



Unit 38: Highway Construction and Maintenance in Civil Engineering

Delivery guidance

Approaching the unit

This unit is applicable to the 'Civil Engineering' pathway of the BTEC Level 3 National Diploma and Extended Diploma in Civil Engineering, as it covers large concrete and earthwork structures, as well as infrastructure projects. This unit ultimately focuses on highway construction and maintenance, with three distinct learning aims covering planning and preparation, design and maintenance.

Methodology for the planning and delivery of this unit could include:

- engaging the local authority 'Highways Engineering Department' into the development of assignments for the design elements of the assessment
- arranging a site visit for learners to view highway maintenance techniques
- engaging with a property developer to design the road infrastructure for the initial planning stages of the development, along with associated highway drainage
- arranging for a guest speaker, such as a civil engineer who specialises in highway design, to visit the centre and give a talk for learners.

The focus of this unit is on highway planning, design and maintenance. The UK highway infrastructure covers a wide range of road classifications, from motorways that are smart interactively controlled to minor B roads that are single-track access. Learners are to look at the processes that are involved in planning, preparing and designing a road; at earthworks and how these are developed and the ways highways can be drained; and different forms of construction e.g. a concrete road or an asphalt/tarmac road construction. Linking this design element to a construction development would give an engaging method of integrating civil engineering into construction activities. Working across two pathways would give some integration for those learners studying both construction and civil engineering.

The planning and design of the road should be from the basis of a new construction, so that all aspects of the planning within the unit content can be considered. Delivery methods can include guest speakers from the highways department and the planning authority. This would give a 'hands-on' approach for learners, including detailed and informative discussions with highway and planning professionals. Tutors may wish to engage with the local authority when delivering this unit, and this relationship may give the centre with good resources on highway design; how planning of such highways is undertaken; and how the local authority maintains its infrastructure.

Gaining access to the standard design details for road construction is essential, in order to demonstrate the national standards that operate in the UK. There are links that have been given in the 'Resources' section of this guide, so that tutors can gain access to the relevant downloadable materials. It is critical to be selective and use those that suitably match the unit content.



Delivery of learning aims

Learning aim A1

It covers the planning and preparation stages of a highway design. Placing this into the context of a new housing estate would give a useful Greenfield approach to the planning of such an infrastructure that will service the new homes. Aspects such as the acquisition of land; the route that the new highway will take; how it will be funded; and its design in terms of line and level all need to be considered. Learning aim A2 examines earthwork construction for new highways, including site clearance, cut and fill, embankment construction and the control of line and level. Reference to any local planning issues or concerns raised by a community for a highway development should be used as engaging resources for the land e.g. compulsory purchase orders.

Tutors could invite a civil engineering contractor who specialises in road construction to visit the centre, as they would help to support learner understanding of learning aim A2, especially regarding the earthwork associated with the construction of a new road, the balance of cut and fill, and how efficiencies are driven through good design.

Learning aim B1

It covers the actual construction of a highway and the different methods of construction. There are two methods of pavement construction that must be covered: flexible and rigid. Small group work with two opposing teams producing a design for the construction of a new road, reinforced with a presentation to a client, would give an ideal opportunity to engage and share learner knowledge. This could be achieved as a micro project with learners conducting research into their method, the machines and equipment required, and the specifications of materials used for each type of construction.

Learning aim B2

It focuses on the drainage installation that is required to ensure that surface water is removed effectively from roads and highways. The standard highway design details (listed in the 'Resources' section) give clear illustrations of the installation of road drainage. It also gives detailed cross-sections of road pavements, so falls can be demonstrated to learners. The connection of road drainage to the associated discharge points needs to be explored in learning aim B3. Local roads workings could be used to demonstrate this, along with earth mapping software programmes. The latter would give aerial views of highway drainage and associated water discharge areas e.g. ponds, dykes, soakaways, SUDS and mains drainage.

Learning aim B4 covers quality control, which focuses on the testing of materials as they are laid *in situ*. It is important to highlight that tests differ between flexible and rigid pavement constructions.

Learning aim C

It covers the maintenance of our highways. The local authority 'Highways Engineers Department' would give a useful resource in the form of a guest speaker, such as an engineer. Tutors could prepare a set of questions based around the assessment criteria for this unit, that focuses on the different methods of repair and what maintenance is required. Similarly, gaining access to a highway maintenance contractor would also give not only employer engagement, but useful resources in terms of visual materials of the methods of repair. These are listed in learning aim C2 and cover a range of repair methods.



Assessment model (in internally assessed units)

Learning aim	Key content areas	Recommended assessment approach
<p>A Undertake the planning and preparation works required for highway construction</p>	<p>A1 Introduction to planning a new highway A2 Earthwork construction for new highways</p>	<p>A set of proposals for a new highway, based on a given scenario, including information about preparatory activities, design of earthworks, pavement details and drainage.</p>
<p>B Undertake the production of plans for highway construction</p>	<p>B1 Forms and methods of highway construction B2 Drainage of highways B3 Drainage of land and sub-soils B4 Quality control</p>	
<p>C Examine maintenance procedures for highways</p>	<p>C1 Introduction to highway maintenance C2 Highway maintenance processes</p>	<p>A report that investigates and evaluates the need for highway maintenance and approaches that can be taken to rectify defects.</p>

Assessment guidance

There are two distinct areas of assessment, including a written report and a set of highway design proposals. To set up the assessment for the highway proposal for learning aims A and B, learners will need to be given a design scenario that covers the following criteria:

- an area of land that the proposed road will route through, along with a location map
- the topographical survey of the route
- aerial access to the proposed site in order to view features that will need to be considered
- drainage discharge details
- environmental concerns voiced by the community
- client’s proposed specification.

This scenario can be amended and extended as soon as learners begin their design route and specification for the proposed highway. Learners need to produce a full set of proposals that cover the aspects of each of the following:

- earthworks
- line and level
- land acquisition
- funding
- planned route.

Learners will need to produce drawings for the scenario in support of their proposals. Here, links to other units may prove useful, such as *Unit 7: Graphical Detailing in Construction* and any surveying and setting out units in the specification.



The second suggested assessment method for learning aim C is a formal report. This should introduce the types of highway maintenance used to repair defects in flexible and rigid pavements. Tutors could give a series of images with defects and ask learners to propose solutions for each repair. Learners can achieve a distinction grade by evaluating the repair in terms of quality and its life span.



Getting started

This provides you with a starting place for one way of delivering the unit, based around the recommended assessment approach in the specification.

Unit 38: Highway Construction and Maintenance in Civil Engineering

Introduction

This unit is a very specialised unit dealing with the highway infrastructure and its installation and maintenance in the UK. Engaging employers in terms of local authorities and highway contractors is essential in supporting you with the delivery not only in terms of resources but also first-hand experience.

The key to the learner's proposals is the setting up of the scenario. This should contain sufficient detail so that learners can cover all aspects of the assessment criteria and contain some drawings of the location. Learners can present their evidence using a verbal and slide presentation, which could be recorded and used as the evidence for the comprehensive verb used in the distinction criteria. Since learners have to explain, this is an ideal method of gathering evidence for the assessment criteria.

Learning aim A – Undertake the planning and preparation works required for highway construction

Learners to be issued with a detailed scenario. The suggested delivery for learning aim A is as follows:

- Learners are to get into small groups and open a large-scale location map. They then have to plan their route. Tutor to act as the voice of the surrounding community, and give comments when appropriate.
- Learners to use tracing paper to plan the route of the highway against the criteria within the scenario
- At the end of the period of planning, learners are to present their route with a justification as to why its direction is appropriate by stating valid reasons.

Once the route is established (as a collective decision), the next stage involves some resource planning. The second part of this mini-task is to make decisions with justification regarding the following questions:

- 'How will the new road be funded: public or private?'
- 'What traffic volumes will it be able to carry?'
- 'How can the environmental impact be reduced?'
- 'How will the public be consulted about the changes?'
- 'What type of highway should be constructed?'

Tutors to ensure that learners debate among themselves, so that they outline all of the considerations that need to be met as part of the assessment evidence.

The next stage is to move onto the construction planning. Learners to obtain a longitudinal profile of the road design against the existing levels so that they can plan to balance the cut and fill volumes. This will need the tutor's intervention regarding design levels and ground levels. A link to a resource has been provided (see 'Resources' section) that details mass haul cut and fill planning. This needs to be applied to the topography of the location and the design levels of the roadway.

Tutors could introduce a variable to make the task more challenging, e.g. weak ground that needs to be stabilised and drained before highway construction works can commence.



Learning aim B – Undertake the production of plans for highway construction

Learning aim B is concerned with the production of plans for highway construction. It includes the design of drainage for land and sub-soils, which needs to be indicated on plans, so this part of the sub-structure can be accommodated in the construction of the highway. A variety of engaging delivery methods can be used to cover this unit content, such as:

- Learners to get into small groups, with the tutor allocating half of the groups with 'rigid' pavements and the other half of the groups with 'flexible' pavements. Learners to then research the construction methods that are suitable and materials specifications for highways with a range of traffic requirements.
- Tutor to culminate the learners' research work and facilitate a debate, getting learners to justify which one to use for the given scenario.
- Learners to produce a cross-section detail with a specification for their justified choice, along with the associated drainage requirements at road kerb positions. This can include road gullies and associated drainage and discharge ditches and outfalls.
- Tutors to use videos to demonstrate the two different methods of construction (links to suitable videos have been provided in the 'Resources' section).
- Investigation of published standard details for highway design of drainage which is covered under learning aim B2. A number of these are available to download on local authority highways websites to assist with this method.
- Learners to investigate land drainage types for the disposal of collected water, methods and procedures (to include soakaways sustainable urban drainage systems, watercourses, catch pits and associated calculations).
- Tutors to show learners the 'Standards for Highways: Volume 4', which details typical drainage arrangements for highways (including manholes) and soakaway designs and provides typical cross-section details.
- Tutors to arrange for a guest speaker from the 'Highways Department' to visit the centre and provide advice about the construction details for flexible and rigid pavement, including a class discussion of the typical details. These could include the build-up of the different layers in a flexible pavement, from the sub-base, base layer and wearing course. Examples of how they instigate repairs would also engage the aspect of highway maintenance.
- Tutors could also arrange for a highways contractor to visit the centre and provide a case study for a design and build highway project, e.g. a toll road.

Presentation of the learner's proposals is a matter of choice. Learners could use small group work activities to deliver an aspect against their design proposals. However, care should be taken with any observation records for the presentation so that all individuals meet the assessment criteria for the unit.

For learning aim B4, use and application of quality control methods could be evidenced by asking learners to create a leaflet about onsite testing, to ensure that flexible and rigid pavements are constructed in accordance with the British Standards and Highways design standards. Images can be included in the leaflet to illustrate the different types of testing that needs to be undertaken.

Learning aim C – Examine maintenance procedures for highways

Learning aim C focuses on the use and application of maintenance to ensure defects in highways are resolved, and the benefits and drawbacks of alternative approaches. The suggested assessment for this learning aim takes the form of a written report. There are several different engaging methods of delivery that could be used to deliver this content, including:



- Tutors can ask the guest speaker from the previous learning aim (the highways contractor) to provide learners with a demonstration of the methods that can be used to repair and maintain both flexible and rigid pavements.
- Tutors can also invite a guest speaker from the local authority to talk about the differences between seasonal maintenance of roads, e.g. summer versus winter, through routine and structural repairs. This should include how roads are surveyed for defects and the recording and commissioning processes involved.
- Tutors can provide learners with a series of visual images of defects. Then learners have to identify the defects and write a repair method statement, justifying their chosen repair method. Tutors can use videos to demonstrate the repair methods that are employed in the UK.
- Tutors can arrange for a site visit for learners to observe road planning work in the field and maintenance processes such as laying a new surface. They can observe a top dressing being applied to maintain the road surfaces and white lining in operation.

This is a very short section within learning aim C, so a holistic approach to the maintenance of a highway should be adopted. This will allow the evidence to be based on a repair with learners demonstrating a recommended technique, then justifying and evaluating that technique.



Details of links to other BTEC units and qualifications, and to other relevant units/qualifications

This unit has link to the following unit within the suite of qualifications:

- Unit 7: Graphical Detailing in Construction

Resources

In addition to the resources listed below, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC Nationals in Civil Engineering. Check the Pearson website (<http://qualifications.pearson.com/endorsed-resources>) for more information as titles achieve endorsement.

Textbooks

Hughes D, *Highways* (5th Edition), ICE, 2015 ISBN 9780727759931 – It is a detailed textbook covering all aspects of highway engineering.

Pitman P, *External Works, Roads and Drainage (A Practical Guide)*, Taylor and Francis, 2001 ISBN 9780419257608 – It is an excellent 'hands-on' approach textbook.

Videos

Access 'YouTube' website and search for the following videos:

'Highway Concrete Machines At Work' by groutaone – It shows a rigid concrete paving being laid.

'World Amazing Modern Road Construction Asphaltting VogeLe Dynapac Truck Mega Machines Europe' by Epic Machines – It shows asphalt road construction machinery laying down a new surface.

'Repairing Potholes Process – Velocity Patching' by New Vision Media – It shows pavement repair using a unique spray method on a tarmacked road.

Websites

'Ice.org.uk' – It is a professional body for civil engineering with information on professional development, career pathways, standards and other resources.

For information on planning:

'Gov.uk' – Search the website for 'Planning and the Major Road Network in England' for Highways England planning guidance.

'Norfolk County Council' – Click on 'Rubbish, recycling and planning', 'Planning applications', 'Design of developments' and then search for 'Highway advice for developers' – It is a useful local authority website covering all aspects of highways development.

'theihe.org' – The relevant professional body for Highway Engineering including standards, professional development and other resources.

Tutor to access a search engine and look for 'UGPTI Earthwork and Mass Diagrams PDF', which provides an example of mass haul calculations for cut and fill.

For information on design:

'Gov.uk' – Search the website for 'Standards for Highways Online Resources the Design Manual for Roads and Bridges'.

'Williams Lea Tag' – Search for 'Standards for Highways in the UK'.



For information on construction:

'Pavement Interactive' and 'The Constructor.org' – These websites give information on pavement types.

Pearson is not responsible for the content of any external internet sites. It is essential for tutors to preview each website before using it in class so as to ensure that the URL is still accurate, relevant and appropriate. We suggest that tutors bookmark useful websites and consider enabling learners to access them through the school/college intranet.