

Unit 30: Public Health Engineering in Civil Engineering

Unit code:	T/600/0431
QCF Level 3	BTEC Nationals
Credit value:	10
Guided learning hours:	60

● Aim and purpose

This unit gives learners the opportunity to gain an understanding of below ground drainage systems and the methods used to treat domestic sewage. Learners will also gain knowledge of the methods used to dispose of solid waste and the processes used to produce drinking water.

● Unit introduction

To enable us to live successfully in communities, care must be taken to prevent the development of disease and ill health resulting from inadequate, inefficient and unhealthy disposal of waste. This is important to most construction projects and is known as public health engineering.

Many civil engineering projects will include elements that require a thorough knowledge of public health engineering. This unit will enable learners to explore the below ground drainage systems used to drain liquid waste from buildings in terms of their design, installation and maintenance. Learners will have the opportunity to explore the methods and techniques used to treat that waste.

The preferred method for dealing with domestic waste in the UK has been by burial in landfill sites. This is however becoming less viable. Learners will investigate landfill techniques and the alternative ways that can be used to dispose of solid waste.

Sources of water supplies are also investigated, and learners will gain knowledge and understanding of how raw water is treated to produce water supplies of drinkable quality.

● Learning outcomes

On completion of this unit a learner should:

- 1 Understand below ground drainage systems
- 2 Understand the methods used to treat domestic sewage
- 3 Know the methods used to dispose of solid waste
- 4 Know the processes used to produce drinking water.

Unit content

1 Understand below ground drainage systems

Below ground drainage systems: disposal; types; design requirements; design calculations; materials and installation techniques; soundness and performance; servicing and maintenance

Disposal: of foul water; of surface water

Types: combined systems; totally separate systems; partially separate systems; grey water systems; eg domestic dwellings, small commercial and industrial buildings, small housing developments, small industrial/commercial trading estates

Design requirements: ventilation of below ground drainage systems; use of open vents and air admittance valves (AAV); limitations on use of AAV; access to below ground drainage systems; rainwater storage and use; grey water storage and use

Design calculations: size of drain; depth of flow; self-cleansing velocity and inclination of drains from given data; methods of determining drain/sewer loadings; self-cleansing velocity and inclination of sewers from given data; maximum depth of flow; Chezy equation; Chezy-Manning equation; continuity equation

Materials and installation techniques: common materials used for below ground drainage systems; methods of jointing different below ground drainage materials; bedding of drains; depth of cover; arrangements for drains passing through building structures

Soundness and performance: tests to below ground drainage systems; alignment tests; mirror and torch tests; obstruction test; rolling ball test; soundness tests; hydraulic and pneumatic tests

Servicing and maintenance: health, safety and welfare; personal hygiene and protective clothing and equipment; tools and equipment required for servicing and maintenance; work sequences and methods of carrying out servicing and maintenance tasks; testing of drains and sewers for toxic or explosive gases

2 Understand the methods used to treat domestic sewage

Treatment of domestic sewage: sewage treatment plants; septic tanks; cesspits

Requirements for each method: location; design; method of operation; sizing based on population; disposal of sludge; disposal of water after treatment; vehicle access

3 Know the methods used to dispose of solid waste

Methods: refuse chutes; landfill; compaction, composting; incineration; sorting, disposal and recycling of solid waste

Solid domestic waste: organic waste (food, garden waste); combustibles (paper, wood, dried leaves, packaging); non-combustibles (metals, tin cans, bottles); ashes; dust; hazardous materials (oils, batteries, sticking plasters, bandages)

Requirements and constraints: legal requirements; health, safety and welfare; damage to the environment; cost implications

4 Know the processes used to produce drinking water

Drinking water: rainfall; sources of supply; hardness; purification for drinking; storage and distribution

Rainfall: hydrological cycle (evaporation, condensation, precipitation); absorption of carbon dioxide, sulphur dioxide and oxides of nitrogen

Sources of supply: eg rivers, streams, shallow wells, deep wells, bore holes, desalination impounding reservoirs; river management; weirs; flood plains

Hardness: hard and soft water; temporary hardness and permanent hardness; pH values; removal of temporary hardness; removal of permanent hardness by the base-exchange process; hardening of acidic water to prevent corrosion; plumbo-solvency and cupro-solvency; palatability

Purification for drinking: properties of potable water supplies eg colour, turbidity, taste and odour; protection of the gathering grounds; effects of livestock, cultivation, nitrates and landfill; storage, impounding and storage/settlement in reservoirs; filtration eg slow sand filters, rapid sand filters, micro-straining; sterilisation and chlorination of water supplies

Storage and distribution: service reservoirs; pumping stations; use of water towers or expansion/pressure vessels; diagrammatic layouts of each method highlighting the components for each installation, distribution, water-main grid systems; minimum pressure; methods of isolation; materials and jointing methods used; disinfection

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 how below ground drainage systems are used to dispose of foul water from buildings [IE2, IE4, IE6, RL6, SM2, SM3]	M1 perform calculations to determine quantity, velocity and depth of flow, pipe size and gradient of below ground drainage from given data	D1 evaluate the standard methods used to test, inspect and maintain below ground drainage
P2 explain how below ground drainage systems are used to dispose of surface water [IE2, IE4, IE6, RL6, SM2, SM3]		
P3 explain how domestic sewage is treated [IE2, IE4, IE6, RL6, SM2, SM3]	M2 evaluate the methods used to dispose of sludge	D2 justify the methods used to treat domestic sewage and drinking water in financial, legal, environmental and health and safety terms.
P4 describe the methods used to dispose of solid domestic waste [IE2, IE4, IE6, CT2, CT6, RL6, SM2, SM3]		
P5 describe the stages of the process used to purify and store drinking water. [IE2, IE4, IE6, RL3, RL4, RL6, SM2, SM3]		
	M3 analyse the techniques used to purify drinking water in terms of efficiency and cost.	

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

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

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet or library resources and use of personal or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add to the relevance of the subject.

Teaching and learning strategies should be designed to support delivery using a learner-centred approach. This would involve learners investigating, for example how solid waste is disposed of in their area and relating this to taught theories.

A series of realistic scenarios should be used to show the calculations for the design of simple gravity drainage systems. The scope of these calculations is intended to give learners a basic understanding and should not be seen as a mathematical exercise. Tables and charts should be used wherever possible.

Processes that involve chemical or biological changes should be taught in broad detail and learners should be given an overview and a basic understanding of the principles involved. There is no requirement for a detailed understanding of the exact biological and chemical changes.

Reference should be made to the Building Regulations, and other relevant standards and guidelines, wherever necessary in order to support delivery. Learners should be encouraged to see how the topics being taught relate to industry practice and standards.

Wherever possible, links should be made with industry and site visits arranged. For example, visits to water treatment plants, reservoirs and solid waste facilities will help learners relate to the topics covered in this unit. Opportunities for learners to access different materials such as pipes will support delivery. A visit to a local materials supplier may provide this opportunity.

Group activities are permissible, but tutors will need to ensure that individual learners are provided with equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken before practical activities are taken. Centres are advised to read the *Delivery approach* section in the specification, and *Annexe H: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.

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 demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction by tutor
Below ground drainage systems Whole-class, tutor-led discussion on types of systems, design of systems (including all relevant calculations) and installation techniques Individual learner work on design calculations. Tutor to correct and amend Site visit to project at below ground drainage stage Small group work. Four groups – materials, soundness, serving and maintenance – each group to prepare and deliver a short presentation on their findings Tutor to summarise, and correct if necessary, group findings
Assignment 1: Below Ground Drainage Systems
Treatment of domestic sewage Whole-class, tutor-led discussion on commonly used treatment methods Site visit to sewage treatment plant Individual learner research on underpinning science and technology
Disposal of solid waste Whole-class, tutor-led discussion on various methods used to remove and dispose of solid domestic waste Site visit to landfill site and/or local authority incinerator, where access is available Individual learner research on the advantages and disadvantages of each method in terms of health and safety, cost and environmental issues Whole-class, tutor-led discussion to summarise, focus and (where necessary) amend, learners findings. Tutor to integrate legal requirements into the discussion
Producing drinkable water Whole-class, tutor-led discussion on hydrological cycle, sources of water, reasons for hardness of water, treatment of hardness of water and purification of drinking water Site visit to local water purification plant Individual learner work on storage and distribution of drinking water to the home Whole-class, tutor-led discussion to summarise, focus and (where necessary) amend, learner findings
Assignment 2: Domestic Sewage Treatment, Domestic Waste Disposal and the Treatment of Water for Drinking Purposes
Review of unit and assignment feedback

Assessment

Evidence for this unit may be gathered from a variety of sources, including well-planned investigative assignments, case studies, reports of practical assignments, leaflets, posters and presentations.

There are many suitable forms of assessment that could be used and tutors are encouraged to consider and adopt these where appropriate. Some example assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used then suitable evidence would be observation records or witness statements. Guidance on the use of these is provided on the Edexcel website.

The structure of the unit suggests that the grading criteria could be addressed fully by using two assessments. The first of these would cover P1, P2, M1 and D1 and the second P3, P4, P5, M2, M3 and D2.

To achieve a pass grade learners must meet the five pass criteria listed in the grading criteria grid.

For P1, learners must explain the common below ground systems used for the disposal of foul water from domestic and small commercial or industrial buildings. This will include separate, combined and partially separate systems. Learners should describe the materials used including clay, concrete, plastics and iron, and must describe how one of these materials is jointed and laid. Learners must show an understanding of the need for access to pipelines and ventilation requirements.

For P2, learners must explain the common below ground systems used for the disposal of surface water from domestic and small commercial or industrial buildings. This will include separate, combined and partially separate systems, and grey water storage and treatment. Learners should describe the materials used including clay, concrete, plastics and iron, and must describe how one of these materials is jointed and laid. Learners must show an understanding of the need for access to pipelines.

Evidence for both P1 and P2 could be in the form of a presentation and/or a report on a real project that has been studied or through verbal questioning based on a case study provided by the tutor. Learners should include sketches or referenced diagrams from texts to illustrate their description, which should be in accordance with relevant standards and legislation.

For P3, learners must describe two methods of onsite treatment for domestic sewage from a small development, including treatment of effluent. They should demonstrate knowledge of onsite treatment for domestic waste water, and should include septic tanks and basic package plants and the methods used to treat effluent. An understanding of how these are sized, operated and maintained must be demonstrated within the description. Examples of suitable evidencing approaches are as for P1.

For P4, learners must describe the methods used to dispose of domestic solid waste. They should describe how domestic solid waste is dealt with at source and the methods available for its disposal. This should include refuse chutes within buildings, compaction of waste, sorting of waste for recycling, a typical method of collecting recyclable waste, disposal through incineration or landfill and a method of recycling a commonly collected material. Learners must also describe environmental constraints associated with disposal methods and health, safety and welfare issues. Examples of suitable evidencing approaches are as for P1.

For P5, learners must describe the stages of the process used to purify and store drinking water.

This should encompass a number of sources and should not focus solely on sources near to where learners are located. A treatment process used for water purification should be identified in terms of the stages that may be used. This need not be in any more detail than the production of a schematic block diagram. Learners should also describe how water is stored following treatment and distributed to users. Reference should be made to service reservoirs or water towers, pumping stations, supply mains and distribution

networks, materials used for pipework and the minimum pressure at which water is supplied to users. Examples of suitable evidencing approaches could be as for P1 and should use leaflets and posters to support a presentation.

To achieve a merit grade learners must meet all of the pass grade criteria and the three merit grade criteria.

For M1, learners must perform calculations on flow in drains. The Chezy equation, the Chezy-Manning equation, the continuity equation and simple mathematical operations should be sufficient. The calculations should be essentially correct but minor amendments after initial assessment are permissible.

For M2, learners must evaluate the methods used to dispose of sludge from sewage treatment processes. They should evaluate the various methods in terms of costs, legal requirements and environmental and health, safety and welfare issues. Examples of suitable evidencing approaches are as for P1.

For M3, learners must analyse the techniques used to purify drinking water in terms of efficiency and cost. Absolute costs are not a requirement and relative costs are perfectly acceptable. Examples of suitable evidencing approaches are as for P1.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria and the two distinction grade criteria.

For D1, learners must evaluate the standard methods of testing, inspecting and maintaining below ground drainage in relation to health and safety. They should also discuss the suitability of each method in terms of their advantages and disadvantages. Examples of suitable evidencing approaches are as for P1.

For D2, learners must justify the methods of water purification for drinking water. This should clearly identify clearly the appropriateness of methods in relation to the properties of the source water and the required properties of the purified water in financial, legal, environmental and health and safety terms.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and 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, M1, D1	Below Ground Drainage Systems	A newly elected member of the local authority public health committee wishes to extend her knowledge and understanding of below ground drainage systems. As a civil engineer, you have been asked to produce a report explaining the difference between foul and surface water and the methods used to dispose of each.	A report supported by drawings, images, photographs, graphs, charts and calculations as appropriate.
P3, P4, P5, M2, M3, D2	Domestic Sewage Treatment, Domestic Waste Disposal and the Treatment of Water for Drinking Purposes	The report you have compiled on below ground drainage systems has been well received. As a result, you have been asked to produce a combination of leaflets and posters on domestic sewage treatment, waste disposal and the treatment of drinking water. You have decided to support this with a presentation to the public health committee.	Leaflets and posters as appropriate. A presentation of the above, using both electronic and other media.

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

This unit forms part of the BTEC Construction and the Built Environment sector suite. This unit has particular links with the following unit titles in the Construction and the Built Environment suite:

Level 1	Level 2	Level 3
		Construction in Civil Engineering
		Plumbing Technology in Building Services Engineering

Essential resources

If it is not possible to arrange site visits, some elements of drainage may be seen within existing buildings and video or DVD materials should be used.

Samples of pipe materials will help learners to understand the materials used. If the centre delivers craft programmes it may be possible for learners to gain some practical installation, inspection and testing experience.

Copies of drawings and utility records are a valuable resource for helping learners to understand the different types of drainage systems and water distribution networks.

Learners will require access to copies of legislation, standards, design charts and tables.

Health, safety and welfare issues must be considered at all times and risk assessments should be undertaken for site visits and any practical work

Employer engagement and vocational contexts

Site visits to solid waste disposal facilities and water treatment installations will add greatly to learner experience. Where possible, visits to construction sites to view drainage installations should be undertaken. These visits may also provide an opportunity for testing, inspection and maintenance to be viewed.

Support to enable centres to initiate and establish links to industry, and to networks arranging visits to industry and from property practitioners is given below:

- Learning and Skills Network – www.vocationallearning.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- The Royal Institution of Chartered Surveyors – www.rics.org
- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI University of Warwick) – www.warwick.ac.uk/wie/cei/

Indicative reading for learners

Textbooks

Association of Municipal Engineers – *Recycling Household Waste: The Way Ahead* (Thomas Telford, 1991)
ISBN 0727716506

Chadderton D – *Building Services Engineering, 5th Edition* (Taylor and Francis, 2007) ISBN 0415413559

Greeno R and Hall F – *Building Services Handbook, 4th Edition* (Butterworth-Heinemann, 2007)
ISBN 0750682205

Purcell P – *Design of Water Resource Systems* (Thomas Telford, 2003) ISBN 0727730983

Twort A, Ratnayaka D and Brandt M – *Water Supply, 5th Edition* (Butterworth-Heinemann, 2000)
ISBN 0340720182

Williams P – *Waste Treatment and Disposal, 2nd Edition* (John Wiley and Sons, 2005) ISBN 0470849134

Journals

Building magazine – CMP

CIBSE Journal – CIBSE

Civil Engineering – Institution of Civil Engineering (ICE)

Municipal Engineer – ICE

Websites

www.ice.org

Institution of Civil Engineers

www.intute.ac.uk

The Intute Consortium

www.rics.org

Royal Institution of Chartered Surveyors

Delivery of personal, learning and thinking skills (PLTS)

The following table below identifies the personal, learning and thinking skills (PLTS) opportunities that have been included within the assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	<ul style="list-style-type: none"> explaining how below ground drainage systems dispose of foul water and surface water explaining how domestic sewage is treated describing the methods used to dispose of solid domestic waste describing the various stages of the process used to purify drinking water
Creative thinkers	<ul style="list-style-type: none"> describing the methods used to dispose of solid domestic waste
Reflective learners	<ul style="list-style-type: none"> explaining how below ground drainage systems dispose of foul water and surface water explaining how domestic sewage is treated describing the methods used to dispose of solid domestic waste describing the various stages of the process used to purify drinking water
Self-managers	<ul style="list-style-type: none"> explaining how below ground drainage systems dispose of foul water and surface water explaining how domestic sewage is treated describing the methods used to dispose of solid domestic waste describing the various stages of the process used to purify drinking water.

● 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	researching for their assignments
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	researching for their assignments
Manage information storage to enable efficient retrieval	compiling and collating data and images for their assignments
Follow and understand the need for safety and security practices	
Troubleshoot	
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching for their assignments and compiling and collating data and images for their assignments
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	
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 	using ICT to produce the reports, leaflets, posters and presentations required by the assignment schedule
Bring together information to suit content and purpose	
Present information in ways that are fit for purpose and audience	
Evaluate the selection and use of ICT tools and facilities used to present information	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	communicating with civil engineering companies, the tutor and other learners using email, with and without attachments

Skill	When learners are ...
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	using mathematical procedures to perform calculations to determine quantity, velocity and depth of flow, pipe size and gradient of below ground drainage from given data
Identify the situation or problem and the mathematical methods needed to tackle it	using mathematical procedures to perform calculations to determine quantity, velocity and depth of flow, pipe size and gradient of below ground drainage from given data
Select and apply a range of skills to find solutions	using mathematical procedures to perform calculations to determine quantity, velocity and depth of flow, pipe size and gradient of below ground drainage from given data
Use appropriate checking procedures and evaluate their effectiveness at each stage	
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	
Draw conclusions and provide mathematical justifications	using mathematical procedures to perform calculations to determine quantity, velocity and depth of flow, pipe size and gradient of below ground drainage from given data
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching for their assignments and for small group work
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	producing the reports, leaflets and posters required by the assignment schedule.