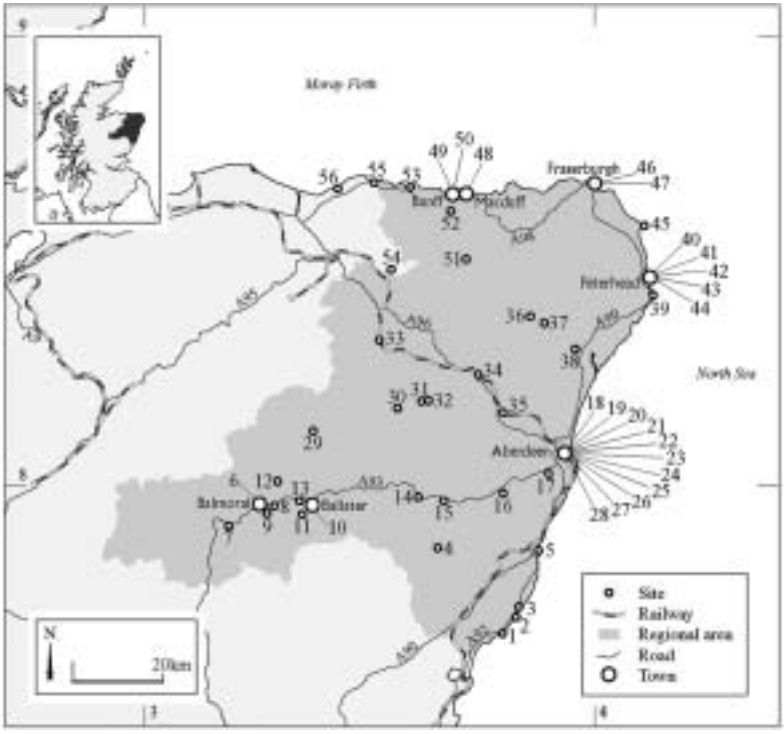


Aberdeenshire and Moray East

1. Johnshaven Harbour
2. Gourdon Harbour
3. Inverbervie Bridge
4. Bridge of Dye, Glendye
5. Stonehaven Harbour
6. Balmoral Estates Bridge
7. Brig o' Dee, Invercauld
8. Abergeldie Castle Footbridge (Private)
9. Crathie Suspension Bridge, Easter Balmoral
10. Royal Bridge, Ballater
11. Birkhall House Footbridge (Private)
12. Gairnshiel Bridge
13. Polhollick Footbridge, Bridge of Gairn
14. Potarch Bridge, Kincardine o' Neil
15. Invercannie Water Treatment Works
16. Park Bridge, Durris
17. St Devenick's Bridge, Cults
18. Joint Station, Aberdeen
19. Bridge o' Dee, Aberdeen
20. Union Bridge, Aberdeen
21. North Pier
22. South Breakwater
23. Leading Lights, Torry
24. Girdle Ness Lighthouse
25. Murchison Oil Platform Model, Maritime Museum, Aberdeen
26. Brig o' Balgownie, Aberdeen
27. Bridge of Don, Aberdeen
28. Wellington Bridge, Aberdeen
29. Bridge of Newe, Strathdon
30. Bridge of Alford
31. Bridge of Keig
32. Castle Forbes Footbridge
33. Gartly Bridge
34. Inveramsay Bridge
35. Bridge of Don, Kintore
36. Methlick Bridge
37. Tangland Bridge
38. Ellon Bridge (Old)
39. Buchan Ness Lighthouse
40. Harbour of Refuge, Peterhead Bay
41. South Harbour
42. North Harbour
43. Port Henry Harbour
44. Graving Dock
45. Rattray Head Lighthouse
46. Kinnaird Head Lighthouse, Fraserburgh
47. Fraserburgh Harbour
48. Macduff Harbour
49. Banff Bridge
50. Banff Harbour
51. Eastside Bridge and Toll House, Turriff
52. Bridge of Alvah
53. Portsoy Harbour
54. Milton of Rothiemay Bridge
55. Cullen Harbour
56. Buckie Harbour

3. Aberdeenshire and Moray East

Introduction

Maritime works are well represented in this chapter by harbours, mainly formerly used for fishing and now largely recreational, at Johnshaven (1884, 3-1); Gourdon (1819, 3-2); Stonehaven (1829, 3-5); Peterhead (ca.1600–1956, 3-40-44), with a Stevenson dry dock; Fraserburgh (1811, 1821, 1830, 3-47); Macduff (ca.1830, 1878); Banff (1775, 1828, 3-50), partly designed by Smeaton; Portsoy (1692, 1828, 1883, 3-53); Cullen (1819, 1835, 1887, 3-55); and Buckie (1855, 1880, 1921, 3-56), with the innovation of concrete pier construction in the 1870s.

Pier development features at Aberdeen Harbour's internationally renowned North Pier (1780, 1816, 1877, 3-21) in which the consumate skills of Smeaton, Telford and Cay can still be appreciated, and for the two latter engineers, also in the South Breakwater (3-22).

Lighthouses are represented by fine examples at Kinnaird Head, Fraserburgh (1787, 3-46), the Northern Lighthouse Board's first lighthouse, now part of Scotland's Lighthouse Museum; Buchan Ness (1827, 3-39); the finely-appointed Girdle Ness Station (1833, 3-24); Aberdeen Harbour Leading Lights at Torry with octagonal cast-iron towers (1842, 3-23); and Rattray Head Lighthouse with its novel quarterdeck (1895, 3-45).

Water supply is represented by the river water filtration works opened by Queen Victoria in 1866 on the bank of the Dee at Invercannie, 18 miles west of Aberdeen, and the aqueduct to the city (3-15).

Bridges are the most numerous works but, being in a relatively affluent area, few received grants from the Highland Road and Bridge Commission; examples noted are Bridge of Alford (1811, 3-30) and Potarch (1814, 3-14), both designed by Telford.

Pre-Road Commission period masonry bridges include Brig o' Balgownie (ca.1320, 3-26); Bridge of Dee, Aberdeen (1527, 3-19); Bridge of Dye, Glendye (ca.1680, 8-4); Invercauld and Gairnshiel of the military era (ca.1753, 3-7, 3-12); Banff (1779, 3-40) by Smeaton; Bridge of Alvah (1772, 3-52); Ellon (1793, 3-38); and Inverbervie (1799, 3-3) and Union, Aberdeen with its impressive main span of 130 ft (1805, 3-29).

Later masonry bridges noted are: Bridge of Keig, probably Telford (1817, 3-31); Eastside, Turriff (1826, 3-51), with tollhouse; Bridge of Don, Old Aberdeen (1830, 3-27); Royal Bridge, Ballater (1885, 3-10), originally built in 1783, rebuilt after a flood in 1799 and destroyed in the 1829 flood, after which an elegant timber bridge designed by Telford served until 1885.

An impressive range of suspension bridges, illustrative of their development, includes Wellington, Aberdeen (1831, 3-28) by Capt. S. Brown, the earliest; closely followed by Crathie (1834, 3-9); St Devenick's (1837, 3-17), now ruinous; Castle Forbes (1863, 3-32); Abergeldie (1885, 3-8); Birkhall House (ca.1885, 3-11); Polhollick (1892, 3-13); and Cambus o' May (1905, 3-13).

The area is also strong in mid- to late-19th century iron beam and arch bridges, the most notable being Brunel's Balmoral Bridge (1857, 3-6); Methlick Bridge (1844, 3-36); Park, Durris (1854, 3-16); Bridge of Newe, Strathdon (1859, 3-29); Inveramsay (ca.1860, 3-34); Tangland (1864, 3-37); Milton of Rothiemay (1874, 3-54); Bridge of Don, Kintore (1882, 3-35); and Gartly (1884, 3-33).

Railway development from the south reached Aberdeen by 1850 with the opening of its first station at Ferryhill in 1850, extended to Guild Street in 1854 (3-18). From 1850–1922 the area was extensively covered by the Great North of Scotland Railway. Its dominant viaducts at Cullen (1886, 3-55) have been noted.

Perhaps the most unusual work is a magnificent model of the Murchison Oil Platform, the full scale version of which was erected between the Shetland Isles and Norway in the 1970s in a 300 ft depth of water. The model is skilfully mounted through several floors of the building of the Maritime Museum in Aberdeen where it is on display and forms an outstanding tourist attraction. The museum also displays details of the landmark Auk Alpha platform erected by 1975 (3-25).

1. Johnshaven Harbour

HEW 2506
NO 7954 6695

This natural harbour, protected by high water rocks, was well established as a fishing port at least as early as 1722 when it is said to have had 26 boats. By 1795 a small wharf existed. The harbour's potential for improvement was referred to in 1837 but not actioned, but by 1868 a short pier existed which was presumably demolished when the harbour was built.

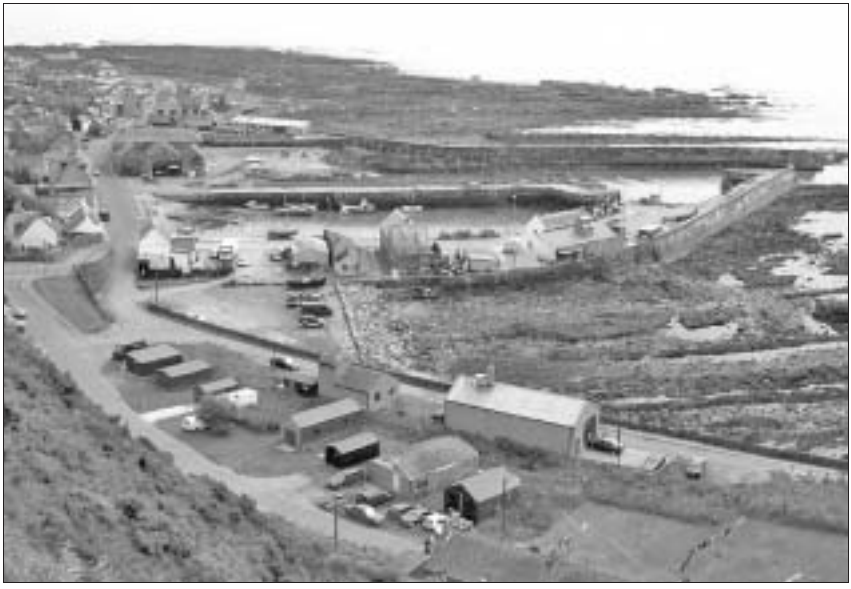
The present harbour of about $1\frac{1}{2}$ acres, with its central jetty, adjoining the inner tidal basin enclosed by the west pier, which is accessed from an outer basin abutting its east side and enclosed by the east pier, was built in 1884 of local stone, possibly from nearby Balandro Quarry, at a cost of over £4000. The harbour, refurbished with concrete in the 1950s, contains from 10–20 ft depth of water at high tide and is now mainly used for leisure activities. [1, 2]

Bottom: Gourdon Harbour

2. Gourdon Harbour

HEW 2507
NO 8257 7062

Gourdon Harbour also originated as a small fishing port. It developed in 1818–19 with the construction to Telford's design of the masonry, rubble-filled central pier by James



Tom Day

Farquhar (of Hallgreen). This was enlarged in 1842 when the West Harbour was formed with the construction of an enclosing pier.

The facilities were further improved in 1859 when the Gutty Harbour was enclosed by a breakwater. In 1959 and 1970 additional protection was obtained by the construction of the east and west breakwaters extending to each side of the entrance channel and the provision of storm gates at the entrance to the West Harbour.

The harbour is now used for leisure activities. [1, 2]

3. Inverbervie Bridge

HEW 2508
NO 8319 7290

This bridge spans the steep-sided valley of the Bervie Water in an impressive single segmental masonry arch of 102 ft span with a clearance above water level of 80 ft. The soffit of the arch is 24 ft wide. The bridge, completed in 1799, was designed and built by architect-engineer James Burn.

To obviate thrust from fill material placed in the tall spandrels and abutments, the roadway was supported on a series of enclosed arched vaults, formerly used for coal storage. Soon after construction it was found that some elements of the blind arches and walls of the abutments had not been built to the dimensions specified and were showing signs of imminent failure. Burn was held responsible for the defects. This may account for the later use of

Inverbervie Bridge

wrought-iron tie rods between face plates to restrain any outward wall movement.

The arch is constructed of dressed masonry and the spandrels and abutments of coursed rubble. The spandrel walls are decorated with occuli, an architectural device used by both Burn and his brother George on their bridges and, unusually, the abutments are pierced by windows and door openings.

The bridge was closed to vehicular traffic in 1936 when it was bypassed by the present multi-span reinforced concrete bridge seen in the view. [3]

4. Bridge of Dye, Glendye

HEW 1378
NO 6511 8608

The Bridge of Dye, built in ca.1680, crosses the Water of Dye with a single semicircular arch of 43 ft span. The bridge, the second oldest on Deeside, was an important improvement on the line of the Cairn o' Mount section of the old military road between Edinburgh and Fochabers. It has recently been bypassed by a new bridge alongside carrying the B974 road.

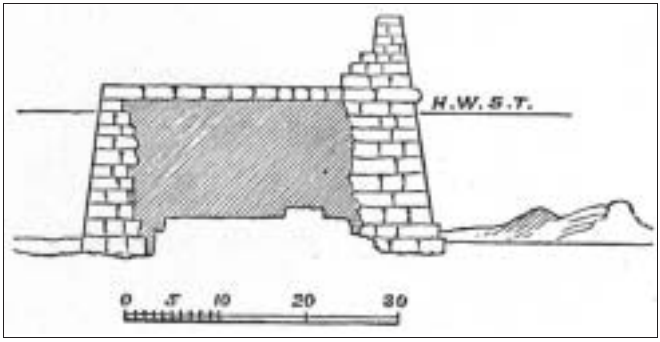
The arch is constructed of roughly dressed masonry and, in the manner of the Bridge of Dee at Aberdeen, is supported on stone ribs, in this case by four ribs spaced $2\frac{1}{2}$ ft apart. The roadway is 11 ft 8 in. wide between parapets. [4]

5. Stonehaven Harbour

HEW 2509
NO 8783 8546

Although a harbour existed at Stonehaven from at least the 17th century, it was reportedly in a poor state until improvements, including construction of the seawall and breasting of the new harbour to the south and other work, designed by Robert Stevenson, were carried out in 1825–26. Before this there was a single pier to which an enclosing pier (1825–26) and an internal jetty (1837) were added to form a double basin. The trade at the harbour increased and by 1895 more than 100 herring boats were fishing from the port each season.

Stevenson's son Thomas, in his text book on the design and construction of harbours in 1864, provides an illustrated section of, presumably, the 1825–26 pier noting that the string or bottle course at roadway level facing the



Stonehaven Harbour pier 1825–26 [Stevenson T. *Design and Construction of Harbours* 1864]

sea had to be hewn off to inhibit shaking of the masonry during storms.

The mass concrete breakwater protecting the harbour entrance was built to a design by J. Barron in ca.1901.

The harbour is now the largest recreational facility of its kind in Aberdeenshire, with three basins extending to $4\frac{1}{2}$ acres in area. [5]

6. Balmoral Estates Bridge

HEW 1070
NO 2621 9492

This bridge over the Dee, commissioned by Prince Albert in 1854, was designed by I. K. Brunel and built in 1856–57. The main structural elements are two riveted plate girders spanning 125 ft between granite abutments. The timber deck is carried on 12 in. deep plate cross-beams.

Balmoral Estates Bridge

The roadway is 13 ft wide between the plate girders which are $6\frac{1}{2}$ ft deep. Brunel touches are the convex flanges, 26 in. wide at the top and 33 in. at the bottom and the pierced upper part of each girder to provide a lattice effect in the parapet. There are four pairs of intermediate stiffeners per girder at 25 ft centres.

The ironwork for the bridge was made by Rowland Brotherhood, Railway Works, Chippenham and was riveted on site. The erection of the bridge was superintended by Balmoral Estates factor Dr Andrew Robertson.

It is understood that Queen Victoria did not consider the bridge's appearance sufficiently ornamental and that for this reason the bridge was not mentioned in her book gleaned from the *Journal of our life in the highlands* (1868). [6]

7. Brig o' Dee, Invercauld

HEW 0336
NO 1863 9094

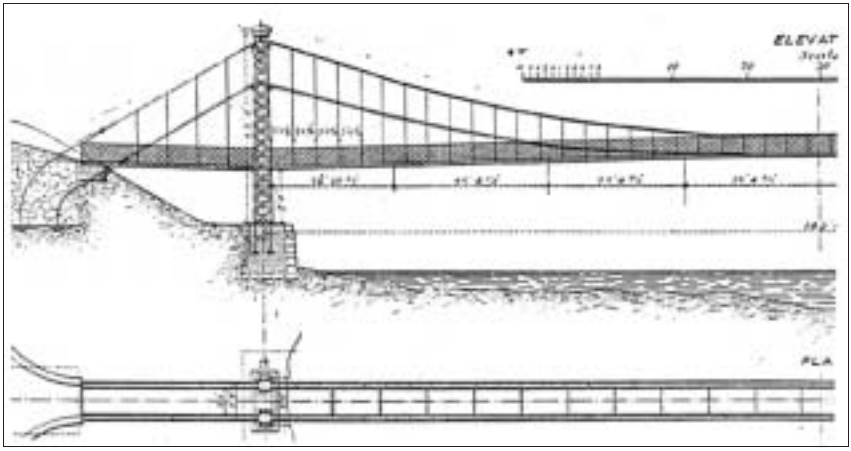
This historic and picturesque bridge, until bypassed in 1859 by the present bridge on the A93 road immediately north, formerly carried the military road from Blairgowrie to Fort George over the Dee at Invercauld. It was built in 1752–53 under the direction of Major W. Caulfeild who, as the successor to General Wade, was responsible for the construction of military roads and bridges in Scotland from 1743–67.

The bridge is asymmetrical with six arches varying from 10–68 ft in span and, characteristically for its genre, the roadway rises sharply from the low river banks to the crown of the main span, has arch-rings of narrow semi-dressed stones varying from 18–39 in. in length laid radially, and rubble masonry (granite) wing walls, buttresses and spandrels. The irregular span dimensions were dictated by the need to obtain suitable pier foundations. The triangular cutwaters have sloping flagged tops. [7–9]

8. Abergeldie Castle Footbridge (Private)

HEW 1560
NO 2874 9536

This private suspension bridge of 146 ft span about $1\frac{1}{2}$ miles east of Balmoral was built across the Dee in 1885 by Blaikie Brothers, Aberdeen. It is said to have been erected for



Abergeldie Bridge [*The Engineer* 7 Aug, 1885]

Queen Victoria to enhance access to the castle. The deck is suspended by iron rods from two sets of wire cables supported from lattice towers.

The bridge replaced a cableway for transporting goods across the river at the castle.

9. Crathie Suspension Bridge, Easter Balmoral

HEW 1558
NO 2660 9425

This bridge, originally erected in 1834 by James Justice Junior, is one of several suspension bridges constructed in north-east Scotland by the Justice family of Dundee. It has masonry flood relief arches at either end that support light-braced iron towers from which the 137 ft central span is suspended. The bridge is 12 ft wide and presumably originally accommodated carriages.

The deck is supported both from catenarian bar-link chains and inclined stays, although neither the latter or the light trusses beneath provide much support. The chains consist of pairs of bar-links 14 ft 8 in. long, each of $2\frac{1}{2}$ in. $\times \frac{1}{2}$ in. cross-section, with a short connecting link formed from a conventional open link with its sides pressed together to embrace a 'T' end on a hanger top.

Because of his concern for the safety of its royal users, the bridge was examined by Brunel when on a visit to the site of Balmoral Bridge in 1854. He advised Queen Victoria's representative, 'I believe you may consider it perfectly

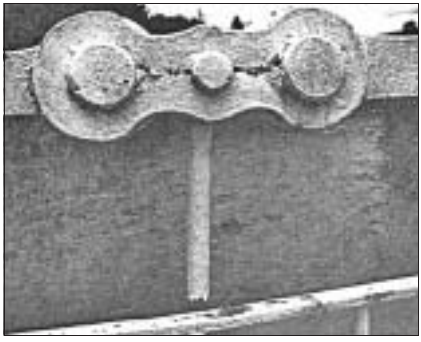
Tom Day

Crathie Suspension Bridge

safe for all ordinary loads tho' quite unfit to bear a crowd of people or a drove of cattle'.

The deck beams, similar to those of the Justice Bridge at Haughs of Drimmie, are constructed of square-section iron bars, but here there is no camber across the width of the deck and the lower beam members have a pronounced downward curvature. The timber deck was replaced in 1989.

According to an account in *The Engineer*, the bridge was 'almost entirely renewed' in 1885 at the expense of Queen Victoria by Blaikie Brothers of Aberdeen. The main chains have the appearance of being original.



Tom Day

Crathie Suspension Bridge – chain detail

The bridge, which for many years has been restricted to pedestrian use, can be easily reached from the B976 road, half a mile to the east of Balmoral. [10, 11]

10. Royal Bridge, Ballater

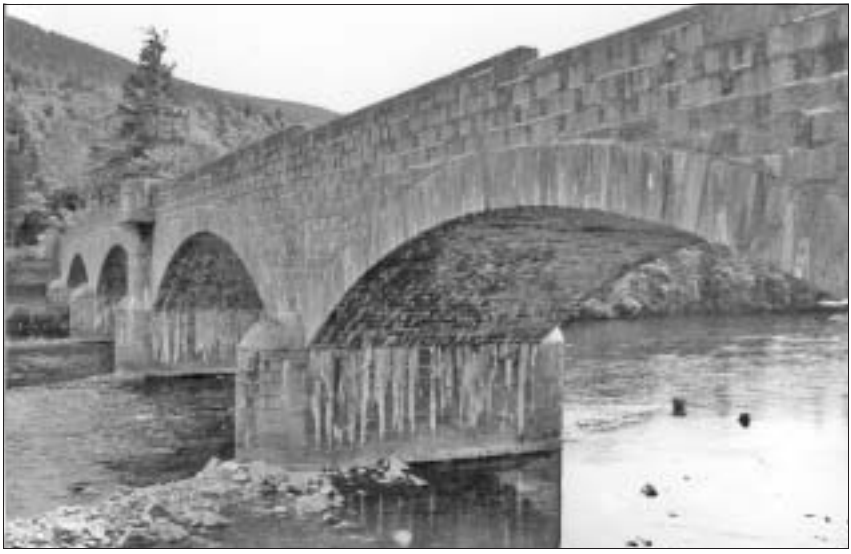
HEW 2106
NO 3721 9559

The present bridge crossing the Dee at Ballater has four 63 ft span low-rise segmental masonry arches constructed of local granite. Its design is similar to that used by Telford for his Highland bridges except for the stepped parapet in elevation. The bridge was completed in 1885 to a design by Jenkins and Marr and the contractor was John Fyfe, Kemnay.

The bridge is on the site of three earlier bridges, the first of which was built from 1781–83 by James Robertson and destroyed by a flood in 1799. The second, designed by Telford and erected by John Simpson from 1807–09, was destroyed in the great Moray flood of 1829. Its centring was probably re-used at Laigh Milton Viaduct (5-4).

These bridges were of masonry, but the third, on a plan prepared under Telford's direction, retaining the gentle arc of the parapet in elevation, was an outstanding timber bridge with four 70 ft spans, basically of traditional construction with slim timber-clad piers, erected by Gibb &

Royal Bridge
Ballater
1885–present



Roland Paxton

RCAHMS – Mr G. Cobb

Ballater timber bridge 1835–85

Son in 1834–35 under Mitchell's superintendence. It utilised the 1809 abutments and was 'built entirely of Braemar natural timber . . . contract price £1857', a modest cost for a quickly erected replacement which served for 50 years. A drawing was published in 1835 in the *21st Report of the Highland Roads and Bridges Commission*. [12, 13]

11. Birkhall House Footbridge (Private)

HEW 2510
NO 3498 9352

A 60 ft span wire-rope suspension bridge over the Muick in the grounds of Birkhall House. This bridge is unusual

Tom Day

Birkhall House Footbridge – pier detail

Tom Day

Gairnshiel Bridge

in that its supports are four decorative cast-iron columns tied back by stranded wire cables to anchorages. The deck is supported on a pair of tensioned wire ropes between the supports with support also from the catenarian cables by means of vertical iron rods. The suspension and deck cables are tensioned by 'Harper's Patent' mechanisms.

The bridge was designed and erected in ca.1885 by Harper & Co., Aberdeen.

12. Gairnshiel Bridge

HEW 2174
NJ 2949 0086

A fine example of a Caulfeild 'military' bridge on the same road as the Brig o' Dee at Invercauld (3-7), from Blairgowrie to Fort George. This bridge, now carrying the A939 road over the Gairn in a single arch of $56\frac{1}{2}$ ft span was built in ca.1753. It is characteristic of its type in having steep approaches, being made of well-built rubble masonry (granite) with parallel side walls, a segmental arch-ring consisting of narrow partly dressed stones of about $3\frac{1}{4}$ ft random depth and a roadway $12\frac{1}{4}$ ft wide between parapets walls 18 in. thick. [14, 15]

13. Polhollick Footbridge, Bridge of Gairn

HEW 2175
NO 3438 9652

A suspension bridge of 180 ft span over the Dee made and erected by James Abernethy & Co., Aberdeen in 1892. Its

Tom Day

deck, stiffened by lattice truss parapets, is suspended from steel wire-rope cables supported on latticed towers.

Polhollick Footbridge

A similar footbridge of 165 ft span by J. Abernethy & Co. was erected in 1905 at Cambus o' May (NO 4210 9770). They are both good examples of the generation of suspension bridges constructed in north-east Scotland from 1890 to 1925.

14. Potarch Bridge, Kincardine o' Neil

HEW 1382
NO 6076 9731

This bridge, on the line of the old military road from Edinburgh via Cairn o' Mount to Fochabers and later to Fort George, carries the B993 over the Dee. It was the second bridge to be constructed in Aberdeenshire for the Highland Roads Commission and is built of coursed granite masonry without decorative features except for the string course at road level. It is an outstanding example of its type. The bridge, designed by Telford, has three segmental arch spans of 65 ft, 70 ft and, 65 ft and is 17 ft wide between parapets.

Construction began in 1811 and the contractor, William Minto, agreed to complete the bridge within two years. During building, while the arch-rings were supported on centring, logs being floated downriver lodged against the temporary works and caused the collapse of the partially completed work. The bridge was completed in 1814 for £4067. Minto also improved $13\frac{1}{2}$ miles of road from just north of the bridge to Alford Bridge. [16, 17]

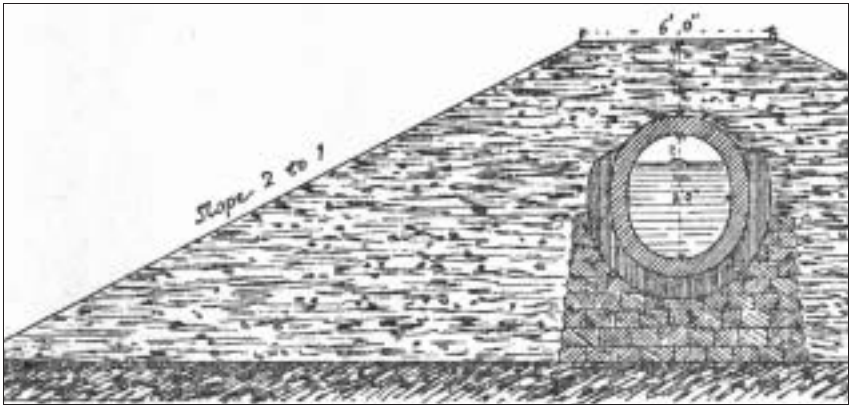
15. Invercannie Water Treatment Works

HEW 2081
NO 6646 9650

The treatment plant at Invercannie, built to supply water to the city of Aberdeen, was opened by Queen Victoria in 1866 and hailed as the jewel in the crown of engineering success. The water was extracted from the Dee at Cairnton and passed through a tunnel 1.3 miles long to the treatment plant where it was stored and then passed though slow sand filters before flowing under gravity though an elliptical cross-section brick aqueduct 3 ft 2 in. wide by 3 ft 9 in. high and $18\frac{1}{2}$ miles long to reservoirs in Aberdeen. The works, with an initial extraction rate limited to 6 mgd, were designed and executed under the direction of John Simpson, engineer, and Easton Gibb was the contractor. The tender sum was £103 999.

In 1886 a new intake, which no longer exists – its building now housing a pump – was built at Cairnton under the direction of W. Boulton, Burgh Surveyor, with a capacity of about 8 mgd.

With the increased demand for water the facilities at Invercannie were enlarged from 1920–26 at a cost exceeding £1 million. The works included the present intake from the river and screening chamber at Cairnton; a storage reservoir of 24 mg capacity; three slow sand filters, 1.4 acres in area; a second aqueduct consisting mainly of steel and cast-iron pipes from 40–48 in. diameter with an ultimate capacity of 14 mgd; a pumping station and main; and a service reservoir of 7 mg capacity. The



Invercannie Water Treatment Works [19]

engineer was George Mitchell and the main contractor William Tawse Ltd.

In 1932 the 1866 aqueduct was lined with concrete 3 in. thick to make it watertight. A section of this aqueduct is preserved at Invercannie.

The water from the works, now managed by Scottish Water, is still the main source of supply to Aberdeen, supplying about 300 000 users. From 1992–95 chemical and ozone treatments were introduced to improve the quality of the sand filtered water and, in 2005, an £11 million membrane barrier to cryptosporidium became operational. [18, 19]

16. Park Bridge, Durris

HEW 0406
NO 7965 9818

This bridge, now carrying a public road, was constructed in 1854 by the Deeside Railway Company to give access from the south to its railway along the north side of the Dee. It has two cast-iron segmental arches of 120 ft span, with a rise of only 14 ft, and is supported on granite masonry abutments and a central river pier.

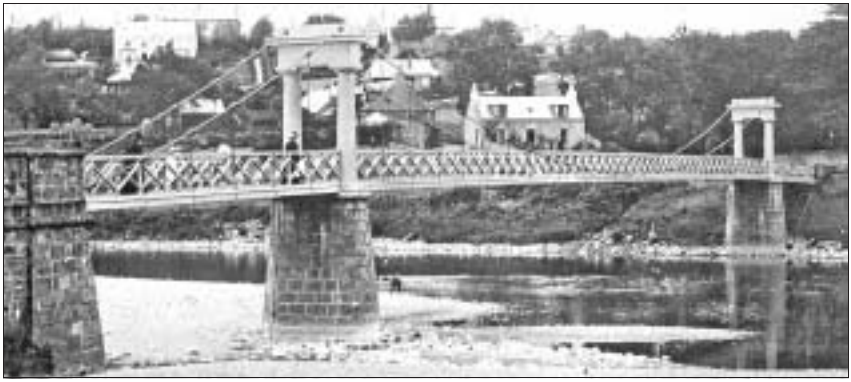
The arches were cast in four sections and support the arcade of cast-iron cruciform-section columns carrying the timber deck beams and floor, which have been renewed.

The bridge is an elegant structure whose profile has been slightly altered by the handrailing required for modern traffic usage. It was designed by John Willet and the iron-work was cast by J. Abernethy and Co. [20]

17. St Devenick's Bridge, Cults

HEW 1820
NJ 8977 0261

This footbridge over the Dee, known locally as Morison's Bridge or the 'Shakkin Briggie', is now derelict. It was built in 1837 to replace a ferry and enabled parishioners of Banchory-Devenick living north of the river to attend church. The minister, Dr G. Morison, paid for the bridge and subsequently the Kirk Session maintained it. From 1952–57 this responsibility was undertaken by Aberdeen City Council who later decided that they could not justify the expenditure and the deck was removed in the interest of public safety. The bridge was extensively repaired in 1920 following flood damage.



St Devenick's Bridge [postcard ca.1920]

As built, the bridge was 305 ft long, the northern end being an unstiffened suspension span of 185 ft with a series of short beam spans at the south end. The main span is supported on masonry piers carrying twin circular 24 in. diameter cast-iron columns, surmounted by a capping beam and chain saddles about 14 ft above deck level. The chains dip 13 ft giving a dip-to-span ratio of 14. The bar-link chains are formed of two $1\frac{3}{4}$ in. diameter bars with short connecting links from which the suspenders and deck beams were hung. The deck was partially stiffened by latticed timber handrails.

The bridge was designed by John Smith, Aberdeen architect. Its ironwork was influenced by the practice of Capt. Brown whom Smith had assisted with the tower design of Wellington Bridge. Smith's expertise is evident in the classical detailing of the columns and lintels. The contractors were John Duffus & Co., Aberdeen (ironwork) and George Donaldson and George Barclay respectively for the masonry and timberwork. [21, 22]

Great North of Scotland Railway

The Great North of Scotland Railway (GNSR) was the only Scottish railway company to assume the title 'Great', yet it was the smallest. It was based in Aberdeen and operated in the north-east corner of Scotland bounded by Aberdeen, Fraserburgh, Elgin and Boat of Garten. The railway was largely made up of branch lines extending northwards and westwards through mainly agricultural countryside

fringed by fishing villages along the coast. It operated a brisk suburban service round Aberdeen and carried much fish.

The company was formed in 1845 with William Cubitt as engineer-in-chief, but he acted mainly as a consultant. He was succeeded by Benjamin Hall Blyth in 1851. The work, which had been delayed because of funding difficulties, started in 1852. The first stage of the railway, 39 miles from Kittybrewster to Huntly, was opened in September 1854. Alexander Gibb acted as resident engineer, surveying the lines and directing work. The main contractor was Mitchell, Dean and Company.

Blyth resigned as engineer in 1856 and was succeeded by Alexander Gibb who had complete charge of engineering operations until his death in 1867. He was succeeded by his chief assistant Alexander Fraser who, in 1868, was followed by Patrick Barnett who served until 1906.

The railway was extended by 20 miles to Keith by 1856 which, with the arrival there in 1858 of the Inverness and Aberdeen Junction (part of the Highland Railway from 1865), allowed the company direct access to Inverness. By 1898 the railway was still single line except for the Keith to Inverness section which was double. Its largest bridges were over the Spey on the Strathspey Railway at Ballindalloch and Carron, and at Garmouth on the Buckie Extension Railway near the coast, all of which have been conserved.

By 1922, when the railway became part of the London and North Eastern Railway, its area of operation was generally comprehensively served. In 1968 the Beeching Axe fell heavily on the GNSR's former lines and only the Aberdeen–Inverness main line survived. The sites of several branch lines have been conserved as pedestrian and cycle routes. [23]

18. Joint Station, Aberdeen

HEW 2511
NJ 9415 0589

The promoters of the Aberdeen Railway and the GNSR planned a joint station in the centre of Aberdeen. Although initial proposals were published in 1850, the year that the railway opened to the south, it was not until 1867 that an enlarged version was eventually built near the west side of the harbour to the design of William Smith, city architect,

Roland Paxton

Aberdeen Station 1914 in 2006

with John Willet being responsible for the design and construction of the train-shed.

This station, said to be have been modelled on Victoria Station, London, had a magnificent arched roof 500 ft long and 102 ft wide. The façade was constructed of ashlar granite from Kemnay. The main walls were 30 ft high and were finished at the ends by square towers that added a further 20 ft to the height. The crown of the roof was 70 ft above ground level. The ironwork contractor was J. Abernethy and Co.

By 1911 a larger station was required and plans were made. This was a difficult task as disruption to the travelling public had to be avoided and the old station had to be demolished before constructing the new one. Work began in 1912, demolition of the old station was completed in 1913, and the new station became operational in 1914.

The new station comprised 13 platforms. Much of the masonry of the office accommodation was freestone from Northumberland rather than local granite which was deemed too expensive. The new roof, covering the present concourse, with its light and airy appearance was smaller than the old roof, being 245 ft long and 97 ft wide, covering

an area not entered by trains. The platforms, extending north and south from the concourse, were provided with umbrella-like steel roof trusses for almost their entire lengths.

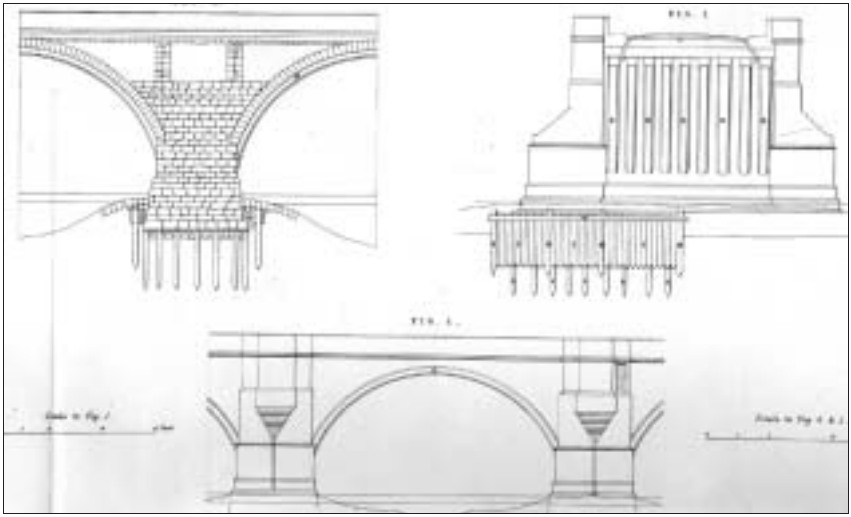
Recently the station has been reduced in size and modernised but the basic structure remains. [24]

19. Bridge o' Dee, Aberdeen

HEW 0150
NJ 9290 0356

This bridge, an outstanding medieval structure built from 1520–27, is the oldest on Deeside, and for many centuries was the only river crossing between Aberdeen and the South. Unusually for Aberdeen it was constructed of freestone, but subsequent widening and repairs were executed in local granite.

The bridge has seven deeply segmental arches of 45 ft span on average, with a rise of 18 ft, supporting a level roadway. The arches are formed of a series of ribs supporting transverse stone slabs. The foundations of the piers and triangular cutwaters are carried on timber-piled foundations protected by rubble aprons. The cutwaters are extended upward to road level to form pedestrian refuges. The bridge was designed by Alexander Galloway and built by master mason, Thomas Franche. It was partially reconstructed in 1720.



Bridge o' Dee drawing [27]

In 1841–42 the bridge was widened by $11\frac{1}{2}$ ft to its present width of 26 ft between parapets. The whole of the west face of the bridge including turrets, abutment and wing walls, half octagons of piers and parapets, spandrels and arch-stones, was carefully dismantled and re-erected as far as practicable to its original form and place in the rebuilt face. At each arch the original outer rib was re-used and four additional ribs were added to support the widened deck.

This project, designed and executed under the direction of John Smith, city architect, constituted an exemplary widening of a historic bridge. Smith's drawing (see figure) and specification were published in 1842. The contractors were Alexander Macdonald and William Leslie. [25–27]

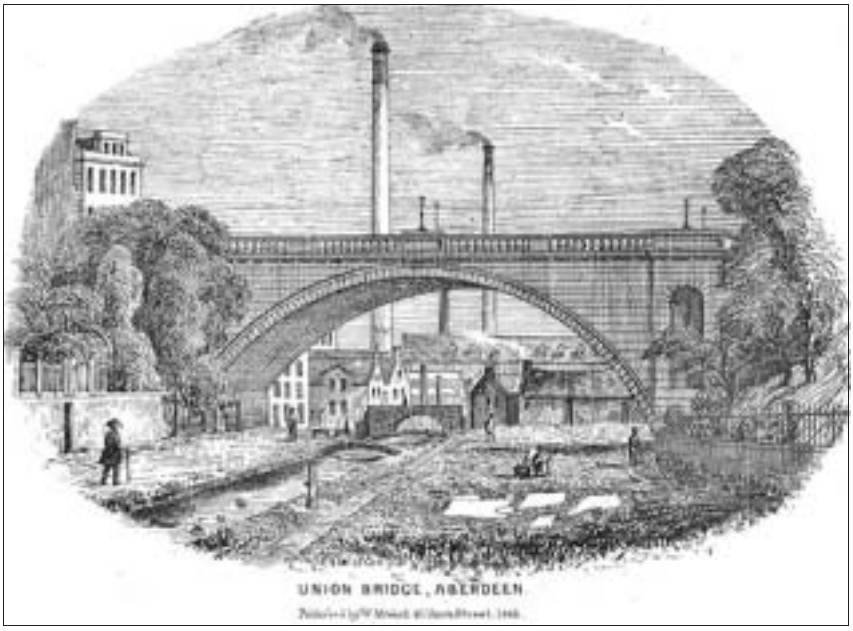
20. Union Bridge, Aberdeen

HEW 1491
NJ 9396 0611

This bridge was built as part of Aberdeen's Georgian civic improvements planned by road surveyor Charles Abercrombie and others to carry the new Union Street over the Den Burn some 46 ft below. Competitive designs were obtained in ca.1800 and that of David Hamilton for a triple-span structure with a main span of 50 ft was accepted. But, after construction had commenced, with Thomas Fletcher, Rennie's assistant on the Aberdeenshire Canal superintending the work for the city, discrepancies in the estimate and levels were discovered and the contract was cancelled.

This situation resulted in designs for single and triple-span bridges being prepared by Rennie. Telford submitted a sketch for a 150 ft span arch, and Fletcher a plan for a 130 ft single-span arch bridge in dressed granite masonry which, with minor modification, was approved by Telford and built from 1801–05.

The rise of the arch is 29 ft and the depth of the arch-ring is 4 ft at the haunches reducing to 3 ft at the crown. To reduce weight the bridge was built with two 12 ft transverse tunnels within each spandrel. In addition there are two semicircular blind arches of 30 ft span above the east abutment and a single arch over the west. The bridge was 40 ft between parapets. The contractor was William Ross and the contract sum £9816.



Union Bridge 1805 [Engraving published by W. Mitchell, Aberdeen 1842]

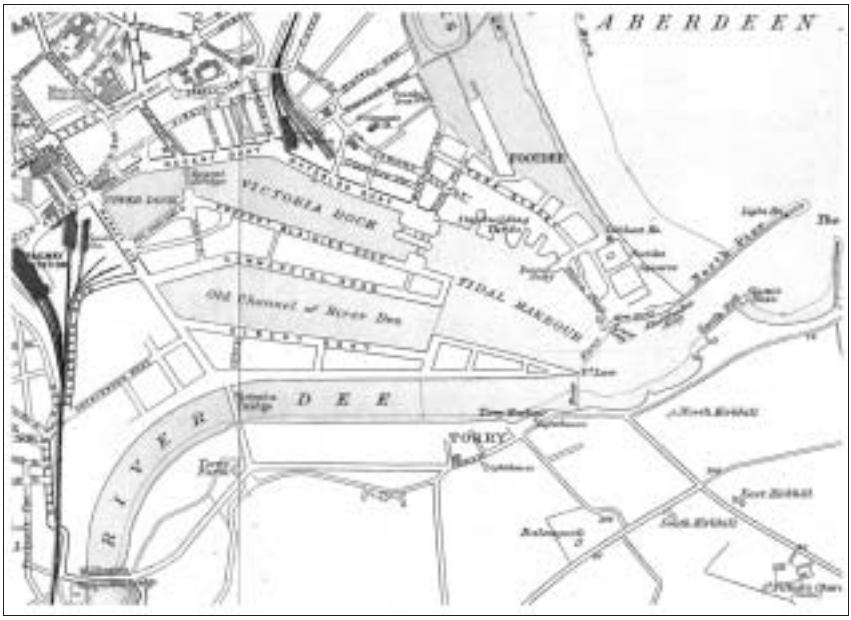
During 1906–08 the bridge was widened by the addition on each side of a three-pinned steel arch-rib which was tied to the main structure. This work was designed by William Dyack, Burgh Surveyor, and the steelwork contractor was Messrs. Findlay & Co., Motherwell. [28, 29]

Aberdeen Harbour

HEW 1377

A port existed at Aberdeen at least from the 14th century, but it was not until 1770 that a start was made on the modern harbour by commissioning a report from John Smeaton, following which the first North Pier, one of the most remarkable in Britain requiring exceptional engineering talent to overcome storm effects, was built from 1774 and twice extended later. A southern breakwater was completed in 1815 and another further east from 1870–73. From the pounding they receive from the sea both have required regular maintenance.

In 1810 Telford proposed a scheme for a large dock adjoining the north shore and what was to become Waterloo Quay to be created by impounding water in the



Aberdeen Harbour map [Groome's *Ordnance Gazetteer of Scotland* 1885]

harbour at high tide by means of an entrance lock. Between 1816 and 1829 very little was done except dredging. The 1831 version of this proposal formed the basis for the Victoria Dock project later developed by James Abernethy. About this time Telford also advised on the new channel for the Dee, reclamation of the Inches, new wet docks and quays and dredging. The cost of the work done under his direction amounted to £160 590.

In 1843, after receiving reports from James Walker and Alexander Gibb, the Harbour Commissioners executed the plans of Abernethy, their resident engineer, and the 28-acre Victoria Dock, and an upper dock west of Regent opening bridge, was built by 1848 with two entrances 60 ft and 70 ft wide and about 20 ft deep, one with a lock for the passage of ships and the other with ebb-gates.

From 1869–72 the channel of the Dee was realigned southwards to Wellington Suspension Bridge at a cost of £51 585 and the old channel was converted into a tidal basin with Commercial Road to the north and Albert Quay to the south.

With the advent of the oil industry, in the 1970s Victoria Dock was redeveloped and the tide locks were removed in

1975 making the whole harbour tidal, with deepening by dredging as necessary. [30–34]

21. North Pier

HEW 1377/01-03
NJ 9590 0570

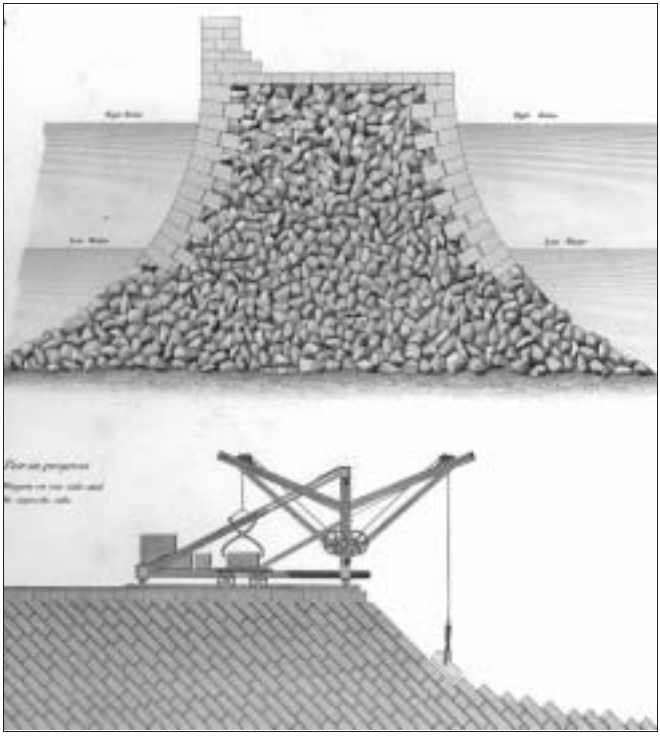
Before the construction of the North Pier, the entrance to the harbour was seriously affected by the southward drift of coastal sand and the deposition of material washed down the Dee. To alleviate this problem, the North Pier, designed by Smeaton, was built from 1774–80 under the superintendence of resident engineer John Gwyn by direct labour. It was about 1200 ft long, 16–30 ft high, with a breadth of 20–36 ft at the base and 12–24 ft at the top, the dimensions increasing seawards. The work, which cost £16 000, was successful. The construction is vintage Smeaton with a trapezoidal cross-section, external walls of horizontally coursed small squared blocks and internal stone hearting.

Besides shielding the harbour mouth the pier, by constricting the channel of the Dee, created a scour which prevented the formation of a sandbar. In 1789, in order to further narrow the entrance channel and to mitigate the

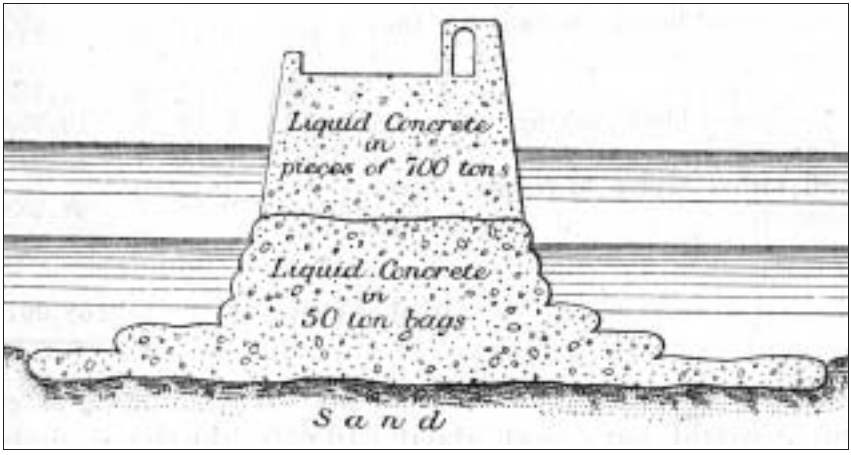
Roland Paxton

North Pier from Smeaton's work with Telford's and Cay's extensions. On right Cay's extension to South Breakwater with lighthouse

North Pier extension 1811–16 (Telford) [30, pl. 37]



North Pier extension 1874–77 (Cay) [34, p. 157]



effects of any easterly swell penetrating the harbour, a catch pier, Abercrombie's Jetty, was built at the landward end of Smeaton's pier.

Unfortunately the increased flow in the river from these measures undermined the foundations of the pier. In 1797 Rennie proposed remedial work to secure the foundations but no action was taken.

In 1802 Telford was consulted about improvements to the harbour, and from 1811 work began under his direction. This included, under the able superintendence of the Board's resident engineer John Gibb, an extension by 1816 of the North Pier seawards by a further 900 ft in substantial construction at a cost of £66 000. The granite blocks were laid diagonally to give them greater resistance to the force of waves.

From 1869–79 the harbour entrance was greatly extended under the supervision of the Harbour Board's resident engineer, W. D. Cay. First, a new South Breakwater was built and then, from 1874–77, the North Pier was lengthened by a further 500 ft with an ingenious application of mass concrete taking the total length to nearly a half mile, the preliminary design for which using concrete bags is shown in the section. These measures extended the harbour mouth into deeper water and increased its width. [30–35]

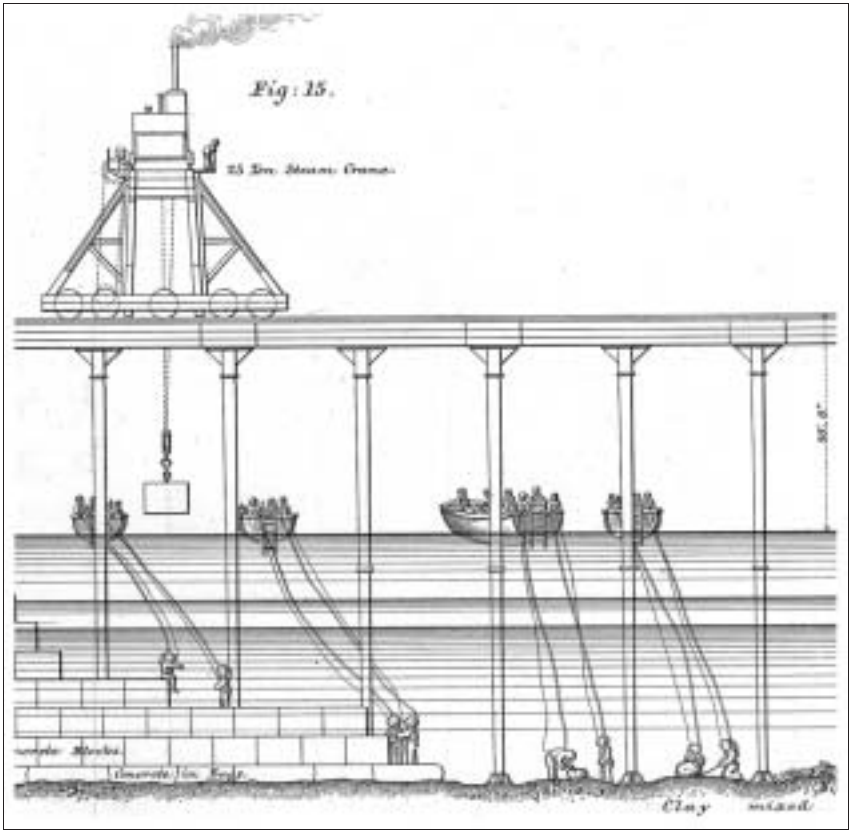
22. South Breakwater

HEW 1377/04-05
NJ 9670 0570

The first South Breakwater, nearly 800 ft long, was constructed under the superintendence of Gibb in consultation with Telford in 1812 to further restrict the channel and to protect the second North Pier extension. This work, which was successful, also increased the depth of the channel.

From 1870–73, as part of harbour entrance improvements, further protection from south-easterly gales was considered necessary particularly during construction of the third extension to the North Pier which was about to start.

Under Cay's direction, a new South Breakwater was constructed of mass Portland cement concrete which in the lower part of the structure was ingeniously deposited from hoppers into bags each containing up to 100 tons of



Top: South Breakwater – concrete construction 1870–73 [34, pl. 9]

South Breakwater in a storm [postcard ca.1910]

concrete. Above this level construction was achieved by means of large concrete blocks, the whole pier being 1050 ft long with a maximum height of 47 ft and a 62 ft high concrete lighthouse at the end. Divers prepared the sea bed before the bags were deposited. The effectiveness of the pier during a storm in ca.1910 can be seen in the view. The seaward 500 ft of the old breakwater was removed in ca.1873. [34]

23. Leading Lights, Torry

HEW 1682
NJ 9538 0530
(West)

The construction of the North Pier and South Breakwater at the entrance to Aberdeen harbour restricted the width of the navigation channel, and it became necessary to provide a navigational aid to assist vessels entering the harbour.

To this end in 1842 the harbour authorities erected leading lights in the form of two lighthouses about 38 ft

Roland Paxton

Cast-iron lighthouse at Torry 1842

high and octagonal in cross-section with sides at the base of $3\frac{3}{4}$ ft and at the lantern of $1\frac{3}{4}$ ft. These lighthouses were designed by harbour engineer James Abernethy, and were constructed of cast-iron.

Externally the castings are detailed to simulate local granite ashlar masonry, while internally they exhibit the typical bolted flange details associated with construction of cast-iron tunnel linings. The two lowest hexagonal elements of the towers are single castings while at higher levels the castings are vertically and horizontally jointed. The contractors for the ironwork were James Abernethy and Co., Aberdeen.

24. Girdle Ness Lighthouse

HEW 1376
NJ 9716 0535

The lighthouse at Girdle Ness was designed by Robert Stevenson and built by John Gibb of Aberdeen. Stevenson's son Alan was the resident engineer and Alexander Slight

Roland Paxton

Girdle Ness Lighthouse

the resident inspector. It became operational in October 1833.

It is the only lighthouse in Scotland to have shown twin fixed lights. These were spaced vertically 70 ft apart at 115 ft and 185 ft, respectively, above sea level. The lower light was enclosed in the galleried lantern at a point where the wall thickness of the tower was stepped, and was supported on a corbelled masonry balcony. This lantern was a 28-sided polygonal structure which was glazed towards the sea, but infilled with cast-iron plates on the landward side.

The upper light is about 119 ft above ground level. In 1833 both lights were produced from Argand burners placed in the focus of 21 in. diameter silvered-copper parabolic reflectors, the upper light comprising 18 reflector lamps. In 1847, when a dioptric light was installed, the original lantern was replaced and transferred to Inchkeith Lighthouse.

In 1890 the lower fixed light was removed and the upper light was replaced by a single revolving light of 200 000 candle power. This light flashed twice every 20 seconds and had a nominal range of 22 miles.

The tower with its distinctive silhouette in the style of a minaret and the distinctive and generous accommodation for the light keepers form an impressive architectural group and one of Stevenson's finest works. The cast-ironwork of the panels at the rear of the lower lantern, the external ladders and the handholds are finely detailed and unique to this lighthouse. The unattributed ironwork is decorated with birds, crocodiles and rustic style bamboo balustrade with animal feet. Lion masks embellish the joints between the astragals of the upper lantern.

The light is still operational and, with all Northern Lighthouse Board lighthouses, is now automated from a control room at its headquarters, 84 George Street, Edinburgh. [36, 37]

25. Murchison Oil Platform Model, Maritime Museum, Aberdeen

This outstanding 25 ft high scale model at the Maritime Museum, Aberdeen, is of the fixed oil production platform,

HEW 2512
NJ 9435 0618

Murchison Oil Platform model at Maritime Museum Aberdeen – *jacket*

Maritime Museum, Aberdeen

named after the eminent Scottish geologist Sir Roderick Murchison, situated at 61° 23′ 49″ N–01° 44′ 26″ E. This is about 120 miles north-east of the Shetland Islands in one of the United Kingdom's most northerly oilfields. The platform was built for Conoco (UK) Ltd and produced oil for the first time in 1980. It is still in production and currently operated by CNR International (UK) Ltd.

The platform is typical of many constructed when the oil industry expanded into deep-water exploration in the 1970s and early 1980s. It consists of a *jacket*, the steel structure below water level, and the *topsides* accommodation above water level housing the equipment, control rooms and offices necessary to operate the platform and for staff quarters and facilities.

The platform, of about 57 000 ton total weight, is supported by the lattice structure of the eight-legged jacket which is 544 ft high and has a footprint on the sea bed 245 ft square. The four corner legs of the jacket are

anchored by 32 piles, eight per leg, each weighing about 263 tons. Besides supporting the applied vertical loading the jacket was designed to withstand the forces exerted by 100 ft high once-in-a-century waves generated by winds of 150 mph.

The jacket was fabricated at McDermott's yard at Ardersier on the Moray Firth. It was constructed on its side and was towed on a barge to its designated site at the Murchison oil field where it was launched onto a template prepared on the sea bed. Its weight at launch was about 25 000 tons. The platform, in operation since 1980, controls 27 wells drilled to reach oil bearing strata at a depth of 9900 ft below the sea bed. These wells gave the platform a maximum production capacity of 150 000 barrels of oil per day.

The topsides of this 1:33 scale model was made by Conoco and used to help design the platform. Its jacket down to the sea bed was built by Donald Smith Modelmakers in 1995.

This impressive exhibit is complemented by other oil rig platform displays including one on the landmark Auk Alpha at 56° 24′ 02″ N–02° 03′ 48″ E erected from 1972–75 and designed by Shell Oil OCD, contractor Redpath Dorman Long (North Sea) Ltd & Wm. Press Ltd. Its steel jacket, which was launched from a land construction site, had eight legs anchored to the sea bed by 20 piles and was 361 ft high with 62 ft above water. There is also a display on the Piper B platform, located in 467 ft depth of water, which came on stream in 1983.

26. Brig o' Balgownie, Aberdeen

HEW 0316
NJ 9413 0961

This fine example of early Scottish bridge building over the Don is believed to have been built ca.1320 by Richard Cementarius, a local mason and the first recorded Provost of Aberdeen. It is a single span Gothic pointed arch with a span of $69\frac{3}{4}$ ft, one of the largest of its kind in Britain at the time, with a roadway 11 ft wide between parapets. The arch is constructed of sandstone and the spandrels and parapet walls are mainly of granite.

Although the bridge formed an important element in the road system northward from Aberdeen it was poorly maintained after the Reformation. A plaque on the bridge states that it was almost totally rebuilt by the Town Council in

1605. In 1605 Alexander Hay executed a Charter of Mortification for its maintenance which later became the Bridge of Don Fund. This fund not only financed major repairs to the bridge in the 17th and 19th centuries, but also provided capital for the construction of a number of other bridges in north-east Scotland. [38]

27. Bridge of Don, Aberdeen

HEW 1300
NJ 9462 0943

The Aberdeen to Peterhead road crosses the Don on a handsome five-arched granite masonry bridge designed by Telford in 1827. Although John Rennie and Robert Stevenson submitted designs for this bridge some years earlier there was a considerable delay before Telford's design, based on proposals by John Smith and John Gibb of Aberdeen, was finalised.

By the end of 1828, before the bridge was finished, both of the outer piers subsided, despite being supported on piled foundations. The north pier ultimately subsided $2\frac{1}{2}$ ft and the south pier $1\frac{1}{2}$ ft. To remedy the situation it was necessary to take down the adjacent arches and the piers that supported them and to increase the bearing capacity of the foundation by driving an additional 69 piles of increased length in each foundation. It was 1830 before the remedial work and the bridge were completed by John and Alexander Gibb of Aberdeen at the cost of £17 000. The bridge has given no further trouble and has carried a progressively increased weight of traffic since its completion.

The segmental arches are each 75 ft span with a rise of 25 ft. The width of the original bridge was 24 ft but this was increased in 1956–59 to 66 ft by the construction of a new reinforced concrete arched bridge of similar profile adjacent to the existing bridge. Messrs. Considere Construction Ltd and A. G. Booth, city engineer, designed the new bridge which was built by Messrs. H. M. Murray & Co. Ltd, Glasgow. [17, 39]

28. Wellington Bridge, Aberdeen

HEW 0317
NJ 9432 049

This suspension bridge, designed by Capt. Samuel Brown RN, was the second of four such bridges to be built in the north-east of Scotland and is the only one now surviving. The bridge, erected in 1829–31, was partially reconstructed

Wellington Bridge and railway viaduct [engraving ca.1870]

in 1930 and closed to vehicular traffic in 1984 when the new Wellington Bridge, just downstream, was opened and remedial work was carried out on this one.

The main span of 215 ft is suspended from two bar-link chains mounted one above the other on each side of the 25 ft wide deck. Each chain is comprised of three lines of rectangular cross-section eye-bar links with short connecting links and cross-bolted in the manner of Telford's practice at Menai Bridge from 1822 and Brown's own practice at Hammersmith Bridge soon afterwards.

The main chains are now the only original ironwork elements of the bridge that have not been replaced, and on visual inspection the drilling and assembly marks punched during fabrication can be seen.

The dip of the chains is 18 ft which gives a dip to span ratio of 1:12. The towers carrying the chains are bull-faced granite masonry, and have semicircular arches over the roadway. The 1886 date above the crown of the road arch at the north end of the bridge refers to the date that the archway was modified.

Calculations for the structure were made for Brown by James Slight who considered this 'the strongest bridge that Capt. Brown has yet erected'. He calculated the maximum chain stress at about $8\frac{1}{2}$ tons sq. in. and all the bars were proved to 9 tons sq. in. The masonry towers were designed by John Smith, city architect, and built by Robert Mearns. Brown was the contractor for the ironwork and timber deck and the iron chains were supplied by

Roland Paxton

Bridge of Newe 1994

Messrs. Thomson, Forman and Son, Pontypridd, being stamped 'Cable TF&S'.

The bridge is currently being tastefully refurbished by Aberdeen City Council with retention of almost all of the historic main chains. [40, 41]

29. Bridge of Newe, Strathdon

HEW 1470
NJ 3741 1209

The operational 70 ft span cast-iron arches of this bridge carrying the A944 road over the Don, erected in 1858–59 for Sir Charles Forbes Bt, were replaced with curved steel sections by Grampian Regional Council during reconstruction in 1992–93 under the superintendence of Alan Silver, Director of Roads. The original appearance has been

Bridge of Newe – original beams and jack-arches [Grampian Regional Council Roads Dept]

attractively preserved by a careful extension of the 25 ft span masonry side arches and re-use of an original cast-iron arch in each façade as a non load-bearing element, so the bridge, which had to lose two ribs and its transverse brick jack-arches, is not really quite what it seems!

The engineer for the original structure was John Willet. The contractor for the mason work and turnpike road diversion was J. Fife & A. Mitchell, and the ironwork contractor, James Abernethy & Co., Aberdeen.

30. Bridge of Alford

HEW 2513
NJ 5613 1717

This bridge, completed in 1811, carries the A944 road over the Don. It is a smaller version of Potarch Bridge and has the same configuration with three masonry arch-spans of 40 ft, 48 ft and 40 ft. It also formed part of the improvement of the strategic road from Brechin to Elgin.

The bridge was designed by Telford, surveyed by William Minto, and the contractor W. Farquharson. [42]

31. Bridge of Keig

HEW 1379
NJ 6179 1868

This bridge, completed in 1817, was almost certainly influenced by Telford's practice. It now carries the B992 road over the Don on a graceful 101 ft span granite masonry arch which is the third of its type in north-east Scotland. The bridge was built by William Minto.

The site of the bridge was chosen so that its foundations were carried on rock outcrops at each side of the river. Although the specification was prepared by Minto, the configuration of the bridge follows the guidelines laid down by Telford for bridges in the Highlands and the structure shows great simplicity and economy of design. [42, 43]

32. Castle Forbes Footbridge

HEW 2514
NJ 6273 1878

This suspension footbridge over the Don was built in 1863. Its span is 141 ft and the ironwork, consisting of wrought-iron rod-chains passing over fixed saddles on top of a pair of cast-iron columns at each bank, was fabricated locally. The bridge's design was probably influenced by other local suspension bridges.

33. Gartly Bridge

NJ 5213 3232

This bridge carries an access road from the A97 road over the Bogie into the village of Gartly. It is an outstanding example of a genre of cast-iron beam bridges common in north-east Scotland. The bridge was constructed in 1884 with ironwork cast by James Abernethy and Co.

The longitudinal beams are spaced at 7 ft centres and span 40 ft between granite masonry abutments. The fascia beams have parallel flanges and are $2\frac{1}{2}$ ft deep. They have an internal shelf which rises toward the centre of the span and matches the curved profile of the upper flanges of the internal beams to a bearing for the transverse beams supporting the roadway. This profile provides longitudinal drainage for the roadway. The barriers either side of the road are formed of solid cast-iron panels bolted together and to the fascia beams.

34. Inveramsay Bridge

HEW 1501
NJ 7413 2465

An unusual asymmetrical double-span bridge with flat iron deck plates supported on the horizontal cast-iron beams of the short span of $15\frac{1}{4}$ ft and the top of the arch frames of the main span of 50 ft. The bridge is about 15 ft wide carried on frames and beams at $7\frac{1}{2}$ ft centres. These frames, which are cast in two pieces are similar to but smaller than those at the Bridge of Newe (3-29) and may be of similar date. The ribs are $16\frac{1}{2}$ in. deep with top and bottom flanges of 5 in. and 8 in. width, respectively.

35. Bridge of Don, Kintore

HEW 1371
NJ 7926 1621

This triple-span iron bridge, erected in 1882, was taken down from 1985–87 and replaced by a steel bowstring structure of similar appearance. The roadway of the central span was carried by two wrought-iron bowstring girders of 120 ft span with a maximum height of 12 ft. They were connected at mid-span above the road by arched ironwork supporting the Kintore coat of arms.

The roadways of the approach spans were supported on cast-iron beams spanning 20 ft between the granite masonry abutments and circular river piers. At the north approach there were two finely detailed cast-iron balustrades. The ironwork contractors were James Abernethy and Co.

36. Methlick Bridge

HEW 0408
NJ 8571 3757

This bridge, constructed in 1844, now carries the A981 over the Ythan near Methlick. It has three openings, two masonry side arches of 14 ft span and a central cast-iron arch of 39 ft span.

The bridge was designed by John and William Smith and is the earliest cast-iron arch road bridge in Aberdeenshire. The roadway was carried on six arch-frame ribs, cast in halves and bolted together at the crown. The arch spandrels are open with vertical supports between the arch ribs and deck beams. The carriageway above the arch is flanked by diagonally-latticed cast-iron parapets.

Recently the bridge has been strengthened internally by means of steel beams composite with a new reinforced concrete deck.

37. Tangland Bridge

HEW 1494
NJ 8878 3608

This bridge, carrying an unclassified road over the Ythan near Methlick, is the only two-span cast-iron beam bridge in Aberdeenshire. The bridge has a flat deck, originally timber, which was replaced by a reinforced-concrete slab, carried on the lower flanges of L-shaped beams. These beams span 35 ft and are 27 in. deep with top and bottom flanges of 5 in. and 15 in. wide, respectively.

The outer ends of the beams are supported on masonry abutments and at midstream they are carried on the cap plates of a pier formed of two cast-iron columns, 12 in. diameter, cross-braced together. The roadway is 9 ft 4 in. wide. The bridge was constructed in 1864 and the ironwork was cast by James Abernethy and Co.

Recently the bridge deck has been strengthened with the incorporation of intermediate internal steel beams, the iron pier cross-bracing has been renewed, and new parapets have been provided.

38. Ellon Bridge (Old)

HEW 2515
NJ 9570 3033

This three-arch masonry road bridge, with spans of 43 ft, 46 ft and 43 ft over the Ythan, built in 1793, is the last surviving example of the work of Banff mason James Robertson. Its roadway was 16 ft wide between parapets. The construction

details are similar to the fine bridge built by him over the Don at Inverurie in 1791, which was demolished in 1924.

Robertson's bridge at Inverurie is well described by Tawse & Allan, the engineers for its reinforced concrete, doubled in width, replacement of 1924–25, in itself a considerable achievement. Regarding Ellon Bridge, mention is made of its foundation being laid at the beginning of August 1791, that the timber centring used for its arches was from Inverurie Bridge having been floated down the Don and up the Ythan, and that it was funded entirely by the subscriptions of private individuals. [44]

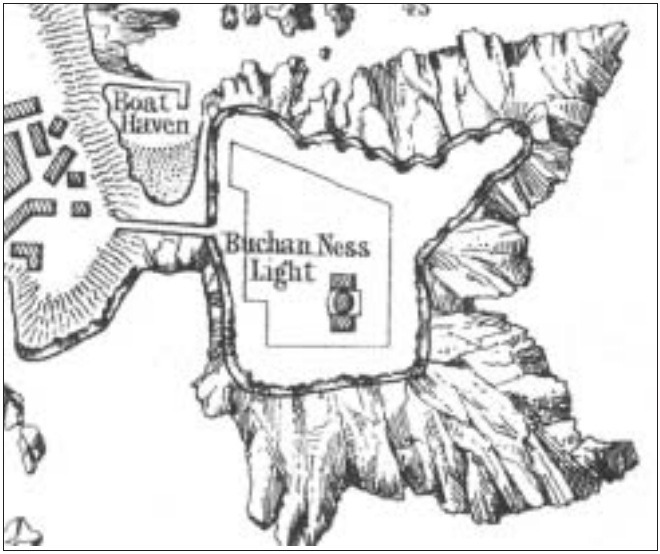
39. Buchan Ness Lighthouse

HEW 2516
NK 1362 4226

The light at this lighthouse on the coast at Boddam, built for the Northern Lighthouse Board, was first exhibited in 1827 at a height of about 130 ft above high-water level.

The circular masonry tower, 118 ft high with 166 steps, and light keepers' accommodation, was designed by Robert Stevenson and built by contractor John Gibb. In 1907, on the instructions of David A. Stevenson, a broad red band was painted on the tower to distinguish it as a day mark.

Stevenson's 'twinkling' light, produced from an array of Argand burners with silvered copper reflectors revolving



Buchan Ness Lighthouse site and approach bridge 1834 [Apdx C to 2nd Report on Tidal Harbours 1847]

more quickly than any previous light, was a success. In 1879 Lord Kelvin considered it one of the three best revolving lights in the world. In order to accommodate a dioptric lens in 1910 a sector of the lantern had to be projected out in the form of shallow bay.

The lighthouse station is situated on a rocky promontory which was at one time an island and in 1834 was connected to Boddam by means of a timber bridge with nine spans of about 20 ft. The bridge was about 17 ft high and 8 ft wide and was erected by John Gibb under Stevenson's direction for about £200. [45]

Peterhead Harbour

HEW 0127

Peterhead Harbour, one of Scotland's largest and most significant in its time, is the agglomeration of three small

Peterhead Harbour plan 1834 [Apdx C to 2nd Report on Tidal Harbours 1847]

harbours, the North and South Harbours and Port Henry, and the much larger Harbour of Refuge to the south. The smaller harbours were constructed in the sheltered water lying between the town of Peterhead and the offshore islands of Greenhill and Inch Keith which were joined to the shore by a causeway. The Harbour of Refuge enclosed Peterhead Bay.

Construction of the small harbours commenced in the 16th century and by the 19th century their individual identities had merged. This process was hastened when the Harbour of Refuge was constructed obviating the need for a separate entrance to the North Harbour, which was then entered through the South Harbour. The piecemeal development of the harbours in the 18th and 19th centuries resulted in improvements from leading engineers Smeaton, Rennie, Telford, the Stevensons, Sir John Coode and Thomas Meik. In 1801 Telford foresaw 'that a very perfect harbour could be formed at Peterhead' and in 1806 Rennie considered Peterhead 'a most important situation for a harbour', opinions borne out by subsequent developments. [46, 47]

40. Harbour of Refuge, Peterhead Bay

HEW 0127/01
NK 1310 4540

This harbour, an area of approximately 300 acres in Peterhead bay, is enclosed by two breakwaters. The north breakwater, constructed 1912–56, is approximately 1500 ft long. It is founded on levelled rock and constructed of 40 ton precast concrete blocks laid in horizontal courses. The south breakwater, constructed from 1892–1912, is approximately 2700 ft long. It is of similar construction but was founded on a shallow tipped stone mound. Convict labour from nearby Peterhead prison was used as direct labour during construction.

Construction ceased during winter months and, to prevent damage by rough seas, unfinished work was secured by 2 in. diameter steel clamps. These were removable and were re-used at the end of each building season. This did not prevent damage to partially constructed work and, in the winter of 1928, a storm displaced a 34 ft long section of wall by 2 in. It was calculated that a force of 2 tons sq. ft was necessary to cause the displacement. The engineer for the project was Sir John Coode. [46]

41. South Harbour

HEW 0127/02
NK 1370 4591

This harbour was developed in the 16th century when a bulwark was built to provide shelter, but the configuration of the present harbour dates from improvements in the 18th and 19th centuries. Using Smeaton's proposals of 1772, existing piers were rebuilt, the south and west piers were constructed and the harbour was deepened under John Gwyn's superintendence. By 1781 more than £6000 had been spent. Smeaton's characteristic construction can still be seen at the back of the south pier.

Proposals by Rennie in 1806 resulted in the further deepening of the harbour and the construction of a return head to the west pier. In 1812 the quay walls along the north, east and west sides of the harbour were completed under Telford's direction, and subsequently a proposal by Robert Stevenson in 1826 for a canal between the North and South Harbours was implemented to a design by his son David. Later 19th century improvements have not altered the general configuration of the early harbours. [31, 46]

42. North Harbour

HEW 0127/03
NK 1379 4620

The creation of this harbour stemmed from a proposal to give access to the South Harbour from the north and from Rennie's proposals to enclose the area sheltered by Greenhill Island. From 1816–22 the first part of this harbour was built to plans proposed by Telford. These consisted of a north breakwater, a graving dock on Greenhill Island, and quays along the southern and western perimeters of the harbour that provided an enclosed area of 11 acres.

Birnie's and Scott's piers were added later and in 1850 the previously mentioned short canal to the South Harbour was constructed. In 1975, when the northern entrance to the sea was closed, the overall depth of water in the harbour was 12 ft at low water ordinary spring tide. [46]

43. Port Henry Harbour

HEW 0127/04
NK 1363 4631

The first breakwater sheltering this harbour was constructed in ca.1600, and the harbour remained almost unchanged until 1878. About this time D. & T. Stevenson

submitted a plan for a new pier, Port Henry Pier, and a new quay along the harbour's south-west quadrant adjoining Birnie's Pier, enclosing an area of about 5 acres.

The Model Pier, dividing the harbour, was constructed from 1873–78, and in ca.1905 Birnie's pier was modified and a new entrance formed which gave the harbour its present configuration. [46]

44. Graving Dock

HEW 0127/05
NK 1367 4611

This dry dock, with conventional stepped sides, was sited off the North Harbour to accommodate Greenland whalers. It was built in granite from ca.1853–55 by James Simpson to a design of Thomas Stevenson and was 148 ft long, about 34 ft wide, and had entrance gates with 13–15$\frac{3}{4}$ ft water depth over the sill. The total cost was £6000. Stevenson wanted to use steam driven pumps to empty the dock but had to accept two 14 in. atmospheric pumps worked by six horses!

The dock was lengthened to about 192 ft in 1953–54; this was probably when the dock's masonry was covered with concrete, and the contractor for the new welded steel 'box' gates was Sir Wm. Arrol & Co. The dock is still in regular use. [46, 48, 49]

45. Rattray Head Lighthouse

HEW 2517
NK 1106 5781

This lighthouse, built from 1892–95 under the direction of David A. and Charles Stevenson for the Northern Lighthouse Board, stands on a rock outcrop several hundred yards offshore. It was one of the Board's most novel lighthouses with a first-class foghorn and engine room below the light tower, the first such to be installed in a rock lighthouse. The lower section of the tower is 55 ft diameter and 46 ft high and built of 20 000 cu. ft of dressed granite blocks, mostly quarried at Rubislaw. It has an entrance door reached by a 32 ft outside ladder. At high water the rock is covered to a depth of about 7 ft, but it is possible to walk ashore at low tide.

On top of this lower tower section a light tower with a base diameter of 21 ft, built of enamelled white brick, rises a further 44 ft and is coped with granite 3 ft thick. Above this

Rattray Head Lighthouse

Northern Lighthouse Board

is the light room, bringing the total height of the lighthouse to 112 ft. The platform on top of the lower section on which the upper tower and siren are placed was known by the light keepers as the 'quarter deck'. [50]

46. Kinnaird Head Lighthouse, Fraserburgh

HEW 1681
NJ 9986 6753

This lighthouse, in a former 16th century tower house overlooking the town and harbour of Fraserburgh, dates from 1787 and was the first to be constructed by the Board of Commissioners for Northern Lighthouses founded in 1786. Its granite ashlar tower, built through the vaulted masonry floors of the old house, is of 16 ft external diameter with walls $2\frac{1}{2}$ ft thick. The lantern is about 58 ft above ground level and 120 ft above high-water level.

The lighthouse was designed by Edinburgh lamp manufacturer Thomas Smith, the Board's newly appointed part-time unpaid engineer, and was the first to use an array of his newly developed oil lamps with parabolic-facetted mirror glass reflectors. The light produced was about

1000 candlepower which, although feeble by modern standards, represented a considerable improvement on the coal fire alternative. This arrangement is known from a drawing made about the time a dioptric (lens) light was installed by Alan Stevenson in 1851.

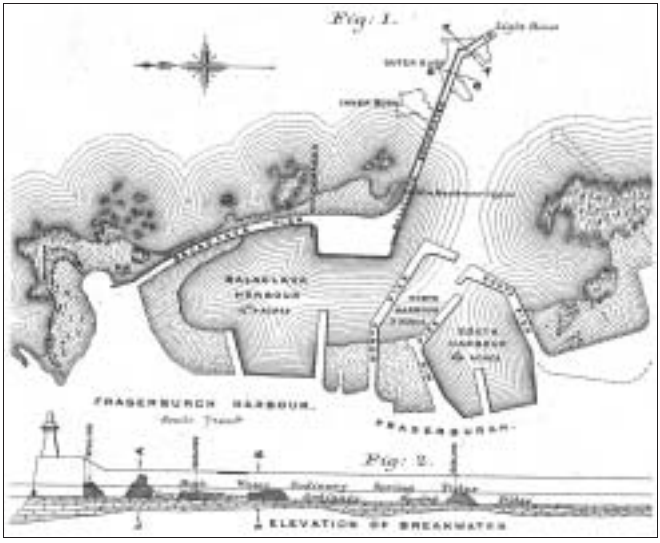
Originally the tower house provided storage accommodation and watch-keeping facilities for the keepers. Additions were made in 1821–30 by Robert Stevenson to provide further accommodation suitable for a 'national establishment'.

The lighthouse now forms part of Scotland's Lighthouse Museum which contains many unique and fascinating relics of the lighthouse branch of civil engineering. [51, 52]

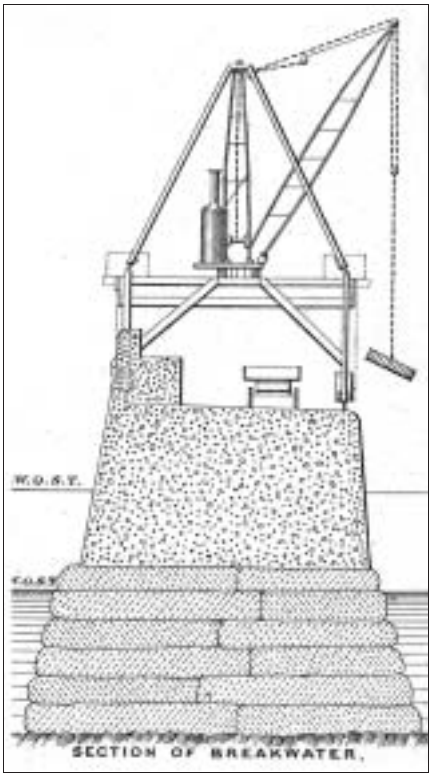
47. Fraserburgh Harbour

HEW 2518
NK 0013 6701

This complex multi-basin harbour is formed from eight piers, two breakwaters and quay walls. The development of the present harbour into one of Scotland's main herring fishing ports commenced in the early years of the 19th century when the North Pier (1807–11) and the South Pier (1818–21) were constructed to the designs of Rennie and Stevenson, respectively. The broad Middle Pier, completed 1830, divided the enclosed space of about 8 acres into the



Fraserburgh Harbour – plan and elevation of breakwater 1887 [54]



Fraserburgh Harbour – Balaclava pier construction [54]

North and South Harbours, arguably then the best such tidal facility in Eastern Scotland with a water depth, depending on the state of the tide, of 11–16 ft inside and along the quays and up to 20 ft at the entrance.

The construction of the Balaclava Pier (1850–57) to the north and west to a design by John Gibb enclosed an area which, with the construction of later piers and quays, became Balaclava Harbour. The Balaclava breakwater, an extension to the pier built from 1875–82, was designed by James Abernethy, who remained consulting engineer to the Harbour Commissioners until his death in 1896.

The Balaclava breakwater works, which cost about £60 000, were carried out by J. H. Bostock, resident engineer, by direct labour. The pier is 860 ft long and has a 72 ft high lighthouse at its end and was of state-of-the-art construction in being founded to low-water level on large bags of concrete filled from a hopper barge after the

method invented by Cay at Aberdeen, above which is a solid mass of concrete 30 ft wide.

Even this massive construction was damaged by north-east gales in 1883, although not fundamentally, being restored at $1\frac{3}{4}$% of the total cost outlay. A spur to the breakwater, built from 1906–08, provided further shelter to vessels using the harbour. Both the breakwater and spur were constructed of mass concrete, the strongest mix being one part of cement to $4\frac{1}{2}$ parts of sand and stone.

The Station Harbour, to the south and east of the South Pier, was the last section to be built. The South breakwater, constructed to provide more sheltered access for vessels entering the older harbours, was completed in 1898. The West and Burnett Piers and the Station Jetty were then built (1908–13) to form the Station Harbour which was deepened to give a depth of 11 ft at low water. [53–56]

48. Macduff Harbour

HEW 2519
NJ 7037 6468

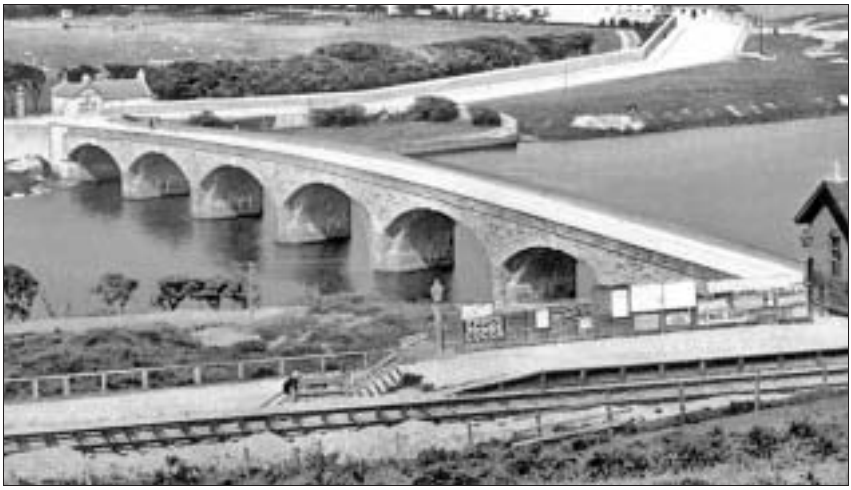
This harbour has four irregularly shaped basins. The first element to be built was the West Pier, completed in 1786, which with the later East Pier formed a harbour of two basins. A breakwater was built in ca.1830 to shelter the entrance which was modified in 1877–78 to form a third basin, for which the engineers were D. & T. Stevenson. The light-tower pier was extended in 1903, and the fourth basin, for which the engineer was A. Henderson, was completed in 1921. [57]

49. Banff Bridge

HEW 1183
NJ 6947 6378

This attractive seven-arch segmental masonry bridge, with spans of 50 ft, carries the road between Macduff and Banff over the Deveron. It was the last of three large bridges in Scotland designed and built under the direction of John Smeaton who, in 1772, estimated its cost at £4548 14s 11d. The lowness of this figure was contributed to by 'excellent rubble stone' available 'from a quarry very near the bridge'. Construction took seven years and it was completed in 1779. A contemporary drawing shows the piers founded on short timber piles.

The roadway of Smeaton's bridge was originally 18 ft wide between parapets but in 1881 the bridge was



Banff Bridge [photograph 1900]

widened on both sides by the removal of the parapet walls and the construction of conjoined segmental arches of larger radius. The decorative occuli used in the masonry of the spandrel walls of Smeaton's bridge and the parapets were re-used. John Willet acted as the engineer for this work. [58–60]

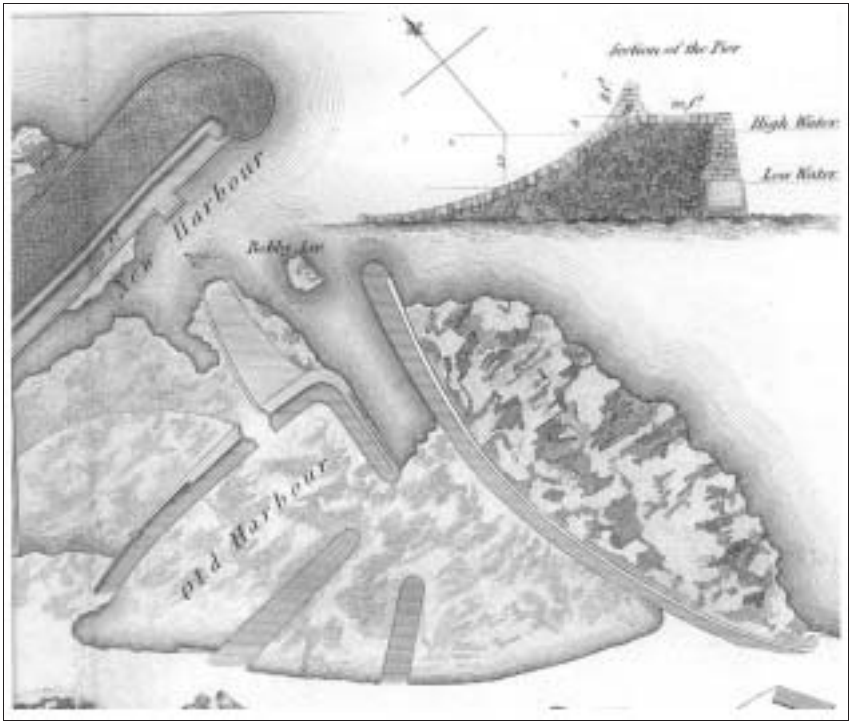
50. Banff Harbour

HEW 2185
NJ 6888 6458

This harbour, because of its position on the western side of the estuary of the Deveron, has always been subject to silting. It has been enlarged twice and, although the layout of the entrance piers has been modified to prevent the egress of sand, the harbour empties at low water. The quays and piers of the harbour include vertically bonded masonry and stone clamps for rubbing strakes.

The first part of the harbour is believed to have begun in ca.1625 when rocks were removed to form a natural haven. It was subsequently enlarged to a plan prepared by Smeaton in 1770. This work, which enclosed the contemporary middle basin, was completed by local labour in 1775.

As silting continued to restrict access to the harbour, Telford prepared a plan to enclose the outer basin and modify the entrance to the harbour. In 1818 a contract for this work was undertaken by local brothers, John, James



Banff Harbour
1821 [61]

and William Smith, who, despite having to rebuild the storm-damaged new quay in 1820 before it was finished, completed their contract in 1828. The resident engineer was John Gibb.

By 1837 the new quay, exposed to the full force of winter gales, had been badly damaged. James Bremner repaired this damage and then ballasted the exterior wall of the quay, which had been built with a shallow slope, with masonry blocks weighing from 15–40 tons These were floated into position. [61, 62]

The use of the harbour is now mainly recreational with some fishing.

51. Eastside Bridge and Toll House, Turriff

HEW 2187
NJ 7141 5034

A triple-span masonry arch bridge over the Deveron with spans of 40 ft, 59 ft and 40 ft built by William Smith in

1826 to a design by William Minto. The bridge exhibits several design details gathered by Minto whilst acting as the contractor on Telford's Potarch, Alford and Keig bridges. The roadway is 18 ft wide between parapets. The tollhouse was designed by William Robertson.

52. Bridge of Alvah

HEW 2520
NJ 6802 6107

This bridge, constructed in 1772 for the Earl of Fife, stands on a spectacular site, south of Banff, where the Deveron forces its way through a rocky gorge 27 ft wide. Although of modest span, the crown of its arch is 55 ft above river level. The bridge, with a large chamber in the west abutment and asymmetric form, has similarities to earlier military bridges. It now carries a local access road.

53. Portsoy Harbour

HEW 2521
NJ 5896 6639

This harbour comprises two small single basins formed by masonry piers. The Old or West Harbour, thought to date from 1692, has a quay wall of vertically set masonry of unknown date and has adjacent warehouses of considerable antiquity. The outer East or New Harbour was built from 1825–28 by the Earl of Seafield to cater for increased herring fishing, and is sited at a more exposed location. Its pier was breached by the sea in 1839 and the harbour became useless.

In 1882–83 the East Harbour was refurbished under the direction of John Willet with a new north pier and the reconstruction and extension of the west pier. Because of the exposure of the east and north pier to heavy seas Willet designed them in solid concrete and they were executed by contractor James Brand of Glasgow. The concrete, consisting of one part cement to six parts of gravel and sand, was deposited in position by means of a 3 ton steam derrick with a 46 ft jib. The cost of the work was £9000.

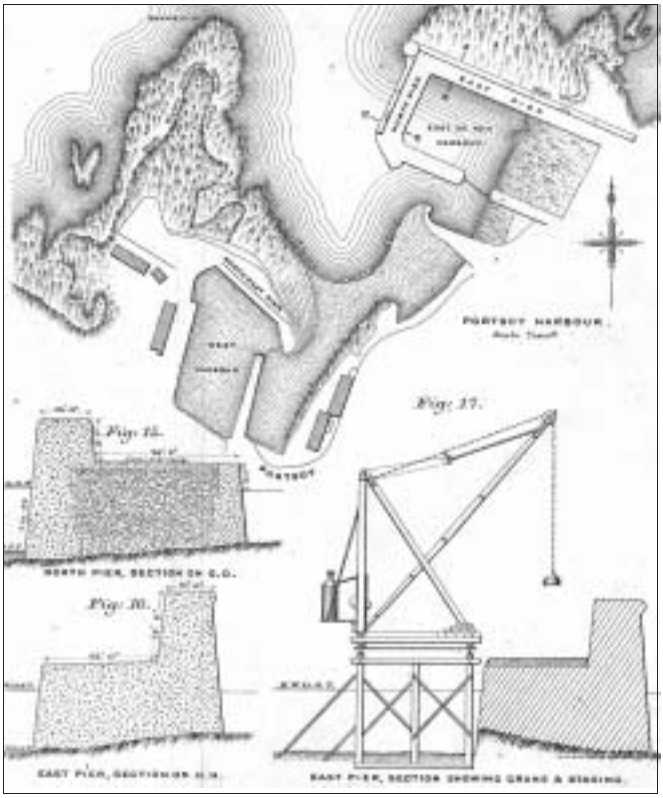
The harbour is now used mainly for recreational activities. [2, 63]

54. Milton of Rothiemay Bridge

HEW 2522
NJ 5478 4807

A substantial five-span bridge arch carrying a minor road over the Deveron, comprising four 52 ft cast-iron frame

Portsoy Harbour enlargement 1882–83 [63]



segmental arch spans and a masonry flood relief span. It was designed by John Willet and built in 1874 towards the end of the cast-iron bridge era with ironwork supplied and erected by James Abernethy & Son, and is attractively embellished with neat iron railings.

In recent years the deck construction has been modified to relieve the arch loading whilst maintaining the external elevation of the bridge. [64]

55. Cullen Harbour

HEW 2186
NJ 5100 6741

This small fishing harbour with two basins is typical of those constructed under the auspices of the Commissioners for Highland Roads and Bridges. The North Pier, built from 1817–19 by William Minto to a design by Telford, comprised coursed masonry walls enclosing rubble infill.

During construction it was found necessary to build a breakwater to prevent the accumulation of sand against its inner face.

In 1835 the enclosed harbour was enlarged by demolishing the breakwater and re-siting it to form the present West Pier. At the same time, to reduce wave action in the harbour during adverse weather conditions, the inner jetty was constructed to form a stilling basin.

In 1886–87 the North Pier was extended to provide protection to the entrance of the harbour. This was constructed of inner and outer mass concrete walls infilled with rubble. The engineer was John Willet and the contractor, R. C. Brebner. The harbour is now used mainly for recreational activities.

The harbour and town are dominated by the three now disused railway masonry viaducts with brick arch-rings completed on the Great North of Scotland Railway coastal line in 1886 under the direction of its engineer P. M. Barnett of Blyth & Cunningham. The nearest viaduct to the harbour is in two parts, one with 13 arches, and the other of eight arches passes over the Cullen Burn at a height of 77 ft. [2, 65]

56. Buckie Harbour

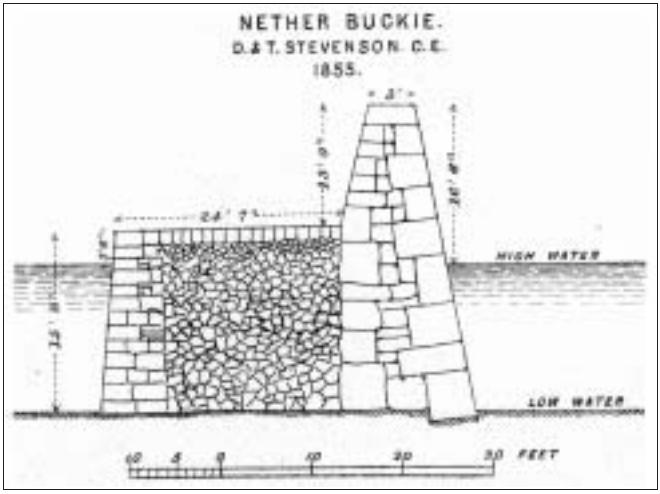
HEW 2523
NJ 4388 6602

The first significant harbour at Buckie, about $\frac{3}{4}$ mile west of the main harbour and enclosing about 4 acres between two piers, was built in ca.1855 to the design of D. & T. Stevenson.

The present harbour at the Salter's Bay site was recommended for a fishing harbour by Telford in 1805 and later the Stevensons. It was eventually built from 1874–80 by direct labour and extended between 1888 and 1921. The 1874–80 work represents an early example of the use of concrete in pier construction. The traditional and new construction can be seen in the cross-sections.

This harbour is also unusual in having a layout with a long pier parallel to the shoreline adjoining five jetties from the shore which divided the harbour into four basins. The entrance is sheltered by an extension to the main pier with a lighthouse at its end.

The consulting engineer to John Gordon of Cluny, who met the £60 000 cost of the 1874–80 work, was W. Dyce Cay who designed the project. The engineer responsible



Buckie Harbour 1855 [Stevenson T. *Design and Construction of Harbours* 1864, pl. IV]

for detailed design was David Cunningham and the resident engineer was James Barron. A model of the harbour gained a silver medal at the International Fisheries Exhibition at Edinburgh in ca.1882.

Buckie Harbour 1880 – cross-section of concrete breakwater [66]

The harbour is now used for fishing, general cargo and recreation. [2, 66]

Further reading

[1] GRAHAM, A. Old harbours and landing places on the east coast of Scotland. *Proc. Soc. Antiq. Scot.*, **108**, 1976–77, 338.

[2] ABERDEENSHIRE COUNCIL. *Directory of North-East Council Harbours 2001*. Aberdeen, 2001.

[3] DAY, T. Kincardineshire's turnpike roads. *Scottish Local History*, **58**, 2003, 35–41.

[4] FRASER, G. M. The Bridge of Dye and its neighbourhood. *The Deeside Field*, 1930, **V**, 38–39.

[5] ABERDEENSHIRE COUNCIL. Op cit. 7, 32–33.

[6] BUCHANAN, A. and JONES, S. K. The Balmoral Bridge of I. K. Brunel. *Industrial Archaeology Review*, **IV**, 3 (Autumn 1980), 214–26.

[7] FRASER, G. M. *The Old Deeside Road*. Aberdeen University Press, Aberdeen, 1921, 212–13.

[8] TAYLOR, W. *The Military Roads of Scotland*. David & Charles, Newton Abbot, 1976, 78 and 158.

[9] NELSON, G. *Highland bridges*. Aberdeen University Press, Aberdeen, 1990, 106–08.

[10] *The Engineer*, 7 Aug 1885, **60** (1), 102–03.

[11] BUCHANAN, A. and JONES, S. K. Op cit. 3, 224.

[12] DAY, T. Gentlemen contractors: the Farquharsons of Monaltrie and the construction of Ballater's bridges, 1775–1812. *Northern Scotland*, **XVI**, 1996, 87–106.

[13] DAY, T. Telford's Aberdeenshire Bridges. *Industrial Archaeology Review*, **XVII**, 2, 1995, 195–201.

[14] FRASER, G. M. *The Old Deeside Road*. Op cit. 212–13.

[15] CURTIS, G. R. Roads and bridges in the Scottish Highlands: the route between Dunkeld and Inverness, 1725–1925. *Proc. S.A.S.*, **110**, 1978–80, 475–96.

[16] *Ninth Report of the Commissioners for Highland Roads and Bridges*, House of Commons, 1821, 38–39.

[17] DAY, T. *Telford's Aberdeenshire Bridges*. Op cit. 201–05.

[18] HUMBER, W. *Water Supply of Cities and Towns*. Crosby Lockwood & Son, London, 1876, 335–50, pl. 33–37.

[19] ABERDEEN WATER WORKS. *Souvenir of the 1920 Extensions of the River Dee Water Works*. Aberdeen Corporation, Aberdeen, 1926, 1–12.

[20] FRASER, G. M. *The Old Deeside Road*. Op cit. 106.

[21] HAY, G. D. and STELL, G. P. *Monuments of Industry*. RCAHMS, Edinburgh, 1986, 209–11.

[22] FRASER, G. M. *The Old Deeside Road*. Op cit. 37–39.

[23] VALLANCE, H. A. *The Great North of Scotland Railway*. David St John Thomas, Nairn, 1989.

[24] JONES, K. G. *The Joint Station*. Great North of Scotland Railway Association, Aberdeen, 1992.

[25] FRASER, G. M. *The Bridge of Dee*. Smith & Sons, Aberdeen, 1913.

[26] MYLNE, R. S. *Master Masons to the Crown of Scotland*. Edinburgh, 1893, 37–38.
[27] THE BRIDGE OF DEE. *The Surveyor, Engineer and Architect for the Year 1842.* Bell & Wood, 1st August 1842. 195–99, pl.
[28] MURRAY, N. Union Bridge widening, Aberdeen, *Min. Proc. Aberdeen Assoc. Civ. Eng.* 1907–08, **VIII**, 69–75.
[29] RUDDOCK, E. C. *Arch Bridges and their Builders*. Cambridge University Press, Cambridge, 1979, 174–75.
[30] TELFORD, T. *Life of*... ed. J. Rickman, Payne & Foss, London, 1838, pl. 35–37.
[31] SKEMPTON, A. W. (ed.) *John Smeaton FRS*. Thomas Telford, London, 1981, 201–04.
[32] *The Reports of Smeaton, Rennie, and Telford upon the Harbour of Aberdeen.* Harbour Trustees, Aberdeen, 1834.
[33] *Aberdeen Harbour. Harbour Improvements.* Harbour Trustees, Aberdeen, 1842. With Abernethy's plan and report for Victoria Dock.
[34] CAY, W. D. The New South Breakwater at Aberdeen. *Min. Proc. ICE*, 1874–75, **39**, 126–59.
[35] TURNER, J. R. *Scotland's North Sea Gateway – Aberdeen Harbour 1136–1986,* Aberdeen University Press, Aberdeen, 1986, 10–63, 154.
[36] MUNRO, R. W. *Scottish Lighthouses*. Thule Press, Stornoway, 1979, 85–86, 89, 91, 94, 121, 145, 208, 241, 244, 251.
[37] LESLIE, J. and PAXTON, R. A. *Bright Lights, The Stevenson Engineers 1752–1971*. The Authors, Edinburgh, 1999, 56.
[38] MILNE, J. *Aberdeen*. Aberdeen Journal Office, 1911, 254–58.
DAY, T. Op cit. 202–05.
[39] GIBB, A. *The Story of Telford*. Maclehose, London, 1935, 254–55.
[40] DAY, T. Samuel Brown in North-East Scotland. *Industrial Archaeology Review*, 1985, **VII**, 154–70.
[41] PAXTON, R. The early development of the long span suspension bridge in Britain 1810–40. *Proc. Intnl Conf. on Historic Bridges, Oct. 1999, Wheeling*. West Virginia University Press, USA, 1999, 179–84.
[42] DAY, T. Op cit. 201–02.
[43] DAY, T. Did Telford rely, in Northern Scotland, on vigilant inspectors or competent contractors? *Construction History*, 1997, **13**, 8–9.
[44] TAWSE, T. and ALLAN, C. E. *The Old and New Bridges over the River Don at Inverurie 1791 and 1924*. D. Wylie, Aberdeen, 1925, 17–48, 149.
[45] MUNRO, R. W. Op cit. 85, 87, 89, 155, 205–07.
[46] BUCHAN, A. R. *The Port of Peterhead from its Establishment to the Beginning of the Twentieth Century*. P. Scrogie, Peterhead, 9–77.
[47] *Second Report of the Commission for Tidal Harbours*. 1847, Appendix C, 310–24.
[48] BUCHAN, A. R. Op cit. 237–39 (photograph).
[49] RCAHMS. *The Sir William Arrol Collection: A Guide to the Scottish Material held in the National Monument Record of Scotland*. RCAHMS, Edinburgh, 1998, 16 (six photographs).

[50] LESLIE, J. and PAXTON, R. A. Op cit. 121, 126, 167.
[51] MUNRO, R. W. Op cit. 54–57 and 87.
[52] LESLIE, J. and PAXTON, R. A. Op cit. 14, 20, 22, 151.
[53] CRANNA, J. *Fraserburgh, Past and Present*. Rosemont Press, Aberdeen, 1914, 316–44.
[54] WILLET, J. The fishing-boat harbours of Fraserburgh, Sandhaven, and Portsoy. *Min. Proc. Instn Civ Engrs*, **87**, 1886–87, pt. i, 123–27, 213–40.
[55] GRAHAM, A. Op cit. 348–50.
[56] *Second Report of the Commission on Tidal Harbours*. Op cit. 325–29.
[57] HENRY, R. *Macduff and its Harbour, 1783–1983*, Porterfield, Macduff, 1983.
[58] SMEATON, J. *Reports of the late John Smeaton FRS, 1812*, **III**, 349–54.
[59] RUDDOCK, T. Op cit. 81–84 and 87–88.
[60] SKEMPTON, A. W. (ed). Op cit. 156, 163–65.
[61] *Ninth Report*. Op cit. 48.
[62] *Second Report of the Commission on Tidal Harbours*. Op cit. 332–34 (Bremner's ingenious practice described).
[63] WILLET, J. Op cit. 130–31, pl. 6, figs 14–17.
[64] DAY, T. The 19th century iron bridges of North-East Scotland. *Journal of the Society for Industrial Archaeology*, Michigan Technical University, 1998, **24**, no. 2, 30–31.
[65] *Ninth Report*. Op cit. 50.
[66] BARRON, J. Buckie Harbour. *Min. Proc. ICE*, 1881–82, **70**, 350–60, pl.