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The World's Leading Laboratory Network

Environmental Monitoring

Environment

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Table of Contents

Cover Photo: Hutt City sewer outfall at Pencarrow Head before completion of the sewage treatment plant at Seaview.

Introduction

Eurofins-ELS is one of New Zealand's leading experts in the areas of:

- Air quality monitoring
- Boiler water
- Environmental water
- Landfills
- Meat industry services
- Potable water for councils
- Sample Integrity
- Swimming pools
- Biological fluids
- Ceramicware and metal food containers
- Food and Dairy Products
- Legionella
- Metals
- Potable water for small communities
- Sewage and effluent
- Trade waste

The company has its origin as part of the Hutt City Council Laboratory and became a private enterprise in 1994. We grew through natural growth as well as the acquisition of local laboratories until in December 2012 we were acquired by Eurofins - the largest laboratory network in the world.

Eurofins Scientific is an international life sciences company which provides a unique range of analytical testing services to clients across multiple industries. The Group is the world leader in food and pharmaceutical products testing. It is also number one in the world in the field of environmental laboratory services, and one of the global market leaders in agroscience, genomics, pharmaceutical discovery and central laboratory services.

We are based in a purpose built facility of 1450 m^2 at 85 Port Road, Lower Hutt. Eurofins-ELS is comprised of four separate laboratory areas – Instrumental Chemistry, General Chemistry, Biological Fluids, and Microbiology. The latter is further split into three separate rooms with clean, cleaner and ultra clean capabilities. The ultra clean lab is used for pathogenic bacteria determinations.

In mid-2016 Eurofins-ELS opened satellite laboratories in Auckland and Christchurch, followed by the opening of a laboratory in Dunedin in July 2017. These laboratories offer full scope testing and sampling services.

Who should read this brochure?

This brochure has been prepared for regional and local councils who monitor the quality of environmental water. Analyses of these waters are performed for various reasons and include:

- To measure the impact of rural and urban development
- For use as a drinking water source
- For compliance against the Ministry for the Environment bathing standards

Chemical Analyses of Environmental Waters

Chemical analyses of groundwaters is important for identifying groundwater conditions, contamination as well as for ensuring drinking water quality.

Screening of groundwater quality usually involves a range of chemical tests that together form a good profile of the analytes present. This includes a set of cations and a set of anions that should be mathematically balanced in normal water sources.

Ion Balances

The calculation of ion balances is performed for two reasons. The first is to ensure the water under analyses is chemically stable and the second is to ensure correctness of the analyses.

We perform the most common cations and anions and then performs the ion balance calculation on the results.

Anions

- Alkalinity
- Chloride
- Nitrate
- Boron
- Sulphate

Cations

- Ammonia
- Iron
- Sodium
- Potassium
- Calcium
- Magnesium

For an ion to contribute to conductivity, it must be dissolved. Unfortunately, some sample aliquots analysed in the lab (especially acidified metals samples) contain material such as leached metals, which were not dissolved when the sample was collected, but have been dissolved by the preservative.

These samples may give high levels of metal ions, which are not balanced by corresponding ions of opposite charge (eg anions). Therefore the interpretation of ion balances must be made with caution.

Ion balances are probably of most use in checking clean water and not leachate or contaminated water.

APHA provides criteria of acceptance based on the value of the anion sum in milliequivalents per litre (meq/L).

Anion Sum (meq/L)	Acceptable difference
0 – 3.0	± 0.2 meq/L or 7%
3.0 – 10.0	± 2%
10.0 - 800	± 5%

The report contains comments to this effect when an ion balance is requested.

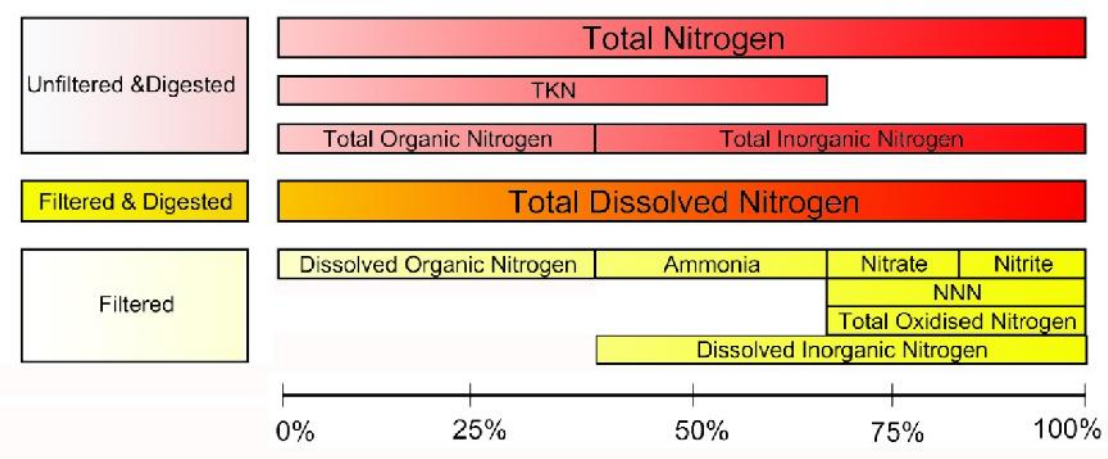
Nutrients Analysis of Environmental Waters

The usual reason for analysing natural waters is to monitor nutrient levels over time, in order to identify trends. These trends can indicate a contamination of natural waters, which if found early enough could be corrected.

Nitrogen Species

Nitrogen forms many different species in the environment, a condition complicated by the fact that some of these species have different names!

The chart below can assist you with some of the terms used for nitrogen and its different states.



The chart shows the different relationships between the species, and can be used to show alternatives ways of analysing for each species.

- NNN is the same as Nitrate plus Nitrite and is also called Oxidised Nitrogen
- Dissolved Inorganic Nitrogen = NNN plus Ammonia
- Dissolved Organic Nitrogen = Total Nitrogen minus DIN
- Nitrate = NNN minus Nitrite
- TKN = Total Nitrogen minus NNN
- Total Oxidised Nitrogen is the same as NNN

These calculations, while valid techniques for determining the analytes, should be considered approximate.

<u>Total Nitrogen</u>

We analyse Total Nitrogen by digesting the sample in a persulphate mixture at high temperatures and pressures. We then analyse the digest in a Flow

Injection Autoanalyser or FIA. The digest is strong enough to break down all forms of nitrogen into the easy to analyse nitrate form.

There are precautions however to the method that requires experience and expertise in performing the test.

The analytical technique is limited by the amount of digesting solution available to complete the digestion.

For example, samples containing high levels of nitrogen will require diluting before digestion. It is possible for the digesting solution to be exhausted before all the nitrogen in the sample is broken down, and for some of it to remain in a form unable to be analysed. Under these conditions the test would report the levels of nitrogen that was digested, leading to inaccurate data. The test would appear to an inexperienced analyst to have operated correctly.

The experience that we have in dealing with such samples ensures this will never happen with your samples.

Total Kjeldahl Nitrogen (TKN)

This form of nitrogen is specific to the digest used – ie the Kjeldahl digestion. It is made up of all nitrogen that breaks down in hot boiling sulphuric acid, and includes ammonia and organic nitrogen. It does not include nitrate or nitrite.

TKN can also be determined mathematically from the Total Nitrogen and NNN tests. This is a common technique for obtaining lower detection levels.

Kjeldahl Nitrogen can also be reported on a filtered sample as Dissolved Kjeldahl Nitrogen, but this is not very common.

Organic Nitrogen

Organically bound nitrogen can be determined by subtracting the ammonia content from the TKN content. It includes most of the natural nitrogen compounds such as protein, cellular nitrogen, and urea.

This form of nitrogen can be reported on filtered samples as Dissolved Organic Nitrogen.

Inorganic Nitrogen

Nitrogen that is considered inorganic includes ammonia, nitrate, and nitrite. We report this by analysing and adding the individual components together.

Ammonia

Ammonia is a compound that has had many names over the years of which ammonium and ammoniacal nitrogen are two. When we test for ammonia we are in fact analysing a gas, which has dissolved into the sample.

The ammonia usually comes from the bacterial breakdown of protein and fertilisers.

Ammonia is an important environmental parameter due particularly to its toxicity to fish. However only a portion of the total ammonia is toxic and this is the unionised portion.

Unionised Ammonia

As it comes into contact with water, ammonia dissociates into NH4+ ions (ionised ammonia) and NH_3 – (unionised ammonia) ions. At normal pH levels such as pH 7, this poses no problem. However, if pH levels increase, the unionised ammonia becomes toxic to both plants and animals.

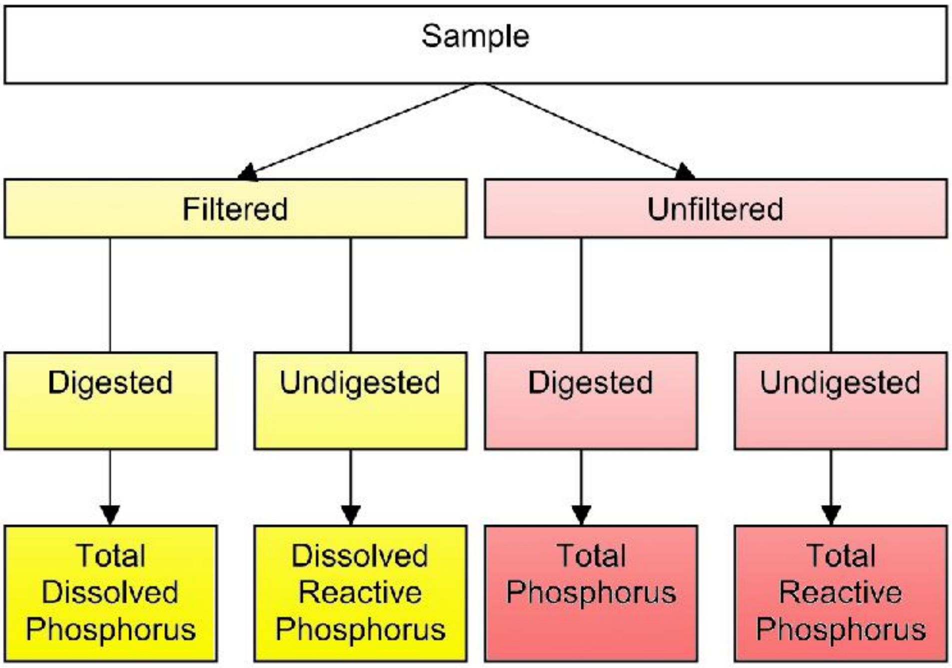
In order to calculate the unionised portion of ammonia we require the pH and temperature at the time of sampling.

We then use a complex spreadsheet of mathematics to calculate the value. In principal, the higher the pH and warmer the temperature, the greater the amount of ammonia is converted to its unionised form.

Phosphorus species

Phosphorus is the second commonly analysed environmental nutrient, and like nitrogen it can take many forms.

Four forms of phosphorus are commonly analysed in New Zealand and we are able to test for each of them by Flow Injection Autoanalyser (FIA), after various forms of pre-treatment.



Dissolved Organic Phosphorus can be measured by subtracting the Dissolved Reactive Phosphorus result from the Total Dissolved Phosphorus result.

In addition to this colorimetric technique we can also analyse phosphorus by Ion Chromatography and ICP-OES.

These two instruments determine phosphate content in different ways and determine slightly different forms of the nutrient. Each technique has its own uses.

Ion Chromatography determines soluble phosphate which is similar to DRP but will report a slightly lower result. The result includes all phosphorus that is readily available to the environment, excluding the portion that is broken down as part of the FIA technique.

ICP-OES is particularly good at determining total phosphorus because of the hot plasma used in the technique. It is used for specialist applications where the FIA technique is unable to produce appropriate results.

Groundwater and Surface Water

The most common sample matrix that we perform nutrient analyses on is ground and surface waters for regional councils.

Nitrogen and Phosphorus are essential for the growth of organisms and can limit the primary productivity of a body of water. In instances where phosphate is a growth limiting nutrient, the discharge of raw or treated wastewater, agricultural drainage, or certain industrial wastes to that water may stimulate the growth of photosynthetic aquatic micro- and macro-organisms in nuisance quantities.

This has been seen in New Zealand with the eutrophication of several North Island lakes, and is a process that is difficult to reverse.

Regional Councils perform routine monitoring and look for trends in the data over long periods of time – often years.

It is important therefore to ensure the continuity and integrity of the database by using the most appropriate analytical techniques.

Non-nutrient parameters are also analysed on environmental waters for the purpose of baseline monitoring. These can include:

- Biochemical Oxygen Demand
- Chlorophyll A
- E.coli
- Enterococci
- pH
- Total Organic Carbon
- Turbidity

<u>Biochemical Oxygen Demand</u>

Biochemical oxygen demand, or BOD, measures the amount of oxygen consumed by microorganisms in decomposing organic matter in environmental water. BOD also measures the chemical oxidation of inorganic matter (ie, the extraction of oxygen from water via chemical reaction). A test is used to measure the amount of oxygen consumed by these organisms during a specified period of time (usually 5 days at 20°C). The rate of oxygen consumption in a body of water is affected by a number of variables: temperature, pH, the presence of certain kinds of microorganisms, and the type of organic and inorganic material in the water.

BOD directly affects the amount of dissolved oxygen in rivers and streams. The greater the BOD, the more rapidly oxygen is depleted in the body of water. This means less oxygen is available to higher forms of aquatic life. The consequences of high BOD are the same as those for low dissolved oxygen: aquatic organisms become stressed, suffocate, and die.

Sources of BOD include leaves and woody debris; dead plants and animals; animal manure; effluents from pulp and paper mills, wastewater treatment plants, and food-processing plants; failing septic systems; and urban stormwater runoff.

Why 5 days?

According to Baird & Smith in their book titled: “Third century of biochemical oxygen demand”, the reason for establishing 5 days as the basis of the BOD test is because rivers in England reach the sea in 5 days or less.

Total Organic Carbon

A dedicated TOC instrument measures the amount of carbon dioxide produced from organics when a water sample is atomised into a combustion chamber.

There has been talk for some time now that this may be a suitable substitute for BOD in order to achieve lower detection limits. While the test is a useful environmental indicator it is not yet accepted as a replacement for BOD.

Microbiological Analyses

A full range of microbiological analyses is available that includes all common tests.

Organic Chemistry Analytes

We offer a full suite of organic chemistry analytes including:

- Semi Volatile Organic Compounds
- Organic Compounds
- Pesticides
- Herbicides

National Environmental Standard for Sources of Human Drinking Water

The National Environmental Standard for Sources of Human Drinking Water (NES) is a regulation made under the Resource Management Act (1991) that sets requirements for protecting sources of human drinking water from becoming contaminated.

It came into effect on 20 June 2008.

For the purpose of this NES, a human drinking water source is a natural water body such as a lake, river or groundwater that is used to supply a community with drinking water. The standard applies to source water before it is treated and only sources used to supply human drinking water ie, not stock or other animals.

This NES complements Ministry of Health legislation for improving drinking water supply and delivery. This ensures a comprehensive approach to managing drinking water from source to tap.

Why it is needed

Contaminants such as microorganisms can pose a risk to human health when they enter drinking water supplies and that water is then consumed. Taking steps to prevent such contaminants from entering drinking water sources is part of a multiple barrier approach to reduce this risk to people.

What it does

The NES requires regional councils to ensure that effects of activities on drinking water sources are considered in decisions on resource consents and regional plans.

Specifically regional councils are required to:

- Decline discharge or water permits that are likely to result in community drinking water becoming unsafe for human consumption following existing treatment
- Be satisfied that permitted activities in regional plans will not result in community drinking water supplies being unsafe for human consumption following existing treatment
- Place conditions on relevant resource consents that require notification of drinking water suppliers if significant unintended events occur (eg, spills) that may adversely affect sources of human drinking water.

The NES requires monitoring and reporting of source water in order to better inform the community of the quality of their drinking water sources, and to enhance Regional Council involvement in community water source planning.

With this information the community can then make more informed decisions about where to take water from and what activities are appropriate in their water supply catchments.

What is a human drinking water source?

A human drinking water source is a natural water body (lakes, rivers and groundwater) used to supply a community with drinking water.

Why do we need a drinking water source standard?

A drinking water source standard will:

- Help councils better manage drinking water from the source to the tap
- Provide better information on the suitability of our drinking water sources
- Provide better integration between councils and communities.

Managing drinking water from source to tap

Recent overseas studies of drinking water contamination and new virulent water borne diseases have highlighted the importance of water management that takes an integrated ‘water source to tap’ approach.

The standard will give decision-makers and the community accurate information about the suitability of their drinking water sources. The community can then make more informed decisions about where to take water from and what activities are appropriate in their water supply catchments.

Providing better integration between the councils that manage drinking water sources and the communities that use those water sources

The roles and responsibilities of councils involved in the management of drinking water sources are not well defined. This results in gaps and sometimes overlaps in the management of and planning for drinking water supplies. Councils and communities need to work closely together so drinking water sources and supplies can be adequately planned for and managed. The standard will better define these relationships and responsibilities.

What does the standard require?

The standard requires:

- The water supplier to carry out water quality monitoring at the point where water is taken and report the findings to the regional council
- The regional council/unitary authority to assess the risks to drinking water supply in the catchment
- The regional council/unitary authority to decide how suitable the water is for use as a drinking water source by combining the assessment of catchment risk, and water quality data
- The regional council/unitary authority to publicly report the water's suitability for use as a drinking water source
- The regional council/unitary authority to consider the effects of activities in the catchment on the waters' suitability for use when processing resource consents and developing regional plans.

The standard also includes:

- monitoring and analytical requirements, including minimum sampling and testing frequencies
- a grading framework, outlining how suitability for use must be determined
- a monitoring framework that defines what parameters must be monitored and the frequency of monitoring. Water supply authorities will only have to monitor those parameters that pose the greatest risk
- the methods and the tests by which the levels of parameters present in drinking water sources must be calculated.

Who will the standard apply to?

All suppliers of water to communities over 500 people and regional councils/unitary authorities that manage these drinking water supply catchments (groundwater and surface water) will be required to comply with this standard.

Communities under 500 people are considered too small to be able to adequately comply with the requirements of this standard. Although the grading of small drinking water supplies will not be mandatory, it is expected that these standards, where appropriate, should be applied to smaller drinking water supplies, in the same way that existing voluntary guidelines are applied.

Bathing Beaches

Water contaminated by human or animal excreta may contain a range of pathogenic (disease-causing) micro-organisms, such as viruses, bacteria and protozoa. These organisms may pose a health hazard when the water is used for recreational activities such as swimming and other high-contact water sports.

In these activities there is a reasonable risk that water will be swallowed, inhaled, or come in contact with ears, nasal passages, mucous membranes or cuts in the skin, allowing pathogens to enter the body.

The sampling program, frequencies, and analytical techniques are detailed in a document prepared for the Ministry for the Environment called:

> Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas published in June 2002 and updated in June 2003 (ISBN: 0-478-24091-0, ME number: 474).

Councils adhering to the guideline values, and using the framework set out in this document helps people using the water for recreation or collecting shellfish for eating to keep informed of health risks. This assists the public to make appropriate decisions to avoid exposing themselves to significant health risks.

If you are currently following a sampling program it is important to remember that the information gathered under this publication may be made available to the public. So it is essential that your laboratory is IANZ registered and can sample the water safely, consistently, and accurately.

<u>An interesting note we have learned</u>

In most cases the ill-health effects from exposure to contaminated water are minor and short-lived, however, there is the potential for more serious diseases.

Most at risk are the small children who play in the mixing zone between water and land. Because microorganisms can proliferate in soil and sand, they are found in concentrated numbers when wave action is present. Unfortunately, this shallow, warmer area is usually where you find the youngest children.

Stormwater Runoff

Stormwater is natural water. It is essentially rain and when it lands on the ground, is known as stormwater. Stormwater that falls from the atmosphere naturally soaks into the earth or flows overland and into streams, rivers and lakes. Of major concern for councils is when sewage enters the stormwater system and discharges into marine or freshwater ecosystems.

Laboratory analysis can be used to find sewer breaks and illegal sewer connections. Elevated microbiological counts can indicate a source of sewage, as can some chemical analyses.

Where fluoride has been dosed into a water supply, laboratory analyses can identify its presence. In a clean stormwater system there should be no fluoride except for the proportion introduced by seawater.

Where contamination of stormwater is suspected, we can analyse samples to confirm the type of contamination. This can then lead to remedial work to identify the source and to clean up the ecosystem.

The types of analyses we would usually test for include:

- Biochemical Oxygen Demand
- Enterococci
- Faecal coliforms
- Hydrocarbon

Some site-specific situations may require the use of specific tests in order to determine the contamination from the land use the stormwater has come from.

These analyses can include:

- Chemicals from industrial sites
- Nutrients from farm runoff

These types of analyses are usually requested after a pollution incident or illegal discharge.

Contact Details

Please feel free to contact us by any one of the methods shown below.

Main Lines

Wellington	Main Telephone	(04) 576-5016
Auckland	Main Telephone	(09) 579-2669
Christchurch	Main Telephone	(03) 343-5227
Dunedin	Main Telephone	(03) 972-7963

Direct Lines

	Accounts	(04) 568-1205
Rob Deacon	General Manager	(04) 568-1203
Sunita Raju	Microbiology Lab Manager	(04) 568-1206
Tracy Morrison	Chemistry Lab Manager	(04) 568-1200
Sharon van Soest	Chemistry Lab Manager	(04) 568-1200
Deb Bottrill	Sample Logistics Manager	(04) 576-5016
Dan Westlake	South Island Lab Manager	021-242-2742
Ralph Veneracion	Auckland Lab Manager	021-242-2711

Email can be directed to staff using "first name last name"@eurofins.com

Courier

Wellington: 85 Port Road, Seaview, Lower Hutt, New Zealand 5010

Auckland: 35 O'Rorke Road, Penrose, Auckland 1061

Christchurch: 43 Detroit Drive, Rolleston 7675

Dunedin: 16 Lorne Street, South Dunedin 9012

Mail

P.O. Box 36-105, Wellington Mail Centre, Petone, New Zealand 5045.

Email

General Information: eurofinswellington@eurofins.com

WEB

www.eurofins.co.nz

IANZ Accreditation Numbers:
Biological 639, Drinking Water 787,
Chemistry 414, RLP 1140