

The Queensferry Crossing – Geodiversity in a major infrastructure project

The Queensferry Crossing opened to road traffic in August 2017, part of a major upgrade to the cross-Forth transport corridor in the east of Scotland, representing a total Scottish Government investment of over £1.3 billion.



As with any major infrastructure project, geology plays a key role in location, planning and materials used. The bridge design and construction process offered an opportunity to demonstrate this and highlight the variety of local geology. It has also contributed to geoconservation by providing new, permanent and very visible rock cuttings of local sedimentary rocks.



The Queensferry Crossing in September 2017. Image Tony Hisgett, Creative Commons Attribution 2.0 Generic license.

Location, location, location

The Queensferry Crossing, taking its name from the historical ferry route used before the Forth Road Bridge opened in 1964, is one of three bridges crossing the Firth of Forth in close proximity (the iconic Forth Rail Bridge being the first in 1890). Geology plays a big part in this confluence of routes, with tough igneous rock on both coastlines causing the Firth to narrow to less than 2 km, compared with up to 4 km upstream and downstream.

This igneous rock – dolerite – is visible in cuttings on the railway and road system, particularly around North Queensferry. To the south, dolerite also forms Hound Point and Mons Hill, which has influenced the shape of the south shore of the Forth. Smaller dolerite outcrops also played a part in bridge design and location. The Forth Rail Bridge uses Inchgarvie as a foundation for one of its cantilevers, and a tower of the Queensferry Crossing is built on the remains of Beamer Island. Geological processes (including erosion, the Ice Age and changing sea levels) and human activity (including quarrying and reclaiming land from the sea) have created a patchwork of varying ground conditions, particularly on the north side of the new bridge, creating many challenges in the design and construction of the road network.

Cutting it fine

Geologists the world over love road cuts. In countries not so richly endowed in geology as Scotland, road cuts often provide the only accessible bedrock exposures. In Scotland, softer rocks tend to be cut back, soiled and planted; and there is a tendency for older cuts in hard rock to be obscured by netting installed to address minor instabilities. On the southern side of the Queensferry Crossing, the opportunity was taken to design a cut in Carboniferous sedimentary rocks which allows

"The cutting design is a prime example of the teamwork displayed on the Queensferry Crossing project, following policy that new rock cuttings should promote a natural appearance and natural regeneration, as far as possible, in line with ongoing slope stability." Paul Mellon, Geotechnical Manager, Transport Scotland

the strata to be exposed safely. Inland natural exposures of these rocks are rare in Central Scotland, so this road cut provides an excellent, prominent illustration of local geodiversity.

These rocks were deposited close to the Equator 340 million years ago, at the edge of a sea in a changeable environment dominated by the interplay between large river systems and changing sea levels. The result is layers of rock showing notable variation, including mudstone, siltstone and sandstone. The environmental conditions of this part of Scotland sometimes allowed the formation of rare oil shale layers. These have played an important part historically in the economy of this area – the world's first petrol station was located in South Queensferry, for example – so it's fitting that the Queensferry Crossing displays some of the rock layers that have contributed to the economic and cultural history of the area.

Policy Requirements, Partnership Working

The Queensferry Crossing was a large and complex infrastructure project involving detailed guidance and many different partners. The overall project was led by Transport Scotland with construction carried out by the Forth Crossing Bridge Constructors consortium. The road cutting design was guided by the 'Design Manual for Roads and Bridges' and, more particularly, Transport Scotland's 'Employer's Requirements' for the contract, and the Replacement Crossing 'Aesthetics Basis' informed by Transport Scotland landscape policy.

The designers translated the policy into specific requirements including:

- New rock cuttings to promote a natural appearance and natural regeneration, as far as possible, by consulting and complying with the environmental design requirements of Scottish Natural Heritage.
- Irrespective of the techniques used for excavation of rock cuttings, the design should achieve aesthetic objectives which avoid or reduce adverse landscape and visual impacts by: exploiting the natural characteristics of the rock to clearly display its form and character; creating ledges, niches and benches on rock cuttings to reflect naturally occurring rock formations, strata and rugged terrain; and enhancing the 'sense of place' by treating rock cuttings as landmarks along the route.

The Final Result

Around 24 million vehicles use the Queensferry Crossing each year, on average 65,000 every day. In appreciating the value of natural-looking rock cuttings, Transport Scotland has used this project to set a benchmark for future infrastructure developments. Drivers and passengers are, in a subtle and indirect way, exposed to Scotland's bedrock with contrasting sedimentary rocks south of the Crossing, and igneous rocks to the north. This geological variety creates the narrow crossing point of the Forth, the landscape setting of the bridges, and in a unique way has defined the detail of the construction of this recent addition to Scotland's heritage.

Further information

- [The Queensferry Crossing](#) – for facts and figures, history, construction gallery

Scotland's Geodiversity Charter presents a vision that geodiversity is "recognised as an integral and vital part of our environment, economy, heritage and future sustainability to be safeguarded for existing and future generations in Scotland". The Charter was first published in 2012, and refreshed in 2017. It is currently supported by 93 signatory organisations. Further information at scottishgeodiversityforum.org/charter/.



Road cut on the southern side of the Queensferry Crossing exposing a varied succession of Carboniferous sedimentary rocks.



Close up of the road cut to the west of the access road, showing how benches have been created to reflect naturally occurring rock formations.

