

Designing and building the dual carriageway is a complex challenge. The main challenges for engineers to consider can be grouped into four main categories:

1. Engineering Constraints
2. Environmental Impacts
3. Human Impacts
4. Mitigation Measures

1. Engineering Constraints

The location and design of the new dual carriageway takes into account a variety of engineering constraints, such as:

- **The location of the existing road**

Sometimes a temporary alternative route needs to be found if the existing road needs to be shut for works to take place. Or, we must shut the existing road to a single lane. This could cause traffic build-up or road users to choose another route which may not be suitable for the volume of traffic. If the existing route is over a bridge which is too small for the new road, we would need to consider building a bigger bridge or expanding the existing one.



- **Other roads**

We might need to build junctions to adjoining roads. Perhaps we need to create a flyover or tunnel to allow another road to cross the new road. We need to consider if the other roads will get busier while works take place on the existing road. We might need to upgrade the other roads to carry the volume of traffic they will need to take during the works.



- **Accessibility routes**

Cycle paths and walking routes may need to be rerouted during works on the road. They might need to be created or upgraded during the work on the new road. The new road could interrupt an existing cycle/walking route and we would have to find an alternative route.



3D Visualisation of a section of proposed footway / cycleway following the existing A8;

- **Power lines**

If the power lines cross the road, we need to check the height of them. We need to consider if the road must be lowered to allow it to pass under. Sometimes, we must move powerlines to allow for the road if they overlap.

- **Utility and cable pipelines**

If existing pipelines cross the road, we need to check their location. We might need to renew them, reroute them or increase their size. We might need to install new pipelines to carry power supplies for lighting or signage, water or wastewater pipelines. We need to consider future access to pipelines for repairs.

- **Railway tracks**

We need to consider how close they are to the new road. We might need to move the road route to make space for the railway. We might need to include any railway crossings in the route design. We will need to consider designing the road to allow future maintenance access to railways.

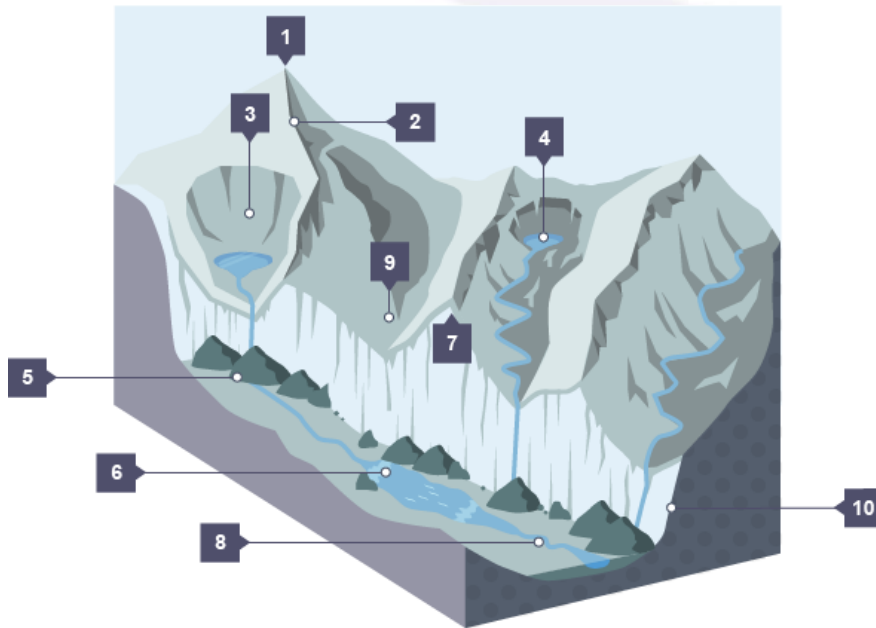
- **Buildings – residential, commercial and industrial**

Residential: the road needs to allow access to residential developments at a convenient distance so we might need to add more junctions to the new road to allow this. If the new road passes closely by any residential buildings, then will the road cause noise or air pollution to an acceptable level? We could have to move residential buildings or remove them and rehouse their occupants.

Commercial and industrial: the road needs to allow access to commercial and industrial developments at a convenient distance so we might need to add more junctions to the new road to allow this. If there are companies operating near the road who need

specialist roads access for large machinery or industrial parts, the road design might need to be wider with longer slip lanes to accommodate this. If the new road passes closely by any buildings, then will the road cause noise or air pollution to an acceptable level? We could have to move industrial buildings or remove them and rehouse their occupants.

- **Topography** (the physical appearance of natural features of an area of land)



1	Pyramidal peak	6	Ribbon lake
2	Arête	7	Truncated spur
3	Corrie	8	Misfit stream
4	Corrie Lochan (or Tarn)	9	Hanging valley
5	Alluvial fan	10	U-shaped valley

The above natural features of the landscape could be protected features, we can't just put a road anywhere. The features could be difficult to build a road on or around. We might need to quarry through rock, build bridges to cross water or deep valleys.



3D Visualisation of the proposed Coire nan Each and Tom na h-Innse Viaducts (click to expand).

2. Environmental Impacts

When considering the environmental impact of a dual carriageway, or any new road infrastructure project, the following topics **must** be considered:

- **Air Quality**

During construction of the road, the air quality of the surrounding environment may be reduced as debris from the materials and exhaust fumes from the vehicles used during construction pollute the air. This may have a negative effect on both the surrounding human population and native species.

- **Road Drainage and Water Environment**

Rivers and lochs - We might need to direct the road around a loch or cross a river. The river or loch may move over time, and we need to account for this in our design. If the road is beside a river or a loch does the road cause an acceptable level of air pollution or noise? If the rainfall onto the road falls off into a loch or river, we need to ensure the river or loch has the capacity to deal with this change.

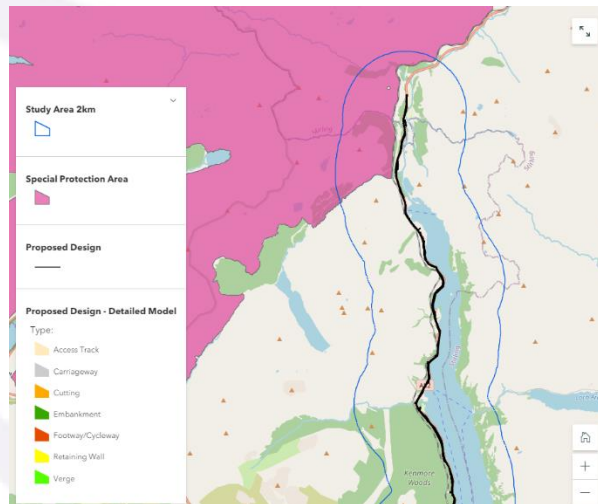
Floodplains - The road might need to cross or go nearby a floodplain. The road might need to be built higher and with deeper foundations to accommodate this. The new road could block a natural water flow and therefore cause a floodplain, is this acceptable in the area it will affect?

- **Biodiversity**

Protected wildlife - for example, birds, bats and fish. If the new road goes through the habitats of these animals, we might need to change the route of the road to avoid them. If the road can't move, we might need to move the animals to a new location. We need to check that an increase in traffic won't cause unacceptable air, noise or water pollution levels.

Plants and habitats - for example, peatland or heathlands. If the new road goes through the habitats or locations of particular plants, we might need to change the route of the road to avoid them. If the road can't move, we might need to move the plants to a new location. We need to check that an increase in traffic won't cause unacceptable air, noise or water pollution levels.

The below figure is a snapshot from a map that shows the proximity of a Special Protection Area to part of the A82 road in Scotland (outlined in black). If maintenance of this road is to take place, what impact may it have to the Special Protection Area?

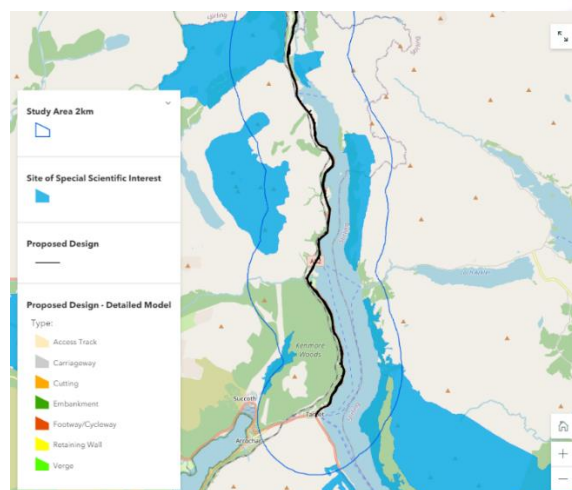


- **Geology**

Types of ground – rock or very soft ground (such as peat) would be difficult to build on. We need to analyse the type of ground the road is to be built on. If the ground is very hard, how will we cut out new paths for the road? If the ground is too soft, how will we make it more stable to enable us to build on it?

- **Landscape and Visual**

Is the road development likely to affect any designated landscapes in the surrounding area, including land for farming or particular viewpoints? Is the road development likely to affect national, regional or local characteristics or distinctive features in the surrounding landscape? Visual impacts can be detrimental to those living in the surrounding area, as well as users of nearby core paths and cycle routes. Sites of Special Scientific Interest (SSSI) are those which have a conservation status due to rare species living there.



- **Noise and Vibration**

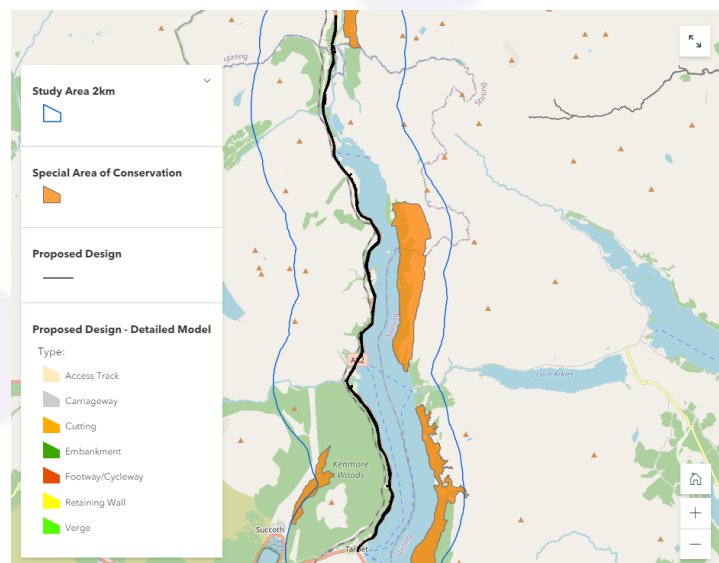
Construction activities over long periods of time can generate large volumes of noise and vibrations from heavy machinery that will become disruptive to surrounding communities and wildlife.

- **Climate**

The construction of new road networks can have a direct and indirect impact on the climate through the release of greenhouse gas emissions (carbon dioxide) into the atmosphere. Prior to construction, environmental specialists will attempt to predict the total carbon emissions emitted to build a wider picture of the environmental impact. With this in mind - how can we reduce the amount of carbon generated during the construction of a road?

- **Cultural Heritage**

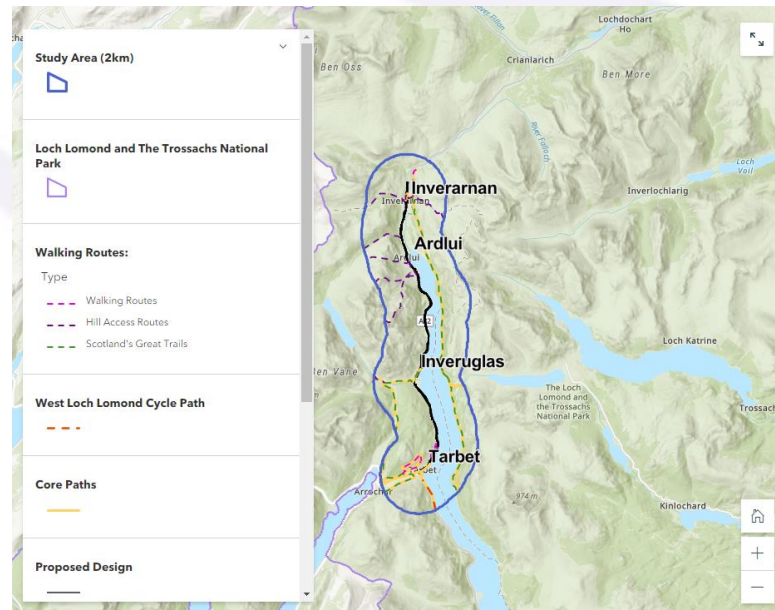
Cultural Heritage is an expression of the ways of living developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions, and values. Across the world, sites of cultural heritage exist e.g. listed buildings and UNESCO World Heritage Sites. It is important to consider whether the new development will remove and or/alter the cultural heritage site and to what extent this can be avoided.



3. Human Impacts

Although environmental impacts must be considered in the designing and building of a dual carriageway, it is also important to consider the human impact that the development can have, including impacts to:

- **Population and Accessibility** - Does the dual carriageway affect any core paths, cycle routes or cause diversions to any major/minor roads? How will this affect journey times and accessibility to surrounding towns/villages/amenities?



- **Human Health** – What is the health profile of the surrounding community? Are there members of the surrounding community or groups of people that are likely to be impacted more so than others?

4. Mitigation Measures

These impacts and constraints must be managed and/or mitigated where possible. The table below provides examples of some possible environmental impacts and potential mitigation measures to reduce the risk:

Impact	Example of Mitigation
Removal of trees	Replantation of trees in specially selected areas for habitat restoration
Removal of a species habitat	Relocation of protected animals that are likely to be impacted. Scheduling of construction activities out with sensitive periods (e.g. seasonal restrictions).
Increased noise during construction	Specific timings of construction works in populated areas or areas with sensitive wildlife
Reduced water quality in a river	Monitoring of water quality during construction

Increased air pollution during construction	Reduce the generation of fugitive emissions of dust/particular matter at source
Impact to an important cultural heritage site	Record works in advance e.g. historic building recording to clearly map out protected areas. Measures to reduce physical impacts on heritage sites from accidental damage include temporary barriers to clearly identify features
Increase in noise and vibrations during construction and operation of the dual carriageway	Introduce adequate training for site workers. Make use of 'best practicable means' to limit noise levels.