Grease
Zinc
Chromium
Copper
Aluminium
Nickel
Lead
Petroleum Hydrocarbons
BTEX

## Radiator Repairs

Biochemical Oxygen Demand*
Suspended Solids
PH
Nickel
Lead
Tin
Zinc
Aluminium
Copper
Iron

## Residential Car Wash / Garbage Bay

Biochemical Oxygen Demand*
Suspended Solids
Oil & Grease
Petroleum Hydrocarbons

## Solvent Degreasing

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Oil & Grease
Aluminium
Arsenic
Cadmium
Lead
Copper
Iron
Acetone
Perchloroethylene
Total Chlorinated Hydrocarbons
Petroleum Hydrocarbons
Phenolic Compounds

## Steam Cleaning

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Petroleum Hydrocarbons
Phenolic Compounds

### Train Washing

- Biochemical Oxygen Demand*
- Suspended Solids
- Sulphate
- Oil & Grease
- Aluminium
- Barium
- Copper
- Iron
- Zinc
- Ammonia
- Lead
- Methylene Blue Active Substances (MBAS)
- Petroleum Hydrocarbons

### Transport Depot

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphate
- Sulfide
- Oil & Grease
- Cadmium
- Aluminium
- Copper
- Iron
- Lead
- Zinc
- Petroleum Hydrocarbons
- Phenolic Compounds
- Total Chlorinated Hydrocarbons

### Cooling Tower, Boiler Blowdown

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Ammonia
- Zinc
- Copper
- Iron
- Petroleum Hydrocarbons
- Total Dissolved Solids

### Commercial Laundry < 2 Ml/Yr

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfate

### Commercial Laundry > 2 Megalitres/Annum

- Biochemical Oxygen Demand*
- Suspended Solids
- Ph
- Sulphate
- Oil & Grease
- Petroleum Hydrocarbons
- Nitrogen
- Ammonia
- Phosphorus
- Total Dissolved Solids

### Equipment Washing

- Biochemical Oxygen Demand*
- Suspended Solids
- Ph
- Oil & Grease
- Aluminium
- Copper
- Iron
- Zinc
- Total Chlorinated Hydrocarbons
- Petroleum Hydrocarbons
- Total Phenolic Compounds
- BTEX
- Acetone

### Feather Washing

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Oil & Grease
- Nitrogen
- Ammonia
- Phosphorus

### Filter Cleaning

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Oil & Grease
- Sulphite
- Sulphate
- Aluminium
- Cobalt
- Zinc
- Lead
- Petroleum Hydrocarbons

### Shipping Container Washing

Biochemical Oxygen Demand*
Suspended Solids
PH
Total Oxidised Sulfur
Sulphate
Sulfide
Oil & Grease
Ammonia
Full Metal Screen
Total Chlorinated Hydrocarbons
Formaldehyde
Pesticides/Herbicide Scan
Petroleum Hydrocarbons
BTEX
Phenolic Compounds
Methylene Blue Active Substances (MBAS)
Acetone

### Analytical Laboratory - Large

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulfide
Copper
Iron
Mercury
Arsenic
Ammonia
Lead
Tin
Zinc
Phosphorus
Total Chlorinated Hydrocarbons
Formaldehyde

### Small Lab, Hosp & Uni Lab, Path Lab, Morgue

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Aluminium
Cadmium
Chromium
Copper
Iron
Manganese
Molybdenum
Nickel
Zinc
Formaldehyde

### Cooling Tower - Industrial

Biochemical Oxygen Demand*
Suspended Solids
Ph
Sulphate
Ammonia
Chromium
Copper
Iron
Lead
Zinc
Total Dissolved Solids

### Photographic Processing

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphite
Sulphate
Iron
Silver
Ammonia
Formaldehyde
Thiosulphate
Acetone

### Drum Washing

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphate
Sulfide
Oil & Grease
Ammonia
Phosphorus
Nitrogen
Full Metal Screen
Total Chlorinated Hydrocarbons
Formaldehyde
Pesticides/Herbicide Scan
Petroleum Hydrocarbons
BTEX
Phenolic Compounds
Methylene Blue Active Substances (MBAS)
Acetone
Total Dissolved Solids

## Water Treatment

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphite
- Sulphate
- Chlorine
- Copper
- Fluoride
- Arsenic
- Iron
- Aluminium
- Zinc
- Barium
- Manganese
- Ammonia
- Nickel
- Chloroform

## Scrap Materials Reclamation

- Biochemical Oxygen Demand*
- Suspended Solids
- Oil & Grease
- Petroleum Hydrocarbons

## Aqueous Waste Treatment Depot

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphate
- Sulfide
- Oil & Grease
- Ammonia
- Phosphorus
- Nitrogen
- Full Metal Screen
- Total Chlorinated Hydrocarbons
- Formaldehyde
- Pesticides/Herbicide Scan
- Petroleum Hydrocarbons
- BTEX
- Phenolic Compounds
- Methylene Blue Active Substances (MBAS)
- Acetone
- Total Dissolved Solids

## Garbage Tip

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphate
- Sulfide
- Oil & Grease
- Ammonia
- Phosphorus
- Nitrogen
- Full Metal Screen
- Total Chlorinated Hydrocarbons
- Formaldehyde
- Pesticides/Herbicide Scan
- Petroleum Hydrocarbons
- BTEX
- Phenolic Compounds
- Methylene Blue Active Substances (MBAS)
- Acetone
- Total Dissolved Solids

## Garbage Truck Washing

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphide
- Oil & Grease
- Aluminium
- Barium
- Iron
- Nickel
- Lead
- Zinc
- Nitrogen
- Ammonia
- Phosphorus
- Petroleum Hydrocarbons

## Grease Trap Waste Disposal

- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfide
- Oil & Grease
- Ammonia
- Petroleum Hydrocarbons
- Iron

### Industrial Waste Treatment
- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphate
- Sulfide
- Oil & Grease
- Ammonia
- Phosphorus
- Nitrogen
- Full Metal Screen
- Total Chlorinated Hydrocarbons
- Formaldehyde
- Pesticides/Herbicide Scan
- Petroleum Hydrocarbons
- BTEX
- Phenolic Compounds
- Methylene Blue Active Substances (MBAS)
- Acetone
- Total Dissolved Solids

### Waste Transfer Stations
- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphite
- Sulphate
- Sulfide
- Oil & Grease
- Aluminium
- Copper
- Iron
- Manganese
- Ammonia
- Nickel
- Lead
- Zinc
- Tin
- Phenolic Compounds
- Petroleum Hydrocarbons

### Chrome Tanning
- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphate
- Total Oxidised Sulfur
- Sulfide
- Oil & Grease
- Ammonia
- Chromium
- Boron
- Total Dissolved Solids

### Salting And Brining Hides
- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphate
- Total Oxidised Sulfur
- Sulfide
- Oil & Grease
- Ammonia
- Fluoride
- Iron
- Boron
- Nitrogen
- Total Dissolved Solids

### Leather Finishing
- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphate
- Sulfide
- Ammonia
- Chromium
- Lead
- Zinc
- Formaldehyde

### Vegetable Tanning
- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulphide
- Sulphate
- Oil & Grease
- Chromium

### Carpet Mfr
- Biochemical Oxygen Demand*
- Suspended Solids
- PH
- Sulfate
- Sulfide
- Phosphorus
- Acetone
- Formaldehyde
- Methylene Blue Active Substances (MBAS)
- Total Dissolved Solids

## Wool Dyeing/Spinning

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Sulphite
Sulphate
Zinc
Thiosulphate
Ammonia
Colour
Acetone

## Wool Scouring

Biochemical Oxygen Demand*
Suspended Solids
PH
Oil & Grease
Sulphate
Sulfide
Arsenic
Formaldehyde
Total Dissolved Solids

## Cotton/Synthetics Dyeing/Spinning

Biochemical Oxygen Demand*
Suspended Solids
PH
Sulphite
Sulphate
Oil & Grease
Chromium
Copper
Ammonia
Formaldehyde
Acetone
Colour