

Unit 4: Understanding Water Quality

Unit code	Y/600/9638
QCF Level 3:	BTEC National
Credit value:	10
Guided learning hours:	60

● Aim and purpose

This unit aims to introduce learners to skills and knowledge associated with water quality and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or onto further/higher education.

● Unit introduction

Almost every living thing on our planet needs water to survive and to humans this substance is vital. Problems with water quality can cause serious problems for humans – from fisheries to crop production water pollution can cause devastation. As a result monitoring and controlling water quality is vital.

This unit focuses on monitoring water for the aquatic habitat with the key focus being on animals and plants rather than farming or crop production.

During this unit learners will begin to understand the importance of managing water quality and the measures that can be taken to reduce the impact of human activity on water quality. Learners will also be able to apply this knowledge to industry for example fisheries management. Water treatments will also be covered to show learners possible solutions to poor water quality so that an aquatic habitat could be improved on to establish a potential successful ecosystem in the body of water.

The unit also allows learners to practise the practical skills which are used in the field and in industry in order to establish good technique in water quality analysis, including measuring a variety of factors, recording results, interpreting data and suggesting improvements to an area of water. The practical element of the unit should help learners to appreciate the impact of physical, chemical and biological factors on the aquatic habitat.

● Learning outcomes

On completion of this unit a learner should:

- 1 Understand the factors, physical, chemical and biological, which influence water quality and aquatic species
- 2 Be able to measure basic water quality factors
- 3 Be able to record and interpret water quality data
- 4 Understand the principles of water treatment.

Unit content

1 Understand the factors, physical, chemical and biological, which influence water quality and aquatic species

Physical factors: the hydrological cycle; physical factors eg influence of human activity, geographical features, surface topographical features

Chemical factors: eg alkalinity, ammonia, carbon dioxide, chlorine, nitrates and nitrites, dissolved oxygen, pH, phosphates, temperature, turbidity, suspended solids, hardness (temporary and permanent)

Biological factors: eg health of aquatic organisms, biological oxygen demand, micro-organisms, flora and fauna present in ecosystem.

2 Be able to measure basic water quality factors

Measuring basic water quality factors: physical factors eg water quantity, flow (meters), temperature (probes), turbidity (light meter), geographical features (satellite pictures), surface topographical features; chemical factors (by use of test kits and other appropriate methods) eg dissolved oxygen, pH, ammonia, nitrite, nitrate, hardness, chlorine, salinity; biological factors (by use of test kits, probes, kick sampling, nets, indicator species) eg biochemical oxygen demand; basic biological sampling methods, eg for invertebrates, vertebrates, macrophytes, algae, microbiological testing; safe practice in water sampling.

3 Be able to record and interpret water quality data

Water quality data: use of water quality data to evaluate the quality of the environment for aquatic species; record keeping eg weather conditions, disease treatments, husbandry factors; biological indicators commonly used to assess water quality, environmental quality standards (set by the Environment Agency) and the River Invertebrate Prediction and Classification System (RIVPACS); toxicity required to fail safety checks; relevant current legislation, eg Environment Act 1995; guidelines and codes of practice relating to water quality and aquatic species health.

4 Understand the principles of water treatment

Methods of water treatment: commonly used water treatment methods, eg aeration, ion exchange, sedimentation, biological filtration, solids removal, activated sludge techniques, UV treatment, ozonisation; nitrogen and phosphorus removal; algal control, eg via bacteria; sequence of treatment; advantages and disadvantages of each method; relevant current legislation and codes of practice in place to satisfy water quality demands eg Environment Act 1995 and methods used.

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P1 explain the hydrological cycle		
P2 explain how the physical environment can change water quality	M1 explain how biological, chemical and physical factors can affect the lifecycle of two named species of aquatic animal or plant	D1 evaluate biological sampling techniques used in water sampling
P3 explain how an aquatic habitat's flora and fauna changes when water quality changes [IE, RL]		
P4 determine the basic water quality of a given aquatic habitat	M2 describe the health and safety considerations when sampling different aquatic habitats	
P5 carry out basic biological sampling for a given aquatic habitat		
P6 carry out a water quality survey on an aquatic habitat for a given period [TW, SM]		
P7 produce a report on the water quality of a given aquatic habitat [CT]	M3 compare data collected to known data for other locations.	D2 explain the use of biological indicator species in given situations.
P8 discuss the methods of water treatment commonly used to meet specified objectives		
P9 assess water treatment methods commonly used to meet specified objectives [EP]	M4 discuss advantages and disadvantages of water treatment methods commonly used in industry.	
P10 explain how commonly used water treatment methods satisfy current legislation.		

PLTS: This summary references where applicable in the pass criteria, in the square brackets, the elements of the personal, learning and thinking skills. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Delivery of this unit will involve practical assessments, written assessment, visits to suitable aquatic habitats and may involve developing links with industry for site visits and guest expert speakers who may be able to talk about specific locations where water monitoring and treatment are used.

Unless the centre has a variety of water bodies on site a lot of this unit will involve site visits, guest speakers and organised visits for practical work. Some of the material can however be delivered using a wide range of techniques including lectures, discussions, seminar presentations, supervised practicals and research using the internet and/or library resources. Delivery should stimulate, motivate, educate and enthuse learners.

Any site visits should be checked for suitability and a risk assessment of activities carried out. Charities that run reserves can often support visits and provide expert guidance about the specific location as well as sometimes being able to design sessions and practical work. It would be beneficial if learners and supervisors of sites were made aware of the requirements of this unit before any activities so that evidence can be collected at the time. For example, learners may have the opportunity to use data logging equipment and a variety of different probes or kick sampling for small invertebrates and they should ask for observation records and/or witness statements to be provided as evidence of this. Guidance on the use of observation records and witness statements is provided on the Edexcel website.

Guest speakers would be also be useful to provide background information on legal requirements and health and safety issues to consider when recording and checking water quality for example safe levels of chemicals, invertebrate sampling, government quality requirements.

Some of the techniques can be carried out by setting up a scenario in a laboratory or classroom if suitable equipment is available. Samples can be collected from a variety of sources and analysis completed in the classroom. The use of data logging equipment could be linked to a series of science-based lectures where, if in a college environment, science specialists may be able to help.

Whichever delivery methods are used, it is essential that tutors stress the importance of animal welfare, sound environmental management and the need to manage the resource using legal methods.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan gives **an indication of the volume of learning it would take the average learner** to achieve the learning outcomes. It is **indicative and is one way of achieving the credit value**.

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

Topic and suggested assignments/activities and/assessment
Introduction and overview to the unit.
Assignment 1: Learning the Ropes (P1, P2, P3, M1, D1)
Introduction to water quality factors assignment.
Research into physical, chemical and biological factors that affect water quality.
Supervised practicals, guest speakers, site visits.

Topic and suggested assignments/activities and/assessment

Assignment 2: Guiding Visitors (P4, P5, P6, M2)

Introduction to water quality measurement assignment.

Investigation of water measurement/sampling techniques.

Guided site visits, supervised practical work.

Assignment 3: Surprise Inspection! (P7,P8,M3,D2)

Introduction to water interpretation assignment.

Investigation of water data recording and interpretation techniques.

Supervised practical sessions, site visits, internet research and guest speakers.

Assignment 4: A Possible Threat (P9, P10, M4)

Introduction to the water treatment assignment.

Guest speakers, site visits, demonstrations, supervised practical, internet research, library research, demonstrations and lectures.

Research and fieldwork into methods of treating water, relevant legislation and codes of practice.

Review of learning and assessment.

Assessment

For P1 learners must explain the hydrological cycle. Evidence can take the form of a presentation, PowerPoint presentation, annotated poster, leaflet or information booklet.

P2 requires learners to explain how physical factors can change water quality. This can be assessed through a question and answer interview session with supporting witness statements, annotated diagrams or posters, a presentation, a guidance booklet for example for the Environment Agency.

P3 looks at the impact of water quality on flora and fauna. For this learners could study two species in detail using internet research and library resources. Evidence could be a research project followed by a presentation or a role-play scenario involving a piece of water where species are threatened and learners are reporting back to colleagues on the risks involved.

P4, P5 and P6 involve carrying out water quality tests on an aquatic habitat. This would best be assessed using photographic evidence, results tables and data, witness statements if site visits are carried out and a learner diary.

P7 can be linked to work carried out for P4, P5 and P6. Learners must produce a report on water quality for either a site they have previously studied or another site. The report can be in writing or an oral presentation but must include all the information stated in learning outcome 3.

P8 requires learners to discuss commonly used water treatment methods. Evidence can take the form of a discussion, presentation, leaflet, guide for an employer or site owner, or new employee handbook.

For P9 learners must assess commonly used water treatment methods. Learners could produce a summary booklet of available treatments, a web page providing guidance on the treatments, a blog of a land owner who has had to carry out treatments or a key for land owners to follow using a series of questions to determine which treatment would be best for their situation.

In P10 learners must explain how commonly used water treatment methods meet the requirements of current legislation. Evidence can take the form of internet research, a leaflet, annotated poster, presentation, web page, a role play of a court case where a body of water has been polluted.

For M1 learners must explain how two named species can be affected by changes to water quality. Evidence could take the form of a letter to the government about the specific area and species involved, a speech by an

environmental charity, a web page calling for action to be taken in relation to a local area or planning a project that school children could carry out to tidy up an area after a problem has occurred and to save certain species.

M2 requires learners to describe the health and safety considerations when sampling different aquatic habitats. Evidence can take the form of a discussion, presentation, leaflet, a guide for an employer or site owner, or a new employee handbook.

For M3 learners must compare data they have collected to that from another source. The comparison can be presented using tables, graphs, charts, pie charts, or other suitable formats and can be presented as a written or oral presentation.

For M4 learners must discuss advantages and disadvantages of water treatment methods commonly used in industry. Again a PowerPoint presentation, guide to land owners, charity booklet, or government guide would all be suitable evidence.

For D1 learners must evaluate biological sampling techniques used in water sampling. Evidence for this could take the form of a pictorial presentation with notes (possibly using appropriate software), or an annotated poster or a project.

D2 requires learners to explain the use of biological indicator species in given situations. Evidence could take the form of notes from a site visit about species observed, presentation, booklet, guide for land owners or a web page.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, M1, D1	Learning the Ropes	You are a recently qualified ecologist and have taken a job at a local charity working in one of their managed centres. You must find out about the techniques used at the site and how the water quality is maintained.	Leaflet, poster, written notes.
P4, P5, P6, M2	Guiding Visitors	A group of secondary school children have arranged to visit the site and you will be acting as their expert for the day. Practise and then demonstrate the different methods that can be used to test water quality.	Witness statements, learner diary, photographs, observation records.
P7, P8, M3, D2	Surprise Inspection!	Your boss tells you that the government will be sending people to check the records for the site to make sure everything is in order. You must collect data and put it into a suitable form that people can easily understand.	Tables, graphs, charts, notes, photographs.

Criteria covered	Assignment title	Scenario	Assessment method
P9, P10, M4	A Possible Threat	<p>A local group of fishermen have reported problems near to your site and they suspect that pollution might be present and harming fish stocks. You are concerned that the problems may spread to your area of water.</p> <p>You decide to help and support the local community trying to clear up the area and suggest which treatments may be suitable.</p>	Notes, reports, presentations, practical notes.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Land-based sector suite. This unit has particular links with:

Level 2	Level 3
Introduction to Environmental Studies	Understanding Fishery Management
	Understand Ecological Concepts and Application

Essential resources

Access to an aquatic habitat is essential so learners can experience the environments where water quality testing is carried out on a regular basis. Habitats that support small invertebrates would be preferable.

The equipment required will include the normal safety gear used in laboratories and in the field; a range of dissolved oxygen meters, thermometers and chemical test kits; water sampling equipment; basic water flow measurement equipment; record keeping equipment and a calculator.

Tutors delivering this unit should be experienced in analysing water and evaluating the results in relation to the effects on aquatic life.

Employer engagement and vocational contexts

Learners would benefit from having access to a working environment. Often this can be achieved by creating links with local businesses or charitable organisations who may even benefit from taking on learners. Local authorities can be a useful source of information as can business education alliances. Charitable organisations can often provide guest speakers to attend and give lectures as well as demonstrations.

Indicative reading for learners

Andrews C, Carrington N and Exell A – *The Interpet Manual of Fish Health, 2nd Edition* (Interpet Publishing, 2002) ISBN 1842860674

Barnes R and Mann K – *Fundamentals of Aquatic Ecology, 2nd Edition* (Blackwell Science, 1991) ISBN 0632029811

Bromage N and Shepherd C – *Intensive Fish Farming* (Blackwell Science, 1992) ISBN 063203467X

Howarth W – *Freshwater Fishery Law: Salmon and Freshwater Fisheries Act 1975* (Blackstone Press, 1987)
ISBN 1851850309

Miller P and Nicholls J – *Handguide to the Fishes of Britain and Europe* (Treasure Publishers, 1986)
ISBN 0002197510

Seagrave C – *Aquatic Weed Control* (Blackwell Science, 1988) ISBN 0852381522

Stirling H – *Chemical and Biological Methods of Water Analysis for Aquaculturists* (Pisces Press, 1999)
ISBN 0952119854

Svobodov Z – *Water Quality and Fish Health* (FAO, 1993) ISBN 9251034370

Templeton R – *Freshwater Fisheries Management, 2nd Edition* (Blackwell Science, 1995) ISBN 085238209X

Journals

Fish

Water and Environment

Websites

www.cefas.co.uk	Centre for Environment Fisheries and Aquaculture Science
www.ciwem.org	Chartered Institution of Water and Environmental Management
www.defra.gov.uk	Department for Environment, Food and Rural Affairs
www.english-nature.org.uk	English Nature
www.environment-agency.gov.uk	Environment Agency
www.fba.org.uk	Freshwater Biological Association
www.fishbase.org	Fish Base
www.freshwaterlife.org	Freshwater Life
www.hse.gov.uk	Health and Safety Executive
www.ifm.org.uk	Institute of Fisheries Management
www.lantra.org.uk	Sector Skills Council for the Environmental and Land-based Industries

Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS opportunities that have been included within the assessment criteria of this unit:

Skill	When learners are ...
Independent enquirers	carrying out internet research and library research, and questioning experts
Creative thinkers	developing a report on water quality
Reflective learners	evaluating work completed
Team workers	carrying out group tasks for analysis
Self-managers	meeting deadlines
Effective participators	completing group tasks.

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	carrying out research
Creative thinkers	applying techniques studied to the working environment
Reflective learners	suggesting improvements to techniques and sites
Team workers	practising techniques
Self-managers	producing written work on time
Effective participators	participating in team activities.

● Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	carrying out internet research writing presentations
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	carrying out internet research on legislation, researching water quality at different locations comparing data
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> • text and tables • images • numbers • records 	presenting written work and data
Bring together information to suit content and purpose	analysing and displaying data
Present information in ways that are fit for purpose and audience	producing presentations
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	using calculations in water analysis
Identify the situation or problem and the mathematical methods needed to tackle it	using formulae to calculate population size estimation
Select and apply a range of skills to find solutions	analysing data
Use appropriate checking procedures and evaluate their effectiveness at each stage	checking data
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	analysing data
Draw conclusions and provide mathematical justifications	using formulae
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	Contributing to video, blogs, and group presentations

Skill	When learners are ...
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	reading information as part of internet and library research
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	completing reports, diaries and other assessments.