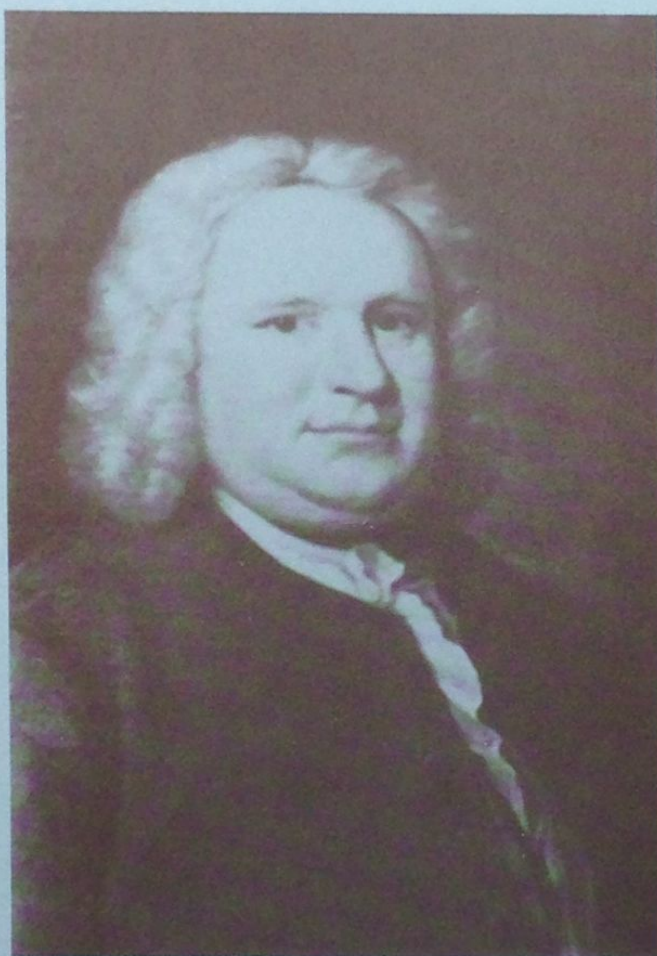


The Engineering Works of John Grundy (1719-1783)

by A. W. Skempton



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John Grundy died 200 years ago, on 15 June 1783, at about the time of his 64th birthday. He belonged to an early generation of English civil engineers which included John Smeaton, F.R.S. and 'that great Genius Mr. Brindley'. In his own day Grundy gained a well-deserved reputation, and he contributed a good deal to the benefit of our country by improvements in the rivers and fenlands of Lincolnshire and Humberside. But by the mid-19th century he was almost forgotten, and remained so until 1938 when Dr Esther Wright drew attention to him and other little-known engineers of the period.¹ More recently, a considerable amount of research has been devoted to Grundy and to his father;² several important documents have come to light, and our present knowledge is well expressed in the booklet by Neil Wright.³

Here, then, it is necessary to touch only in the briefest way on Grundy's life and family history. My purpose is to examine his engineering works. These are listed in the Table at the end of the paper, together with a selection from the large number of his reports including some on schemes that were not carried into execution.

JOHN GRUNDY

He was baptised on 1 July 1719 at Congerstone in Leicestershire, the son of John Grundy and Elizabeth (née Dalton) his wife. John Grundy senior (c. 1696-1748) 'of Congerstone, Land Surveyor and Teacher of the Mathematics', as he described himself in the 1730s, had a wide-spread practice as a surveyor, but became increasingly concerned with civil engineering matters involving fen drainage and rivers. In 1735-6 he was consulted on the drainage of Deeping Fen, and in April 1736 he and Humphrey Smith were jointly appointed 'Surveyors and Agents' (i.e. engineers) to the Adventurers, Owners and Proprietors of this large tract of fenland in Lincolnshire. At about that time he and his family moved to Spalding. In 1742 he was appointed sole Agent, a post he held, with freedom to undertake some outside work, until a year before his death.

There can be no doubt that 'our' John Grundy was trained as a land surveyor and civil engineer by his father, under whom he worked as assistant (with a few jobs of his own) in the early 1740s. His independent engineering career effectively begins in 1745 with a series of works at Grimsby for the Duke of Ancaster. In 1748 he became engineer to Deeping Fen. Among numerous reports written in the 1750s two at least led to major works. From 1760 the scale of his operations expanded notably, and by 1771 when Yeoman, Smeaton, Grundy, and some others founded the Society of Civil Engineers⁴ he occupied a senior position near the top of his profession. After 1776, however, we know of only two reports and no works by him.

Before the canal 'boom' of the late 1760s few civil engineers in England could earn more than a modest income. To

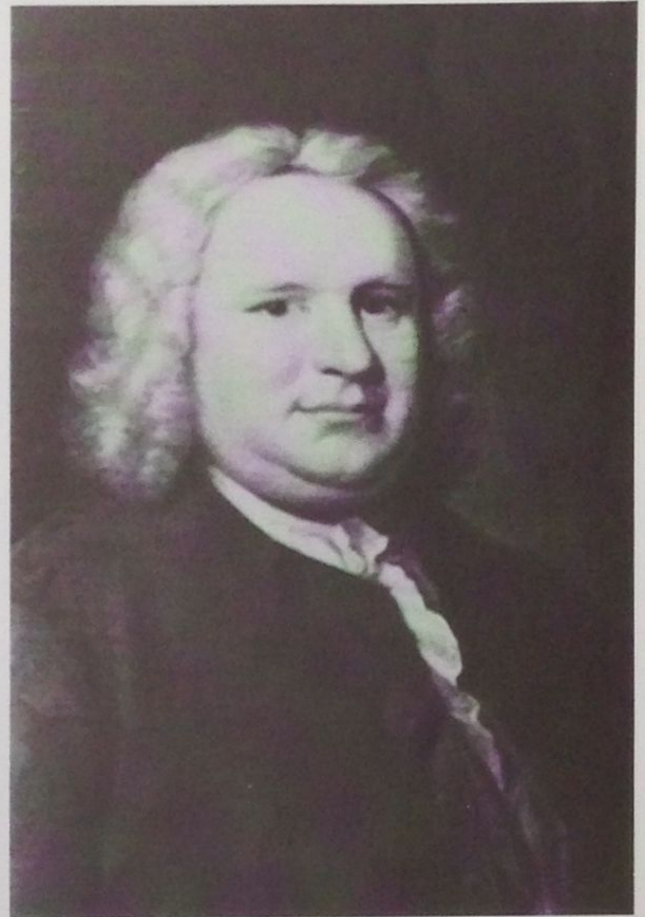


Fig. 1 John Grundy, 1719-1783

supplement his earnings Grundy began trading in timber from the Baltic and goods from Holland, and later owned a sloop and a sailing barge. Also, from 1762, he took on a part-time job as Collector of the Land Tax for the Spalding District.

In January 1743, he married Lydia Knipe at Spalding. Two of their children, Mary and Lydia, survived infancy. Mary married William Thompson of Spalding, and their descendants represent the family at the present time. Grundy's wife died in 1764. Two years later he married Mrs Ann Maud, widow of the Revd John Maud of St Neots, but there were no children of this marriage. Grundy was buried at Spalding, the town where he and his family had lived for many years in a house facing the River Welland. His portrait⁵ was painted probably about 1770.

SOURCES

Grundy kept manuscript copies, and any printed copies, of his reports and plans, the originals having been sent to the clients. A complete short-title list is given in his 'Catalogue of Books and Papers' compiled in 1767 with additions to 1776, which also includes a list of his father's papers.⁶ This is referred to here as *Catalogue*. At some later time he copied selected reports and drawings (on a reduced scale) into a series of probably ten quarto 'report books'. These and various other engineering documents were purchased by Sir Joseph Banks in 1793 from Grundy's son-in-law William Thompson, and eventually sold at Sothebys in 1918.⁷ Vol. 2 of this set is now in the Institution of Civil Engineers⁸ referred to as *Report Book*. The present whereabouts of the others is not known. A few original manuscript reports and plans exist in libraries and county archives, and all of his

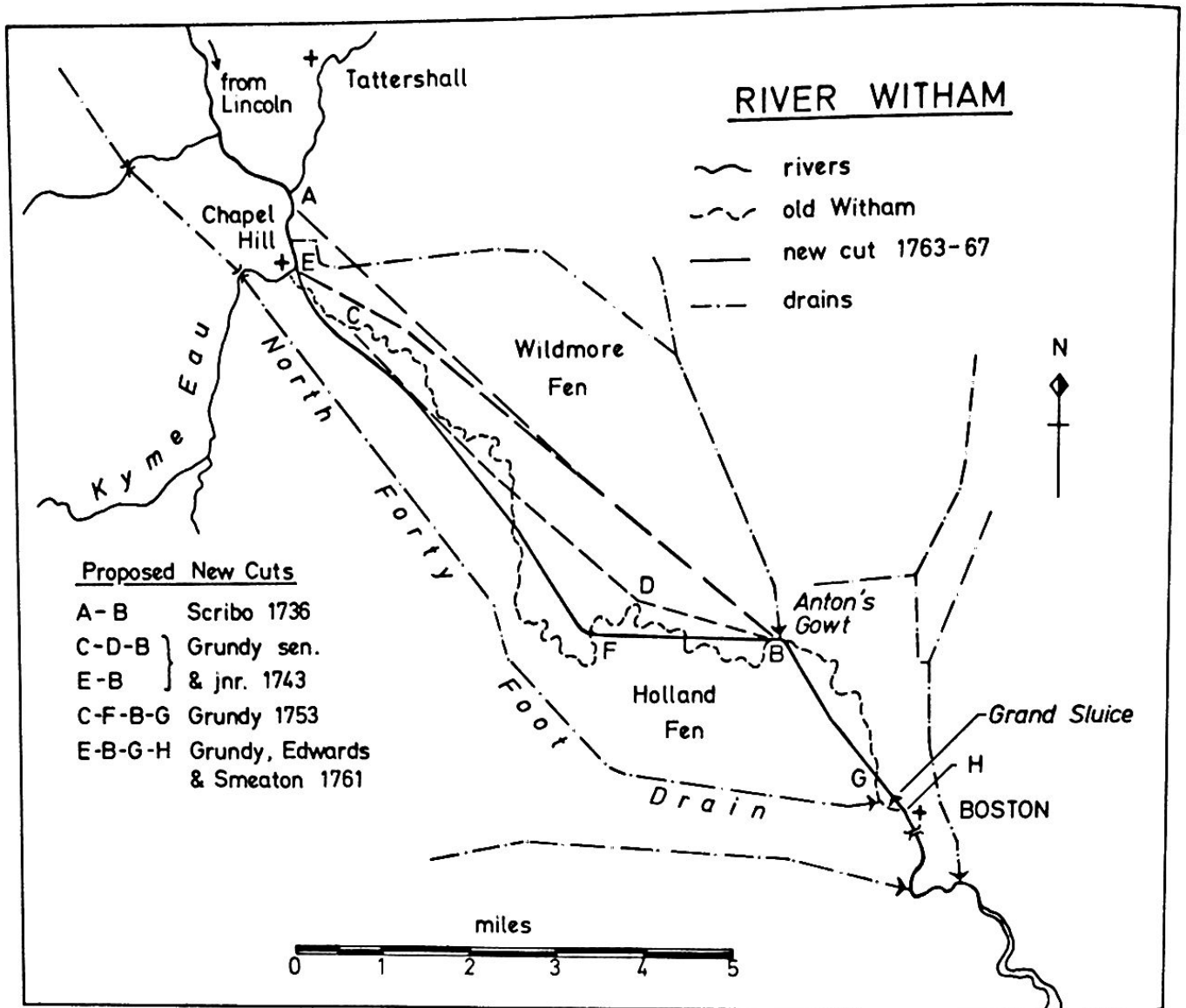


Fig. 2 The River Witham

printed reports and plans have been found.

The other type of source material consists principally of Minute Books of the various authorities for whom Grundy acted as engineer. Most of these books are now in either the Lincolnshire or Humberside county record offices.

THE NOVICE ENGINEER, 1739-1744

PINCHBECK SLUICE

An outfall sluice was built between October 1739 and April 1740 on the Blue Gowt Drain for the Pinchbeck area, near Spalding. It had a 12ft waterway with pointing doors 7½ft high. The contract document is signed by John Grundy (senior) and he drew up the estimate, but the drawing accompanying the contract is by Grundy junior.⁹ We can assume that he acted as his father's assistant during construction.

SEA WALL AT PALLING AND WAXHAM

Between August 1742 and January 1743 Grundy executed repairs to the breached sea wall embankment on this part of the Norfolk coast, in accordance with plans prepared by his father. His report gives details of the work with sketches, including groynes or 'jetties', and sheet piling.¹⁰

RIVER WITHAM, 1743-44

The Grundys *père et fils* produced a survey of the Witham from Lincoln to the estuary below Boston, with numerous accurate levels. This was issued as an engraved plan dated 1743¹¹ and accompanied a 48-page printed report published in 1744;¹² both signed 'John Grundy Sen. and Jun. of Spalding, Engineers'. The report is chiefly from the pen of Grundy senior; the survey is perhaps mainly by the son.

The object of their investigations was to devise a scheme for improving navigation on the Witham and drainage of the adjacent fenland. They identified the three main causes of trouble as the bad state of the river embankments, the 'prodigious meandering Course of the River' between Anton's Gowt and Chapel Hill (see Fig. 2), and the diversion of the upland waters north of Kyme Eau through a tunnel into the North Forty Foot Drain (opened c. 1720). The authors then gave eighteen 'theorems' or guiding principles and finally put forward their proposals, with estimates. First: the existing river channel between Anton's Gowt and Chapel Hill could be scoured and widened, but a preferable scheme was greatly to shorten the course by a new cut about 7 miles long as shown at CDB in Fig. 2 or by a new cut of similar length entirely north of the river in Wildmore Fen as shown at EB; this being a modification of a proposal already made

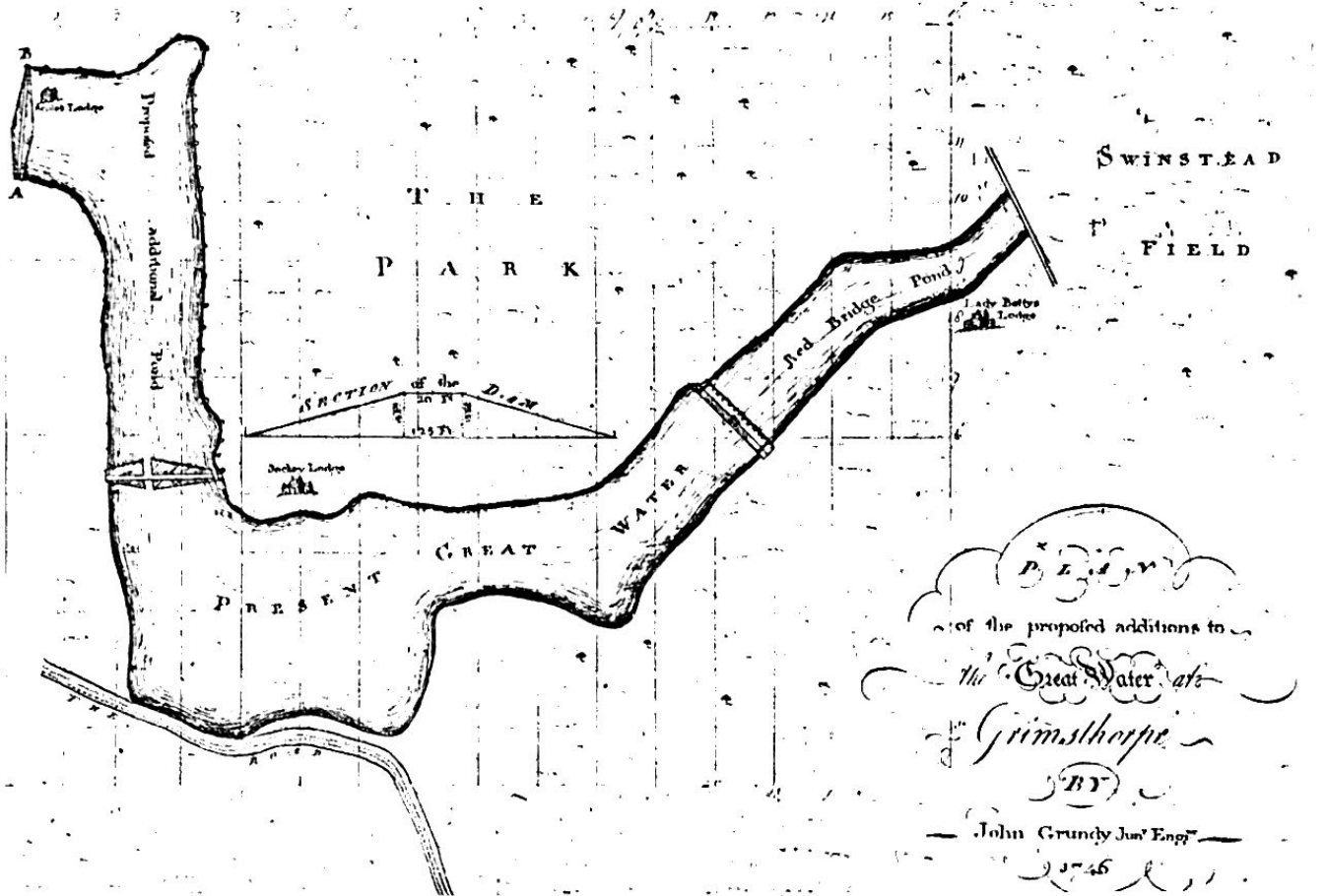


Fig. 3 Grimsthorpe Great Water plan, 1746

by James Scribo.¹³ The cut was to be properly embanked, the banks set back at least 30ft from the water's edge, and the cut to have a top width of 70ft with an average depth of 7ft. Second, to scour, widen, and bank the river from Chapel Hill to Lincoln. Third: to build two stanches of flash locks in this length to maintain an adequate depth of water in dry seasons. Fourth: to extend the drain west of the river (and north of Kyme Eau) almost up to Lincoln and turn its water into Kyme Eau, stopping the North Forty Foot Drain just south of this stream. Fifth: all drains, banks, and sluices to be reinstated.

The scheme proved too expensive for the landowners to contemplate at that time, but it served as a basis for future plans and indeed most of its features, with some modifications, were eventually put into effect as we shall see.

EARLY WORKS, 1745-1759

GRIMSTHORPE DAM

Between 1745 and 1752 Grundy carried out several commissions for the 3rd Duke of Ancaster on his estate at Grimsthorpe in Lincolnshire. In approximate chronological order, these include an earth dam to impound a large ornamental lake 36 acres in extent called the Great Water (see Fig. 3), regrading a slope in the park to allow a better view of the lake, a reservoir for topping up the lake, a piped water supply to the house (Grimsthorpe Castle), and new Stew Ponds for fish.

Completed c. 1748 the Great Water dam is the earliest known example of an earth dam with a clay core-wall, a type of structure used for some late 18th-century canal reservoirs and widely adopted in the 19th century for water supply reservoirs.

The dam has a maximum height of 18ft, a length of 420ft and a crest width varying from 15ft at the ends to 25ft in the middle. The downstream slope, modified by more than 200 years of soil creep, was probably formed originally at 2 : 1 and from what can be seen of the upstream face it slopes at approximately $3\frac{1}{2} : 1$. The original outlet sluice, near the middle of the dam, has been replaced by a spillway on the right bank.

In the *Report Book* there are two relevant plans, both by 'John Grundy Junr. Engr.' and both dated 1746. The first of these¹⁴ shows two small lakes or 'ponds' above and one below Red Bridge and, further downstream, the Mill Dam Pond of 17 acres, the latter being impounded by an earth bank 10ft high. This is clearly the layout before Grundy began his alterations. Three sketch sections show what he proposed to do, namely (i) to raise the little dam at Red Bridge to enlarge and combine the two upper ponds into one, shown as 'Red Bridge Pond' in Fig. 3, (ii) to raise and strengthen the Mill Pond dam, and (iii) to build a new dam 12ft high near Jockey Lodge impounding a pond of about 4 acres. A section of this dam shows a clay core. Moreover, a report¹⁵ by Grundy, dated 1741 in the *Catalogue*, mentions 'clay for the wall within the bank' when referring to a small dam for a proposed 3-acre pond at Osbaston in Leicestershire; so the idea of using a clay core was not new (so far as Grundy is concerned) even in 1746.

Evidently the raising of Red Bridge dam went ahead, more or less as planned, but instead of proposals (ii) and (iii) the Mill Pond dam was removed and a new (i.e. the present) dam built near Jockey Lodge, much larger than in the first proposal and some 50yds further downstream.

As the Ancaster account books are missing from 1741 to May 1747 the cost and exact date of construction of the

Great Water dam are not known. Mr Binnie, who first realised the significance of this pioneer structure¹⁶, suggests 1748. This is an entirely acceptable date as the dam could not possibly have been finished before 1747 and certainly it must be earlier than mid-1749 since Grundy's final payment (in a total of £346) for 'Pond Works and Levelling' dates to 15 June 1749.¹⁷

The dam undoubtedly had, and still has, a clay-core wall. Not only is one shown in what may be considered as the preliminary design (i.e. the first proposal of 1746), but it is specifically mentioned in a report of 1758 when investigations were in progress to trace the course of leakage from the Great Water.¹⁸ In fact the dam was sound in all its parts including the 'Clay Wall'; leakage occurred through a swallow hole in the lake bottom.

The second plan¹⁹ (Fig. 3) shows a 'Proposed additional Pond' to be formed by a dam at Scoles Lodge on the line A-B. An undated report²⁰ gives a section and specifications for this dam. Leading dimensions and some other details are shown in Fig. 4. Except for a greater height it probably represents closely the Great Water dam as built. The clay is specified to be 'well Rammed and Watered', and the estimated cost comes to around £800.

There were several swallow holes in the valley downstream of the Great Water (indeed, one near the site of Scoles Lodge is clearly visible today), and in his report Grundy suggests that after trying to stop (i.e. to plug) them, a trial bank should be built to impound a temporary lake as an experiment to check on watertightness, the bank then to be incorporated in the dam. The trial bank was constructed, a short distance upstream of the line A-B and of the existing swallow hole. Traces of the bank can still be seen and it is marked on a plan of 1767, but the experiment must have proved to be a disappointment.

However, in 1766 Grundy revived the notion of a dam at Scoles Lodge, this time with a proposal to construct an impervious clay blanket over the entire valley bottom.²¹ He also gave a revised design for the dam, shown in sketch profile added to Fig. 3 and in more detail in the plan of 1767 previously mentioned,²² again with a central clay core but now with a maximum height of 30ft, somewhat flatter slopes, and the water face protected by stone pitching. The upstream clay blanket, which he specified with great care, is technically sound and of historical interest. But neither the dam or the blanket was constructed; the cost may have been too high or perhaps the Duke had lost interest in the scheme.

The idea of a dam at Scoles Lodge might have originated in 1746 as the date on Fig. 3 suggests, but the design in Fig. 4 is probably later. The report is listed in the *Catalogue* between Grimsthorpe items dated 1747 and 1751. The trial bank could have been built in the first batch of work, i.e. before the mid-1749 payment (though obviously subsequent to completion of the Great Water), or it may be the 'work at the New Pond' referred to in the Accounts between November 1750 and February 1751, under the direction of Grundy and William Hodgson. It cannot be later than the payment (totalling £142) to Grundy in 1752 for the second batch of work at Grimsthorpe which includes the water supply scheme, the new Stew Ponds, and 'Stopping Swallow Pits'. A date of c. 1749 for the design (Fig. 4) is therefore unlikely to be wrong by more than a year or two.

GRIMSTHORPE WATER SUPPLY

The scheme involved pumping from a deep well into a cistern and taking the water in lead pipes from the cistern down to Red Bridge and up to Grimsthorpe Castle, a distance of

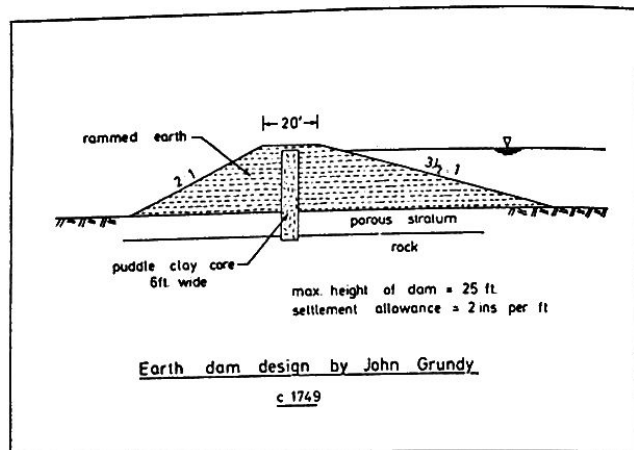


Fig. 4 Earth dam design by John Grundy, c. 1749

one mile with a difference in head of 10ft, the water to be raised from the well by three pumps in series operated by a triple crank driven from a 'horse engine' or gin.²³ An elegant circular engine house was erected next to a square building for the cistern beside the well. The accounts record payments in June 1751 to Joseph Smith, engineer, for 'Pumps and Engine' and from June to September 1751 to labourers for digging trenches and laying pipes. Grundy supervised the work, which must have cost well over £300.

DEEPING FEN, 1748-1764

Grundy was appointed 'Agent' to the Adventurers of Deeping Fen on 18 May 1748 at a salary of £50 p.a. Featherstone continued as assistant at £40 p.a. Grundy held this post until 1764, when Thomas Hogard succeeded him, but he then became consulting engineer to the Adventurers with a retaining fee equal to his previous salary.

As Agent he had charge of all engineering and maintenance work on the banks, drains, sluices, and the River Welland, and also kept the accounts. His account book from 1753 still exists.²⁴ This and the Adventurers' minute books²⁵ give a good idea of the work involved, though no technical details are available.

A continuing charge was the raising, strengthening, and maintenance of the Welland banks for which the Adventurers had responsibility: Deeping Bank, 13 miles in length, and the 5 mile Country Bank, on the west and east sides of the river respectively, upstream of Spalding. A particularly demanding job must have been the almost complete rebuilding of the Six Doors Sluice on the Welland. Originally constructed c. 1731 by John Perry as a scouring sluice, Grundy extended the floor, raised the existing doors and provided another set of doors pointing seaward to stem the tide. A little later, in 1754, he rebuilt the navigation lock. Next year three new wind drainage engines were erected on Hills Drain and in 1758 a new sluice on the Forty Feet Drain, while in 1759-61 he deepened the Welland by more than 2ft, between the Six Doors and Spalding bridge, using a 'hedgehog': a spiked roller dragged along the river bed to loosen the silt so that it could more easily be sluiced away to sea. These are some of the works accounting for an annual expenditure averaging about £1400 during the years 1748-64.

STALLINGBOROUGH SLUICE, 1751

In November 1749 Grundy prepared preliminary estimates for a new outfall sluice in the south bank of the Humber near Stallingborough, about half way between Grimsby and Immingham, the purpose being to improve the drainage of low grounds belonging to Mr Bouchrett.²⁶ By 1751 the

decision had been made to go ahead, and early in July of that year Grundy spent several days taking levels of the land and drains in relation to the floor of the existing old sluice. On the assumptions (i) that there should desirably be a fall of 1ft per mile between water level in the drains and the floor of an outfall sluice, and (ii) that water in the drains should be at least 1½ft below ground level, he concluded that the floor of the new sluice must be laid 4ft lower than the old one. The drains would have to be deepened correspondingly.

This having been agreed, contracts were let, and on 19 August Grundy visited the site to find the carpenters already making the dovetail piles and preparing timbers for the floor. A fortnight later work was well under way, with William Hodgson as foreman or resident engineer. No doubt the job was completed by the end of that year.

The *Report Book* includes a sketch elevation and a foundation plan. The sluice is in the usual 18th-century style with counterforted brick walls, a pair of self-acting pointing 'sea doors' 8½ft high and a draw door on the land side to maintain water level in the drains during dry seasons and also to be used occasionally for scouring the outfall. The waterway has a clear width of 6½ft. The planked floor and the walls rest on cross beams or 'ground sills' 10 x 8 inches in section, with square piles 8ft long under the walls. Three rows of dovetailed sheet piling between 7 and 10ft run right across the structure, protecting the foundations against the effects of underseepage. The floor of the sluice was 9ft above low water in the Humber and about 6ft below ground level in the drainage area.

RIVER WITHAM, 1753

Landowners interested in the drainage of land adjacent to the Witham held meetings in 1752 and 1753 to consider further the proposals put forward by Grundy senior and junior in 1744, and a later scheme by Daniel Coppin involving the North Forty Foot Drain. Details of the latter need not concern us, as a preference emerged for the plan of shortening the river course along the line CDB (in Fig. 2) and Grundy was asked to reexamine this scheme.

In fact his report, written in October-November 1753, with a sketch plan,²⁷ came up with an improved line CFB striking a balance between land in Wildmore and Holland Fens, an extension of this line from B to G (near Boston), and a proposal for a large outfall sluice, with an adjacent navigation lock, just upstream of Anton's Gowt at B. The cuts, and the river from C to Chapel Hill, were to have a bottom width of 56ft and depth of 6 to 8ft, with banks kept 40ft from the water's edge, and the 'Grand Sluice' had to provide a 50ft waterway. The rest of his report followed closely the scheme for river and fens above Chapel Hill as proposed in 1744, including stopping off the North Forty Foot south of Kyme Eau and taking up the tunnel there. The total cost of the works was estimated by Grundy at about £23,000.

A meeting held at Lincoln on 15-17 November 1753 approved his report, with one exception: the sluice should be placed near point G rather than B.

The inclusion of an outfall sluice on a tidal river is an interesting point, as such a structure had specifically been ruled out in the 1744 plan in accordance with the opinion that tidal flow must be restricted as little as possible, even at the expense of higher river banks having to be built miles further upstream. By 1750 or thereabouts Grundy had departed from this view, strongly held by his father, and may well have been influenced by the successful reconstruction of Denver Sluice on the Great Ouse completed in that year.

THE YEARS 1760-1771

During this period Grundy directed construction on four major schemes, and work was carried out on two others for the plans of which he was largely responsible.

RIVER WITHAM, 1761

It will be recalled that in 1753 the position of the proposed Grand Sluice was still undecided. Grundy suggested in 1757 that it might be built at Boston bridge. Langley Edwards, asked to comment on this idea, reported in favour of placing the sluice on a short cut (GH in Fig. 2) just upstream of Boston.²⁸ In other respects he agreed with Grundy's 1753 plan, though recommending that the cut or channel for the Witham should be 10ft wider.

Encouraged by what seemed to be the emergence of an acceptable scheme, the landowners asked Smeaton to join Grundy and Edwards in a reexamination of the whole question. The three engineers took 'a fresh View of the River and Fens' in October 1761 and reported on 23 November.²⁹ An engraved plan by Grundy appeared early in 1762.³⁰

Their report, one of the classics of 18th-century engineering literature, states briefly and logically the principles involved, and gives detailed recommendations with a summary of the estimated costs. In essence (i) the best line for the new channel is EBGH (Fig. 2), (ii) the channel should have a regular declivity along its length (about 5 inches per mile), a bottom width of 50ft, and banks 40ft back from the edge of the cut, (iii) the sea sluice to be on the cut GH, with pointing doors giving a 50ft waterway, the adjacent lock to have three pairs of gates, (iv) the depth of the new channel and elevation at the top of the sluice draw doors to be such that water level is not less than 2ft below ground, and (v) there should be three pound locks, not stanches, on the river between Chapel Hill and Lincoln. Proposals for scouring and widening the river and improving drainage of the fens followed much the same pattern as in the 1744 report. The estimated cost was rather more than £54,000.

The choice of the line EB was based strictly on engineering principles. For more practical reasons the line CFB remained preferable, and at a meeting on 13 January 1762 this was agreed,³¹ with the modification that the cut should be extended almost up to point E.

All three engineers gave evidence on the Bill in Parliament and the Act was obtained in June 1762. Work began in April 1763 with Langley Edwards as engineer in charge.³² Grundy's involvement with the scheme now came to an end. A measure of his contribution is that, when the Witham Commissioners paid the engineers' fees, he received £254; Edwards charged £90, and Smeaton £73.

LOUTH NAVIGATION

In October 1756 Grundy was asked to survey and produce a scheme for a navigation or canal from Louth to the north-east Lincoln coast. He selected Tetney Haven as the best point of entry, and submitted a detailed report, with a plan, for which he was paid £30 16s. in April 1757. A copy of his report is in the Louth Navigation minute book.³³

Nothing much happened during the next three years, but from January 1760 the minute book gives a rather full account of events, starting with the decision to open a subscription list. In March the Town Clerk of Louth wrote to Smeaton, saying 'An actual Survey hath already been taken by Mr. Grundy and he is of opinion the making this intended Navigation is very practical. But yet the Gentlemen are not willing to proceed till they have Grundy's opinion confirmed by you.' A fortnight later Grundy's 'Survey and

Plan' were delivered to Smeaton in London. The two engineers met on site in August 1760, some letters subsequently passed between them and, with minor revisions and corrections, their reports were printed in August 1761³⁴ along with the engraved plan (Fig. 5).³⁵ As would be expected, Smeaton made several useful and perceptive comments, but in all essentials he agreed with his colleague's proposals.

It is interesting to note that in 1759-60 Grundy's fee was one guinea a day plus 7s. 6d. for expenses. This contrasts with the fee of 5s. or 6s. per day charged in 1757 by the well-known land surveyor William Fairbank of Sheffield.³⁶

After further delay the Act was obtained in March 1763. Probably at about that time Grundy prepared 'Plans of Sluices, Locks, Bridges and Tunnels for Louth Navigation', as listed in the *Catalogue*, and in February 1765 he was appointed engineer at a salary of £300 *p.a.* out of which he had to pay the resident engineer. The latter, James Hogard, took up his duties in the following month and work began.

From March 1765 to June 1766 the principal jobs were to execute a cut 40ft wide, 9ft deep and $\frac{3}{4}$ mile long from the old sea bank towards low-water mark, and to build the outfall sluice and adjacent navigation lock. Similar to, but smaller than, the combined structure of this type on the Market Weighton scheme (Figs. 13 & 14), the sluice had a 16ft waterway in two arches with pointing doors and draw doors, and the lock, 100ft in overall length, had four pairs of gates: two pairs to land and two to sea. The sea doors of the lock were 15ft 9ins high.³⁷

By the summer of 1767 the canal had been cut for the greater part of its 7 miles from the sea lock through flat fenland, the depth being such that water level was nowhere

less than 2ft below ground surface. This ensured that the canal could act as a main drain: one of Grundy's guiding principles.

Hogard now took over as engineer at a salary of £140 *p.a.* It was under his direction, then, that the seven locks from the edge of the fenland up to Louth were built, in a length of four miles, and also that the decision was made in 1769 to locate the canal basin further out of the town than originally planned, in order to save the cost of two further locks.

Remains of six of the seven locks still survive, from which it can be seen that they have plank floors on a timber grillage. The walls are in brickwork, with a stone coping, rising to a height of 13 to 15ft above the floor. The leading dimensions are: 86ft between gates, 15ft 3ins clear width, and 5ft 4ins of water on the sills, to accommodate Yorkshire Keels. The falls range from 5 to 8ft, totalling 45ft in the seven locks. Above the top lock (now demolished) the canal opens out into a basin 66ft wide and 700ft long.

The first lock up from the fen has straight walls. But the walls of the six other locks were built in four segmental arches with vertical timber posts at the springings held by land ties (Fig. 6). The locks appear to be exactly as described by Padley in 1828, apart from later repairs and their now ruinous condition, and he mentioned that one of them is 'getting old and weak'. Moreover the minute book reveals no programme of rebuilding prior to 1828, so it seems certain that this very unusual form of construction was adopted in the original works. Clearly the intention was to increase the resistance of the walls to lateral earth pressure, presumably as an alternative to counterforts.

The navigation was opened throughout in May 1770 at

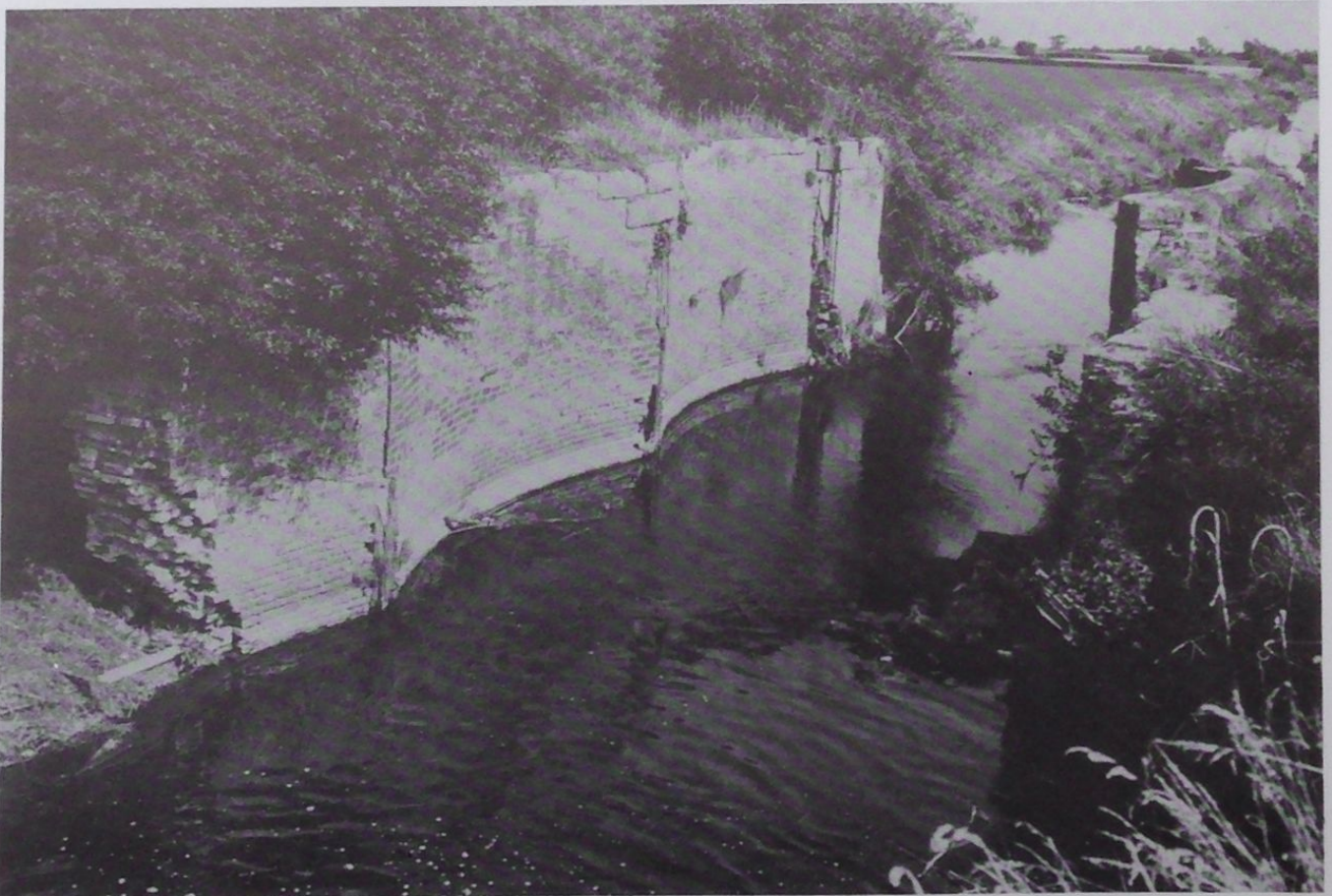


Fig. 6 Remains of Salter Fen pound lock on the Louth Navigation

a total cost of £27,500. It had two fixed bridges and four timber swing bridges. The River Lud, running off the Wolds, provided an ample water supply.

HOLDERNESS DRAINAGE

Up to the mid-18th century the 11,200 acres of low ground in Holderness shown in Fig. 7 drained into the River Hull at a point marked 'Old outfall' about four miles north of the Humber. This outfall also received upland waters from Lambwath Stream, Kelwell Water and two streams near Leven. Further south, Ganstead Stream flowed into the river at Stoneferry Sluice. The first important works to achieve a much-needed improvement were carried out under an Act of 1764.

Grundy gave evidence on the Bill, and the Act authorised the greater part of a scheme proposed by him in a printed report written in December 1763,³⁸ supported by Smeaton in an independent report dated 12 February 1764,³⁹ and illustrated in an engraved plan by the land surveyor Charles Tate.⁴⁰

The works included (i) remodelling of the internal drains to the pattern in Fig. 7, (ii) raising and strengthening the flood banks on the east side of the river, (iii) cutting a new main drain 1 1/2 miles long from Fore Dike, and another from Ganstead, leading into a Mother Drain one mile long from point D to (iv) an outfall sluice just above the bridge in Hull (see Fig. 17). This new Holderness Sluice (Fig. 8) had a 20ft waterway in two arches separated by a central pier 6ft wide, each arch having a pair of pointing sea doors 9 1/2 ft high and a draw door on the land side. The foundations included five rows of sheet piling each running across the entire width of the structure and the walls were in brickwork with an ashlar stone facing. The sills were 1ft below low water in the river which, according to Grundy's levels, lay 6ft below Sutton Carrs and 9ft below the carrs near Leven. The fall from the water level in the drains in these distant grounds to low water

in the river at Hull Bridge was around 6 inches per mile, a figure also adopted as the gradient for the bottom of the main drain, and quite acceptable so long as the drains and sluice had an ample capacity. In addition, however, the drains carried the upland waters flowing from a catchment far larger than the drainage area itself.

In his report Grundy recommended for the western main drain an average depth of 6ft and a bottom width of 14ft (which was adopted). For the Mother Drain he proposed a depth of 10ft and a 24ft bottom width; this water was also to be the waterway of the sluice. Smeaton, commenting on the sluice, suggested that given total protection by the river banks a waterway of 18 or 20ft might be sufficient. As we have seen, the latter dimension was adopted but the Mother Drain, from false economy, was made with the narrower width of 18ft.

The Trustees of Holderness Drainage, appointed in accordance with the Act, at their second meeting⁴¹ ordered 'that the two Engineers Mr. Grundy and Mr. Smeaton be wrote to desiring they'll come over immediately to view the low Grounds and Carrs and attend the next Meeting to give such Information relating to this Drainage as may be wanted'. This they did, attending at Beverley in July 1764, and agreed to provide working drawings of the sluice. Grundy produce the drawings, one of which has survived (Fig. 8),⁴² and sent them to Smeaton who made some valuable comments (mostly on the foundations) and prepared a very detailed bill of quantities with estimates totalling nearly £1,800. This second report by Smeaton is dated December 1764.⁴³

Progress of the work can be followed in the Trustees' minute books. Grundy was engineer in charge, with Tate as surveyor, John Hoggard supervising the river banks, and Joseph Page of Hull as resident engineer on the sluice and main drains, at a salary of £80 p.a. Construction of the sluice began in March 1765 and excavation of the drains started a few months later. Grundy made frequent site visits and one of his several progress reports is extant.⁴⁴ The sluice, Mother Drain, and the two main drains were completed by October 1767. Grundy and Page then left the scene, but work on the river banks and the drainage north of Fore Dike continued for five or six years under Hoggard's direction. Finally, Commissioners were appointed to conduct an exact survey and valuation of land within the drainage area, and their Award is dated May 1775.⁴⁵ The total cost of the scheme came to about £24,000.

A very substantial improvement had undoubtedly been achieved, but further works were necessary to perfect the drainage. Apart from widening the drains and sluice back to or even beyond Grundy's original proposals, the principal feature was the separation of the upland waters from the internal drainage; this was achieved first by William Jessop in the years 1787-95 and secondly under an Act of 1832 following Edward Page's scheme of leading the drainage water to a new outfall on the Humber at Marfleet. Grundy's Holderness Sluice and western main drain thereafter continued (well into the present century) to carry the upland waters of Lambwath and Leven into the river Hull.

DRIFFIELD NAVIGATION

Works carried out during the years 1767-70 to Grundy's design and under his direction enabled Yorkshire Keels to navigate between a canal basin in Great Driffield and the River Hull at Emmotland Cottage, whence the river was navigable to the Humber.

Driffield Beck, culverted into the head of the basin, provided a sufficient supply of water. From Driffield to

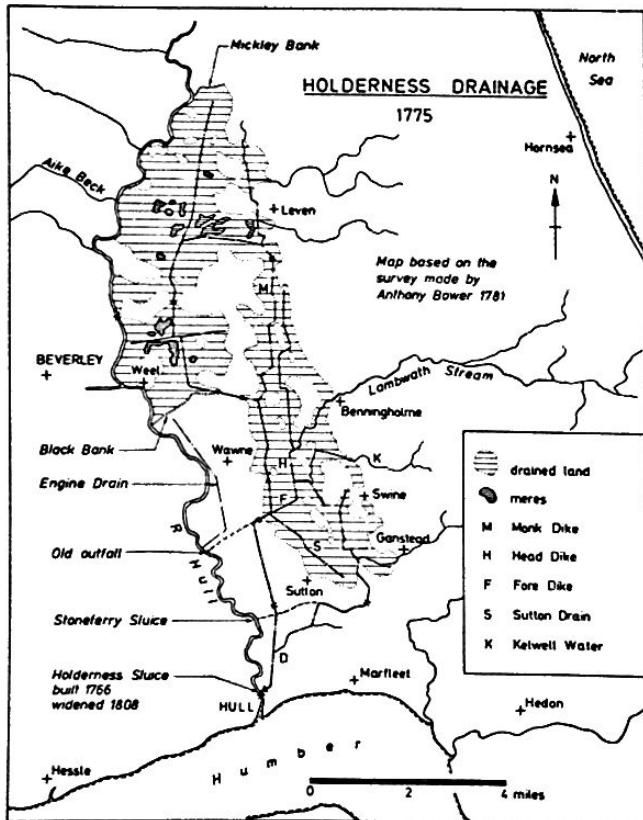


Fig. 7 Holderness drainage, 1775

A PLAN & ELEVATION of A SEA SLUICE.
designed for the Drainage of part of Holderness
in Yorkshire by John Grundy Engineer
1764.

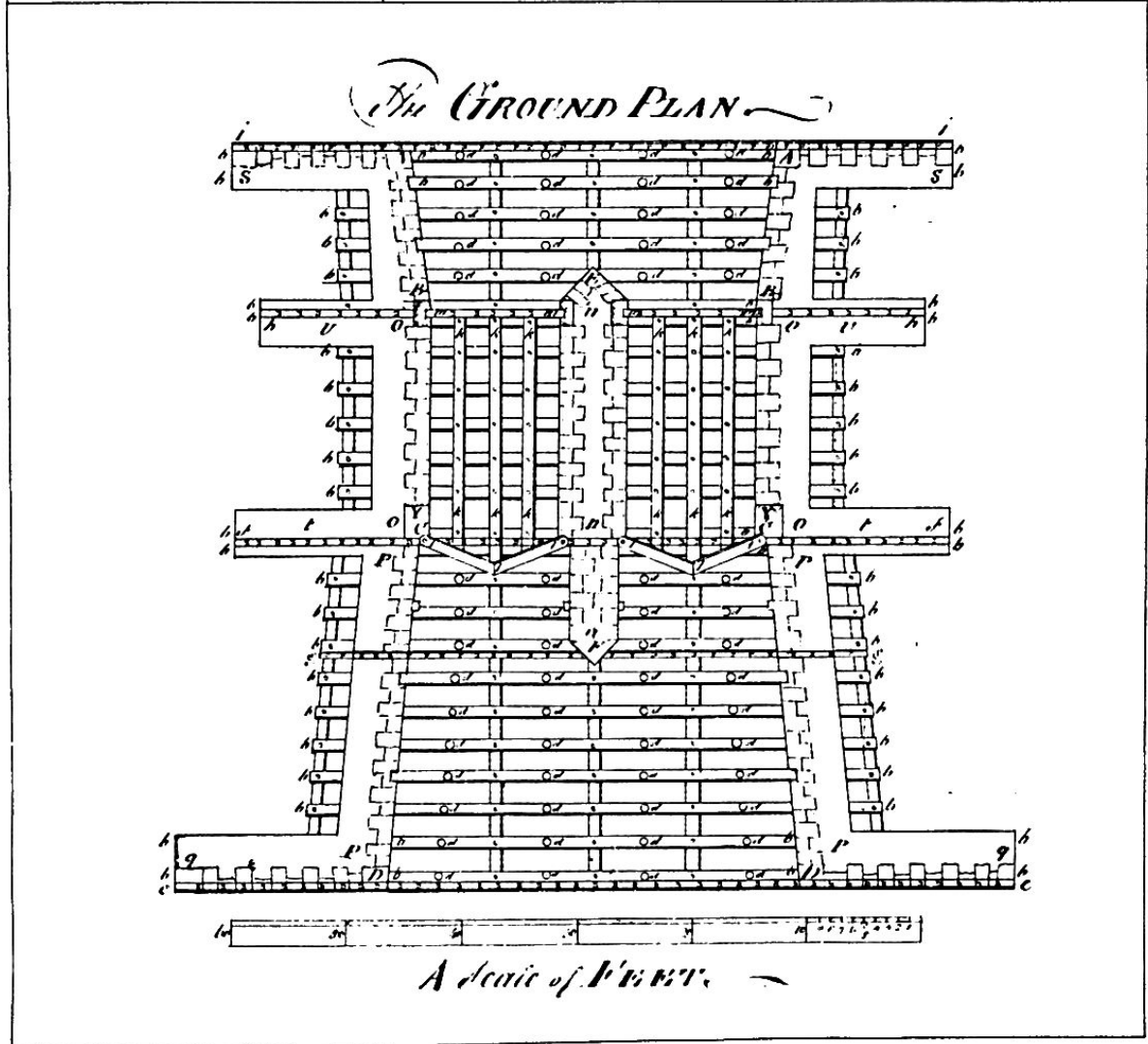
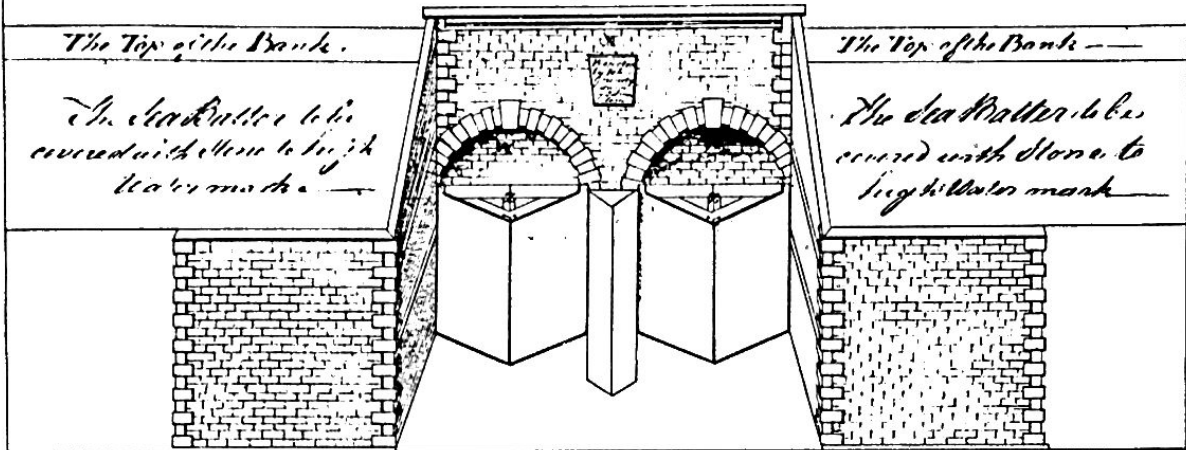


Fig 8 Holderness sluice, 1764

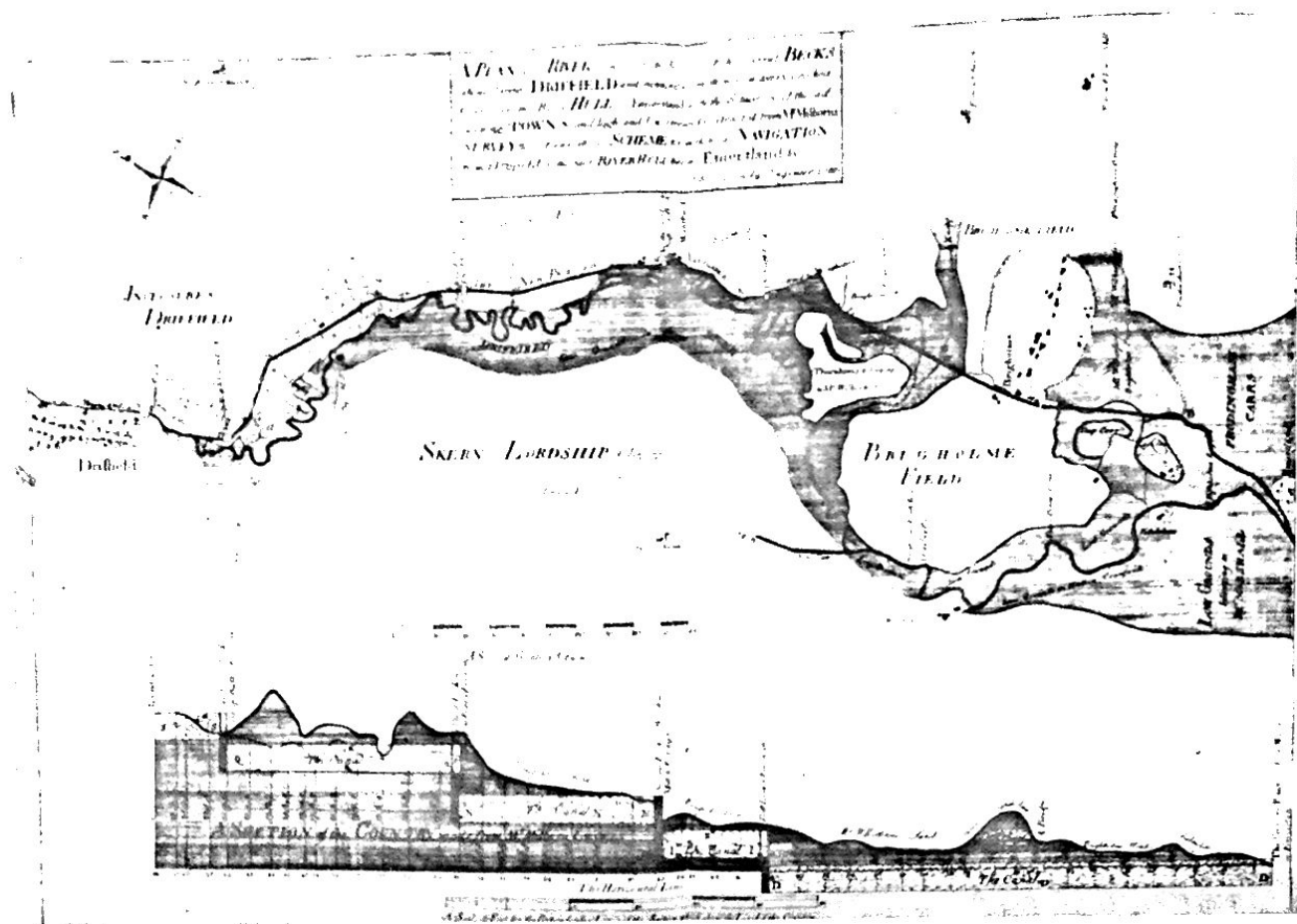


Fig. 9 Plan and section of Driffield Navigation, 1766

Wansford a fall of 25ft in three miles was accommodated in four locks, thence the canal ran on a dead level for two miles past Brigham to Fisholme where it entered Frodingham Beck, a tributary of the Hull, and the Beck was deepened along its $\frac{3}{4}$ mile length to Emmotland. Without a sluice at Fisholme the two mile level is effectively part of the river. It is embanked for most of its length, and its depth (typically 8ft) was such that it could serve both for navigation and as a drain for the adjacent low ground.

The survey, by Isaac Milbourn under Grundy's direction, was published as an engraved plan and section (Fig. 9)⁴⁶ and Grundy's printed report on the scheme is dated 18 December 1766.⁴⁷ He gave evidence in Parliament, the Act was obtained in May 1767, and in August he became engineer in charge.⁴⁸ His working drawings are listed in the *Catalogue* as 'Plans of Driffield Navigation, the Locks and Swing Bridges'.

Samuel Allam of Spalding arrived in October as resident engineer; work began on the first lock soon afterwards, and the firm of James Pinkerton & John Dyson contracted to excavate the canal in May 1768. The navigation was opened in May 1770 at a cost of about £13,000.

The locks were slightly smaller than on the Louth Navigation, accommodating vessels up to 61ft in length and 14½ft wide with a draught of 4ft. They had timber floors, sheet piling under the gates, bearing piles supporting the structure, and straight brick walls with masonry coping. A horse-engine was used to drain the excavations. Timber swing-bridges carried the roads at Wansford and Brigham over the canal.

ADLINGFLEET DRAINAGE

Smeaton in 1755 and Grundy in 1759⁴⁹ had been consulted

on the drainage of Haldenby and Eastoft respectively, parts of the 5,000 acres of low ground known as Adlingfleet Level (Fig. 10). In those days a somewhat haphazard system of drains led to an inadequate outfall sluice at Ousefleet, and little in the way of local improvement could be done until a more logical drainage scheme was introduced for the whole area. At the request of the principal landowners Smeaton prepared such a scheme in December 1764, based on his own levels and a land survey by Charles Tate. This chiefly involved a new main drain 5.8 miles long and a 10ft waterway sluice at Trent Falls where low water mark is almost 2ft lower than at Ousefleet.

The necessary Act was obtained in March 1767, Commissioners were appointed, and in June they asked John Grundy to take charge of design and construction, with David Buffery as resident engineer (salary £50 p.a.), and Tate continuing as surveyor.⁵¹

Grundy followed Smeaton's plan with only minor variations. He produced drawings and specifications for the sluice on 17 July, contracts for building it were let four weeks later; soon afterwards work began on raising the southern barrier bank (Green Bank in Fig. 10) and in October Pinkerton & Dyson contracted to excavate the main drain 'agreeable to Mr. Grundy's dimensions'.

By June 1768 the sluice had been finished and Grundy issued instructions for opening the outfall into the Trent. In December of that year he wrote a report⁵² detailing the small 'stop sluices' to be built on each of the side drains, where they entered the main drain. The report also gave an exact account of the work, now completed, by Pinkerton & Dyson on the main drain (170,000 cu yds of excavation), backfilling against the sluice walls, cutting through the Trent embankment, and excavating for the foundations of bridges over the drain.

In June 1769 'all the material works of the Drainage being completed', Grundy was paid £302 for his fees and expenses. Tate likewise received £275, and Buffery was retained on an *ad hoc* basis to continue letting small contracts and certifying work done on some further bridges, deepening of existing drains, additional raising of barrier banks, and so on. Finally, the Commissioners made their Award in June 1772. The total cost was approximately £7,000.

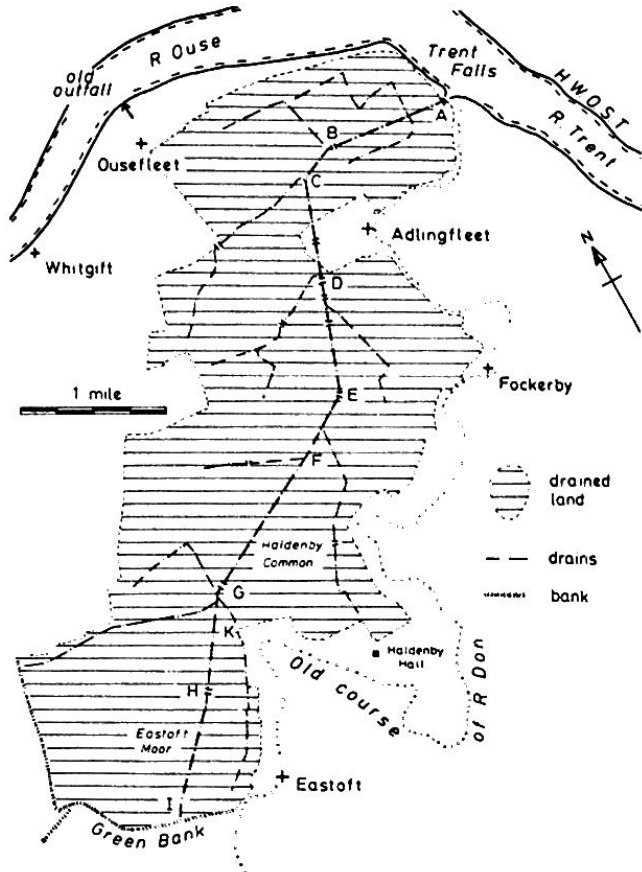


Fig. 10 Adlingfleet drainage, 1772

Leading dimensions and some technical details may be summarised as follows. Main drain: bottom width 10ft, cut on a dead level from A to E the depth varying from 15ft at the sluice to about 8ft at the lowest ground around D and E; further south the bottom rises at a slope of 10 inches per mile, ending at a depth of 6ft; average fall of water level from I to A just over 12 inches per mile; the drain is crossed by eight brick arch bridges. Sluice: 10ft waterway, counter-forted walls in stone-faced brickwork 5ft thick at base, timber floor with cross beams, four rows of dovetailed sheet piling 10 to 12ft deep and bearing piles 9 to 10ft long; a pair of oak pointing doors 12ft high and a draw door, also in oak, 8ft high at the ends of an arch 10ft long; sills about 1ft above low water in the Trent. Side drains: typically 5ft bottom width, 6ft deep, totalling 12.3 miles in length. Barrier bank: 7ft high, 6ft top width with side slopes of 1.75 : 1.

The drainage was admirably planned and executed. Up to 1929, when a new sluice was built nearby to the original one (the remains of which can still be seen), the only significant alteration was widening the main drain by 2ft from A to the bridge between C and D, and the consequent rebuilding of the bridge at B, in 1839.

LANEHAM DRAINAGE

An engraved plan of a scheme for draining low grounds in the flood plain of the River Trent, on the west side of the river north of Laneham, in Nottinghamshire, was published in 1769 by Grundy and George Kelk.⁵³ From the following entries in the *Catalogue* it is clear that Grundy prepared estimates and drawings and that the scheme was carried out: 'Laneham Drainage, Scheme, Estimates as projected in 1764 and Executed 1770, 1771, 1772', 'Plans of Laneham Drainage 1769 & 1770', and 'Plans and Estimates for the Sluices for Ditto'. The minute book for this period has not been found, nor is it known whether Grundy was engineer in charge of construction.

DEEPING FEN, 1769-70

Ordered in March 1769 to produce a comprehensive scheme for 'perfecting' the drainage of Deeping Fen, Grundy completed in February 1770 a report of 151 pages with a plan and an additional 14 pages of estimates (dated April 1770).⁵⁴ The most important of his proposals was the provision of an improved outfall for the Welland by making a cut about 100ft wide, 7ft deep, and 1½ miles long, partly behind the sea wall and partly across salt marshes, from the head of the estuary at C (Fig. 11) to the main channel at A, which runs along the edge of the sands to Fosdyke. A dam would be required across the existing channel just below point C to divert flow into the cut. Grundy also recommended that a sluice and navigation lock be built at point A to prevent silt being brought up the rivers in high tides.

His other recommendations included widening and deepening the River Glen, and the Welland for 3 miles downstream of Spalding, and several of the principal drains, as well as the construction of a catchwater drain west of Market Deeping proposed already in 1768 by Thomas Tofield.⁵⁵

Finally, Grundy adopted another of Tofield's proposals, for extending Vernatts Drain alongside the Welland, under the Glen in an inverted syphon and on to a new outfall sluice at A. But whereas Tofield had suggested that the extension and the drain itself should be cut with a bottom width of 40ft on a dead level from the sluice right up to the Fen at a depth of 2ft below low water mark, Grundy thought this extra depth was not justified technically or in terms of cost.

This difference of opinion emerged at a meeting between the two engineers at Retford, and they agreed to seek Smeaton's advice. In reply (27 March 1770) Smeaton outlined the principles of flow in open channels, showing that water below the level of the outlet is not 'dead' but, on the contrary, the extra depth is beneficial; and inferring that where, as in this particular case, the fall has a very low gradient (less than 4 inches per mile) the additional cost is justified.⁵⁶ In other words, Tofield was right.

The Adventurers, having considered all these matters, decided in 1772 to enlarge Vernatts Drain and extend its outfall, but only so far as the Reservoir (a proposal made nearly twenty years earlier by Grundy senior), to construct a catchwater drain, and to enlarge the Glen.⁵⁷ Further action on the Welland outfall was postponed, and Grundy's idea of a sluice at point A seems never to have attracted serious attention. But after more than thirty years and the publication of several reports a cut was eventually made from point C to Fosdyke, with great benefit to the drainage of Deeping Fen.

Grundy's bill for his services came to £250, paid in 1772. His daily fee must by now have increased to three or even five guineas.

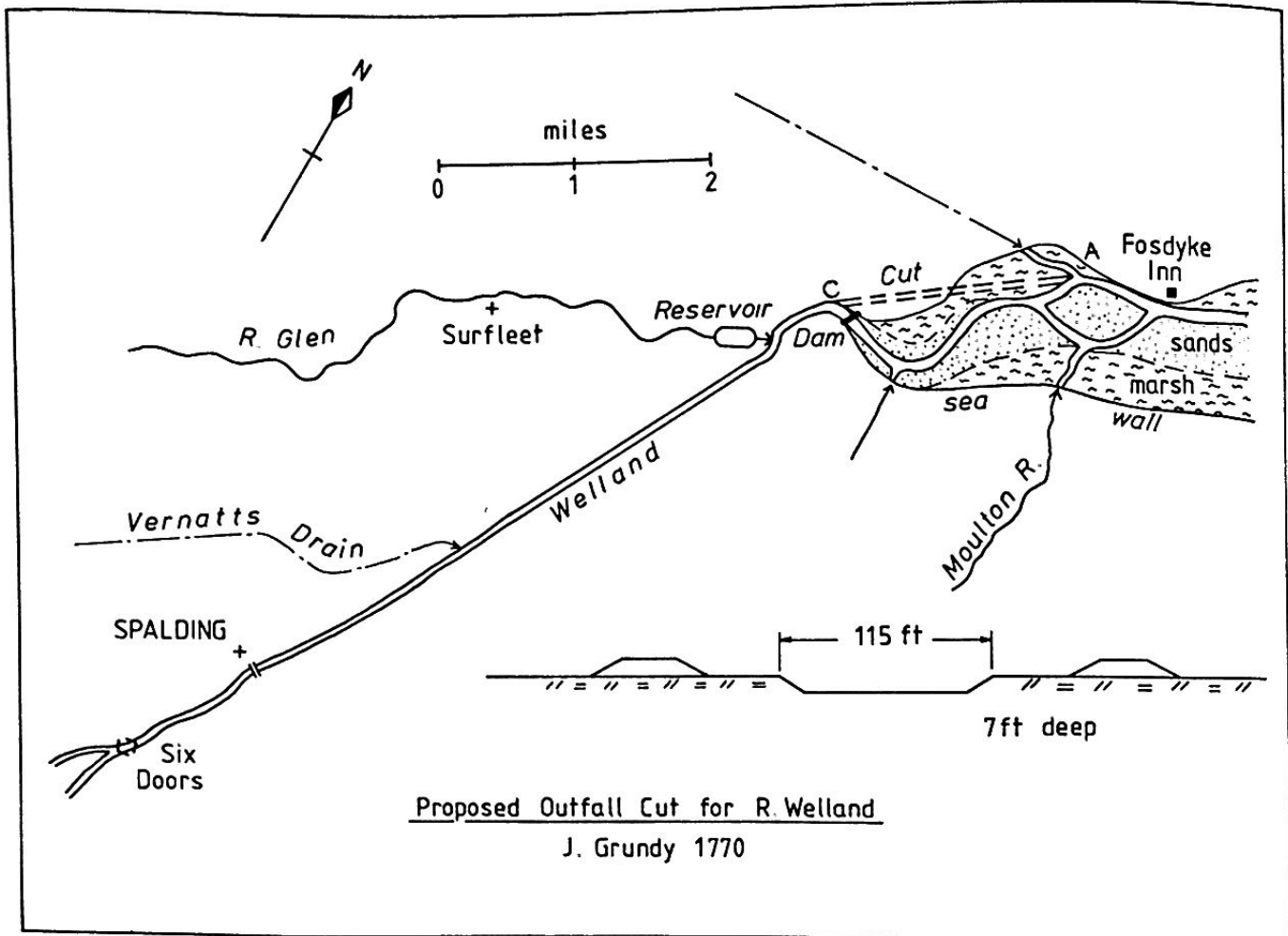


Fig. 11 Deeping Fen and Welland outfall

WEIGHTON DRAINAGE AND HULL DOCK

The last years of Grundy's active professional career, from 1771 to 1776, are distinguished by two of his most important projects: Market Weighton Drainage and Navigation, and the planning of Hull's first dock. During this period he also reported on at least fifteen other schemes.

WEIGHTON DRAINAGE & NAVIGATION

An Act was obtained in May 1772 'for Draining and Preserving certain Commons, low Grounds, and Carrs in the Parish of Market Weighton and other Adjacent Parishes... and for making a Navigable Cut or Canal from Market Weighton to the River Humber'. The land to be drained, shown in Fig. 12, amounted to 16,400 acres; a cut 6 miles long from the Humber to point C served as the Mother Drain and lower part of the canal; from C up towards Market Weighton the canal was to be completely separate from the drainage system. Foulney River needed scouring and deepening, numerous side drains were required, and the Act stipulated that water level in the canal must be kept not less than 3ft below ground surface. On the other hand a minimum depth of 4ft of water was required for navigation.

The scheme had been drawn up by John Smith, and in June 1772 he was appointed engineer in charge with Samuel Allam as resident engineer (at £54 p.a.).⁵⁸ Three months later, however, the Trustees called on Grundy for a second opinion. He reported without delay on 2 September,⁵⁹ proposing a better site for the outfall sluice and lock, a different method of building it, a lower level for its sill, and 9 locks instead of 4 to take the fall of about 60ft. The report

was accompanied by a longitudinal section and drawings of the sluice and lock.⁶⁰ His revised scheme found acceptance; he became chief engineer, new contracts were signed 'according to the plans of Mr. John Grundy', and construction started almost immediately. The works were carried out in three well defined stages.

- (i) 1772-75. Sluice, lock and Mother Drain. Grundy in charge (his fees to December 1775 being £160), Smith as assistant (until 1773), Allam as resident; James and John Pinkerton contractors for excavation, Joseph Smith for masonry and brickwork, John Everingham for carpentry. Cost about £26,000.
- (ii) 1776-80. Cutting the drains (total length 43 miles), deepening Foulney River (length 12 miles) and other streams (length 6 miles). Allam in charge, Pinkertons principal contractors. Cost about £14,000.
- (iii) 1781-83. Canal above point C, with 3 locks in 3½ miles to the canal head 1½ miles from Market Weighton; this being a revised plan by Luke Holt,⁶¹ who took over from Allam in 1781. Contractor for excavation George Vickers, for masonry Rowland Myers and for carpentry John Harrup. Cost about £8,000.

Several land surveyors were employed, the principal ones being Joseph Jewitt, William Hildyard, and Charles Tate. The Commissioners made their Award in November 1784. One-quarter of the total cost of £48,000 was attributed to navigation and three-quarters to drainage.

The Mother Drain was cut with a bottom width of 30ft and side slopes of 1½ : 1, on a dead level at low water level

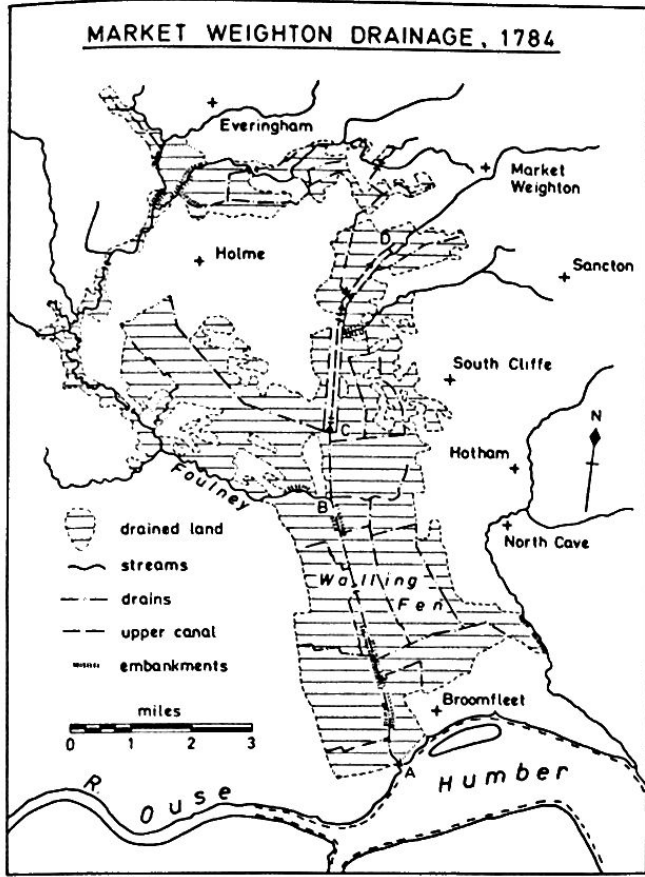


Fig. 12 Market Weighton drainage, 1784

in the Humber. This gave slightly more than the minimum required depth of 7ft (3ft freeboard and 4ft of water) below the lowest ground in Walling Fen, and an average depth along the 6 mile length of about 14ft. The total volume of excavation in this drain amounted to 870,000 cu yds.⁶² It is banked where it passes through very low ground to avoid flooding.

A measured section and general plan of the sluice and lock are shown in Figs. 13 & 14. The sluice has a 30ft waterway in two arches; the lock has a clear width of 15ft and a length of 70ft between each of the two pairs of gates. Sill level of the sluice and lock is at LWST. The wall over the arches (apart from the parapet), the side walls, and middle wall rise 5ft above HWST which is 18ft above LWST; the lock walls are therefore 23ft high above sill level. The pointing doors (Fig. 15) are 12ft high, with a canopy. The whole structure rests on a timber grillage supported by bearing piles, and there are four rows of dovetailed sheet piling.

The great pit for the foundations, 18ft deep with a bottom area of 12,600 sq ft, was excavated behind the Humber bank. After completing the structure new banks were built curving back to the side walls of the lock and sluice, and the old bank removed down to floor level. In this way the use of a cofferdam was avoided.

Repairs were carried out in 1826 and again in 1855-6, and very recently the draw doors have been replaced by roller gates. In most other respects the lock and sluice remain essentially as completed to Grundy's design in 1775. A view from the sluice looking back along the Mother Drain is shown in Fig. 16.

HULL DOCK

The need for extra space for shipping in Hull harbour and

for a Legal Quay had long been recognised, but it was not until 1773 that a satisfactory solution to the problems emerged.⁶³ Asked for his opinion on the effects of building the Quay as a solid structure projecting 40ft into the harbour on its west side, Grundy reported in October 1772 that it would oppose too much obstruction to flood water coming down the river, that a flood relief channel could however be provided by enlarging the old moat or 'Town Ditches' (Fig. 17) and that, with great advantage, the north part of the moat would provide a suitable site for a large 'wet dock' (i.e. a dock with lock gates to maintain water at high tide level) to accommodate unladen ships, thereby relieving pressure on space in the harbour.⁶⁴

This idea was quickly taken up and elaborated: the dock should be of sufficient depth to accommodate fully laden ships so that the Legal Quay could be located on one side of the dock, leaving the need only for a 15ft quay on open piled foundations in the harbour itself. Acting for the Board of Customs, John Wooler in January 1773 prepared outline plans and estimates. In April, Smeaton reported favourably on the 15ft quay in the harbour. Further to satisfy those who still feared the flood threat, Smeaton and Grundy jointly examined the problem again and wrote (separate) reports in December.⁶⁵

The way now lay open for an application to Parliament. Grundy drew up detailed plans and in an estimate covering four folio sheets dated 31 March 1774 worked out the cost at £67,832 exclusive of ground to be purchased, parliamentary charges, fees, etc.⁶⁶ The Act was obtained in May and in November Grundy received £300 for his work.

His plans and report on the dock are unfortunately lost, but recently discovered entries in the *Catalogue* include:

- (i) Rough Plan of the Town and Harbour of Hull in Yorkshire, with the Designs for a Wet Dock, Quays, &c. done in 1774.
- (ii) Mr. Page's Plan of the Corporation Ditches at Hull, preparatory to the above Plan of the Dock &c., done in 1773.
- (iii) Surveys, Levels, Views, Observations, Report, Scheme and Estimate for making a Wet Dock, Quays and Wharfs in the Port of Hull 1773 and 1774.

Work began in March 1775 with Henry Berry, the

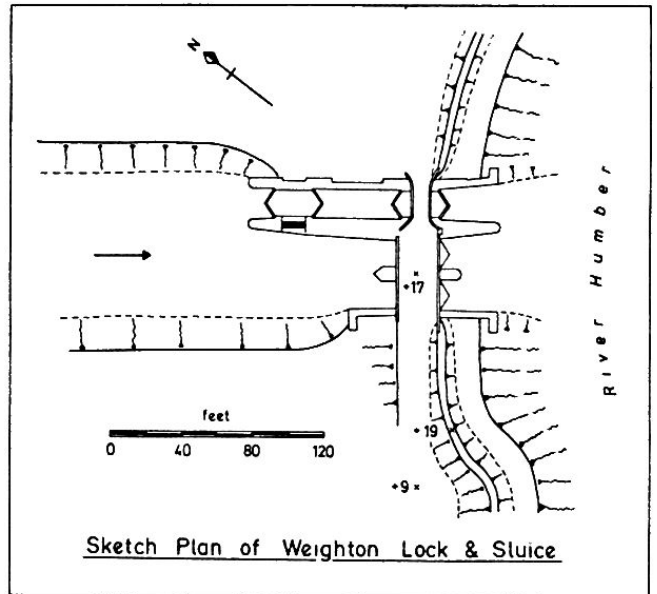


Fig. 13 Sketch plan of Weighton lock and sluice

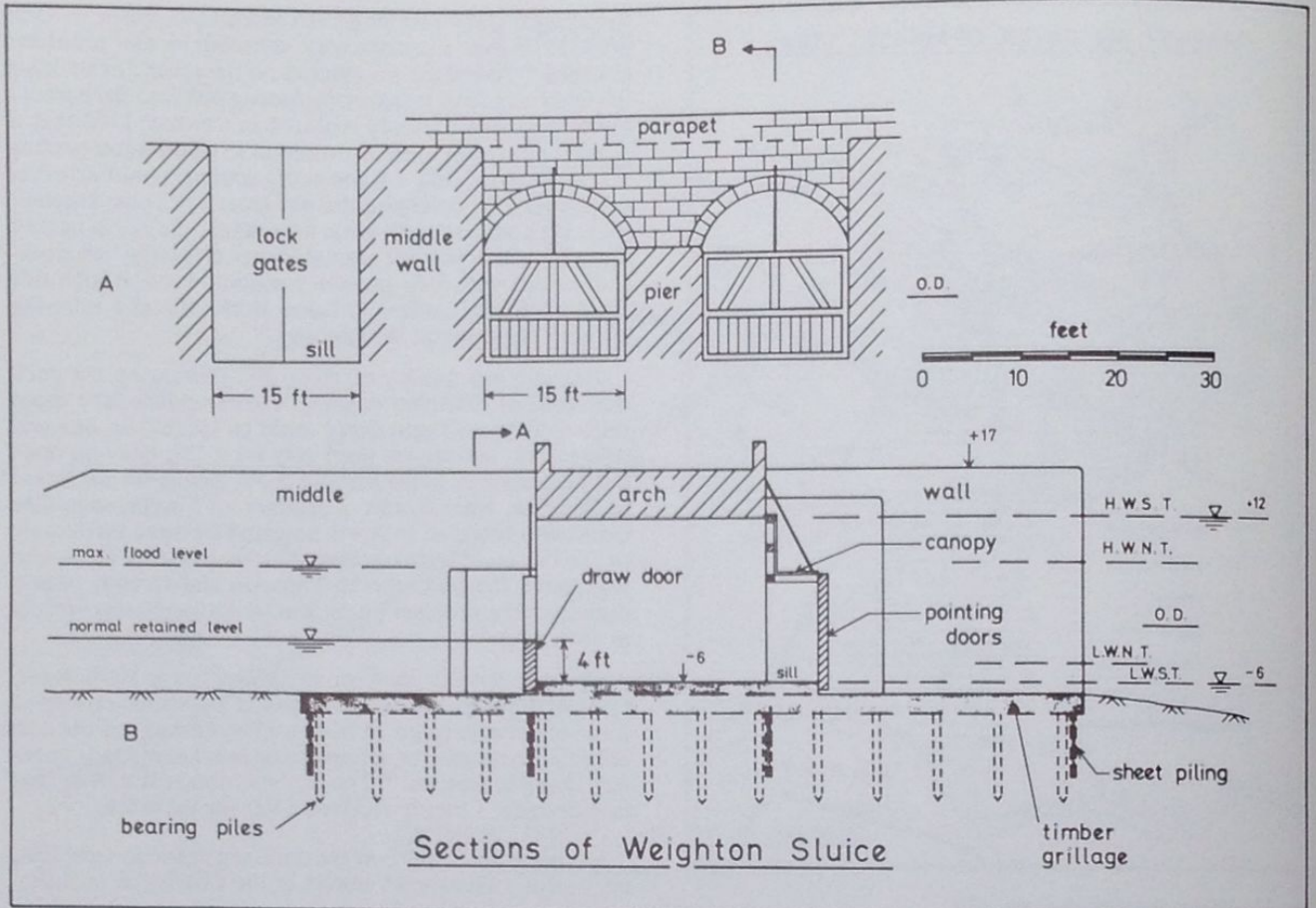


Fig. 14 Sections of Weighton sluice

Liverpool dock engineer on intermittent leave of absence, as engineer in charge and Luke Holt as resident engineer. The opening of the dock took place in September 1778 at a total cost of £73,000.

As built, the dock was 1,703ft long and 254ft wide (giving an area of nearly 10 acres) with a 20ft depth of water. The walls, rising 24½ft above dock bottom, were in brickwork with a massive stone coping. The lock had a timber floor, stone-faced brick walls, a length of 120ft between gates and a width of 36ft; it retained a depth of water of 18ft on the sills.⁶⁷ Up to 100 ships could be accommodated in what was the largest commercial dock of the 18th century in England.

On Berry's suggestion the dock was made about 17ft wider than in Grundy's plan, and the Legal Quay enlarged.⁶⁸ But there is no evidence that in other respects the layout and construction differed materially from the 1774 design.

The dock walls (Fig. 18) had a base width of 10ft and widely spaced counterforts, and were founded at dock-bottom level on timber planking, sleeper beams, and 10ft bearing piles. They had an adequate resistance to overturning but, with no depth of soil in front and therefore no passive earth pressure, their resistance to sliding was provided only by friction between brickwork and planking. This proved to be barely sufficient, and in places the walls moved forward as much as 2 or 3ft. Similar problems with the lock walls led to their having to be partially rebuilt in 1785-6, and the entire lock was reconstructed under Rennie's direction in 1814-15 with an inverted arch floor.

The original design is therefore open to criticism, but in 1774 there was little experience of construction on this scale in soft ground and absolutely no reliable methods of calculating the forces involved in such conditions. Hull dock,

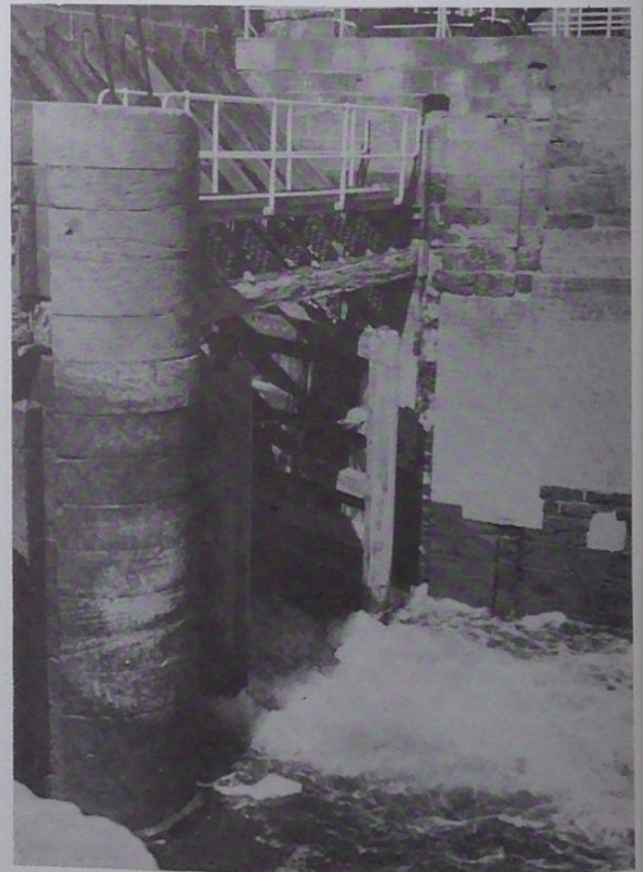


Fig. 15 Weighton outfall sluice



Fig. 16 Weighton mother drain

Grundy's last major work, like Grimsthorpe dam, his first, must be regarded as pioneer structures the merits of which outweigh their shortcomings.

Acknowledgments

I am grateful to Dr and Mrs J. M. Hopper of Grantham for information on the Grundy and Thompson family and for the loan of a typescript on the two John Grundys. Mr P. B. Grimes generously devoted time to showing me the sites of Grundy's works at Grimsthorpe. Mr L. C. Sands, Clerk to the Market Weighton Drainage Board, provided facilities for my wife and myself to study plans and Minute Books etc., as did Mr. G. W. Haywood, Clerk to the Adlingfleet & Whitgift Drainage Commissioners. Mrs Catherine Wilson kindly allowed me to spend a day examining documents (including Grundy's Catalogue of Books and Papers) temporarily withdrawn from the excellent exhibition which she had arranged at the Museum of Lincolnshire Life. The seven drawings in the paper are by Mrs Anne Langford of Imperial College.

NOTES

Where not given in full, locations of source material are abbreviated as follows: BDL = Bodleian Library, BM = British Museum (British Library and Map Room), HRO = Humberside Record Office, LAO = Lincolnshire Archives Office, LCL = Lincoln City Library, MCL = Manchester Central Library, RGS = Royal Geographical Society, RS = Royal Society (Smeaton Collection). Titles of printed reports and engraved plans are shortened.

- 1 E. C. Wright, 'The early Smeatonians', *Trans. Newcomen Soc.*, 18 (1938), pp. 101-10.
- 2 J. M. Hopper, 'Lincolnshire worthies: the two John Grundys', *Lincolnshire Life*, 20 (1983), no. 3, pp. 24-7.
- 3 N. R. Wright, *John Grundy of Spalding, Engineer, 1719-1783. His Life and Times*, Lincoln, 1983.
- 4 A. W. Skempton & E. C. Wright, 'Early members of the Smeatonian Society of Civil Engineers', *Trans. Newcomen Soc.*, 44 (1971), pp. 23-42.
- 5 Portrait (artist unknown), the property of Mrs Margaret Thompson of Langham. Photograph by the Museum of Lincolnshire Life.
- 6 'A Catalogue of Books and Papers... belonging to the late Mr John Grundy and to John Grundy of Spalding in Lincolnshire, taken in 1767', MS bound quarto, 112 pp. In possession of Mrs Margaret Thompson and loaned by her in 1983 to the Museum of Lincolnshire Life.
- 7 Personal communication from Mr A. P. Woolrich.
- 8 'Surveys Levels Reports Schemes and Estimates in Works of Draining Navigation and other Business in Engineering. By John Grundy of Spalding Enginr. Vol. II', MS bound quarto, 353 pp., Institution of Civil Engineers Library.
- 9 LAO Measure 3/1/23. Contract documents and drawing for Pinchbeck Sluice.
- 10 *Report Book*, pp. 77-130.
- 11 *A Map of the Antient River Witham (with Levels)* by John Grundy Sen. & Jun. 1743; BDL, BM, LCL, RGS, RS.
- 12 *A Scheme for Restoring the Navigation of the River Witham and draining the Low Lands contiguous thereto*, by John Grundy Sen. and Jun. 1744; BM.
- 13 *J. House of Commons*, 30 March 1736. Scribo's proposed cut is shown in Grundy's plan.
- 14 *Report Book*, folding plan at p. 184.
- 15 *ibid*, pp. 59-65 with plan but no section of the proposed dam.
- 16 G. M. Binnie, 'The evolution of British dams', *Trans. Newcomen Soc.*, 47 (1976), 207-24.
- 17 LAO 2 Anc 6/5, Ancaster Account Book 1749-52. 'Levelling' in this entry refers to regrading the slope in front of Grimsthorpe Castle.
- 18 *Report Book*, pp. 176-82.
- 19 *ibid*, folding plan at p. 151.
- 20 *ibid*, pp. 143-9.
- 21 *ibid*, pp. 187-97.
- 22 LAO Ancaster Archives.
- 23 *Report Book*, pp. 151-65 with drawing.
- 24 LAO Deeping Fen 1/10, Grundy's Account Book.
- 25 LAO Deeping Fen 1/1 and 2, Adventurers' Minute Books 1669-1755 and 1756-1776.
- 26 *Report Book*, pp. 275-303. 1749 estimates, report and site diary of 1751, and drawing.
- 27 Printed report of meeting, held at Boston 19 October 1753, with Grundy's report and plan. Institution of Civil Engineers Library.
- 28 The reports by Grundy and Langley Edwards are summarised in W. H. Wheeler, pp. 149-50. *A History of the Fens of South Lincolnshire*, Boston, 1897, pp. 149-50.

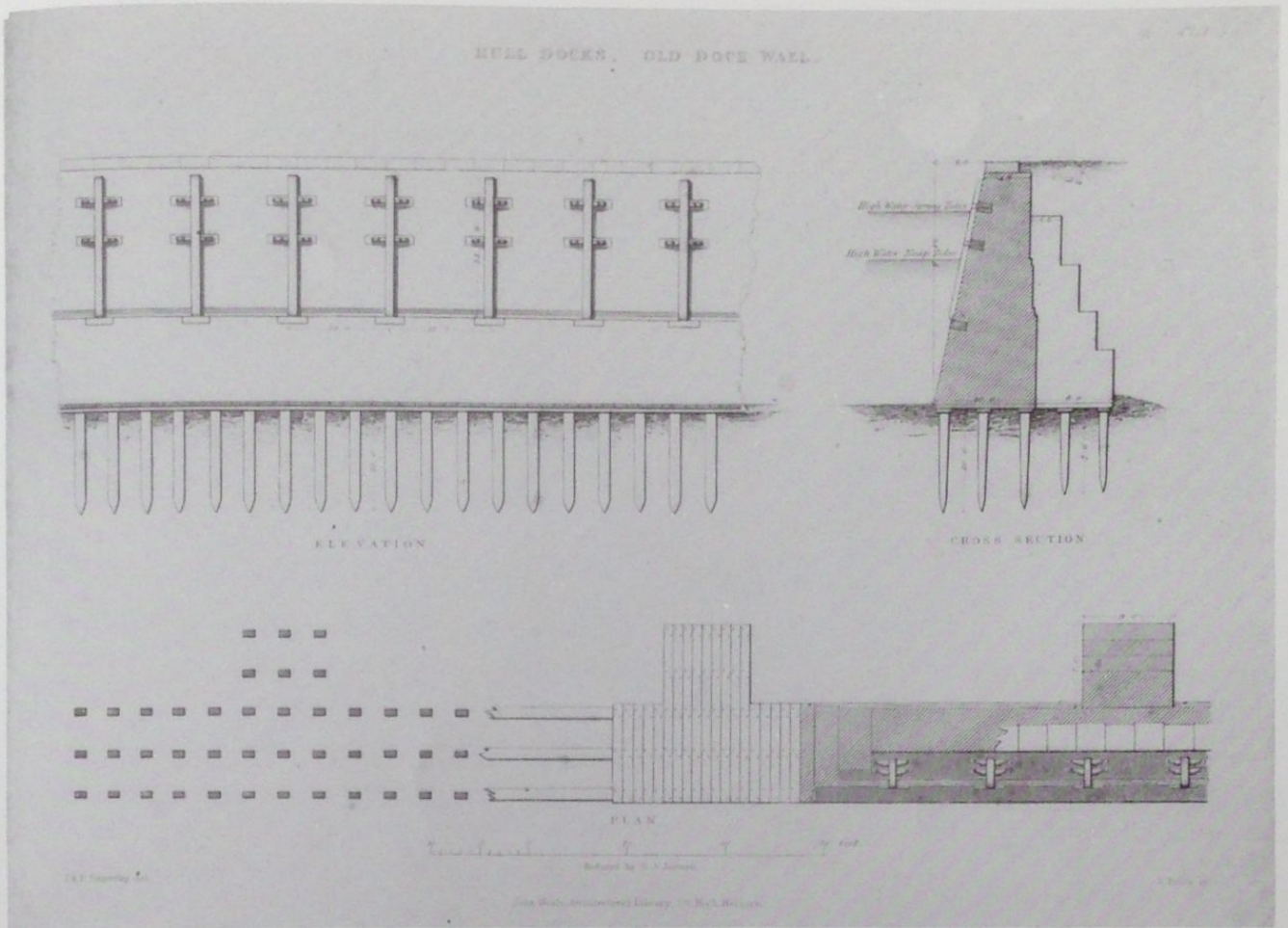


Fig. 18 Hull dock wall section

29 *The Report of John Grundy, Langley Edwards and John Smeaton on the River Witham and the Fen Lands on both sides of the said River*, Lincoln, 1761; BDL, BM, LCL.

30 *A Plan of the River Witham and adjoining Fens and Low Grounds with the New Works proposed to be Executed for Draining the said Fens and Restoring the Navigation*, by J. Grundy, 1762; BDL, BM, LCL, MCL, RGS, RS.

31 As noted and shown on the engraved plan.

32 LAO, LRA 1/1, Minute Book of the Witham Drainage Commissioners 1762-75. BS 4/1/1 Minute Book of the Commissioners for Navigation 1762-86.

33 LAO, LRA 5/1 Louth Navigation Minute Book 1760-1828.

34 *A Scheme for executing a Navigation from Tetney Haven to Louth*. By John Grundy. To which is added the Report of John Smeaton, Nottingham, 1761; LCL.

35 *A Plan of the Proposed Navigation from Tetney Haven... to Louth*, by John Grundy; BM, LCL, MCL, RGS.

36 T. W. Hall, *The Fairbanks of Sheffield*, Sheffield, 1932.

37 J. S. Padley, *Louth Canal. A Description of the Locks, Bridge, &c.* [in 1828], Louth, 1832; LCL.

38 *The Report of John Grundy, of Spalding, Engineer. Concerning the Drainage of the Low Ground and Carrs... in Holderness*, 1764, HRO.

39 *Reports of the late John Smeaton*, London, 1812, Vol. 1, pp. 88-89.

40 *A Plan of an Actual Survey of part... of Holderness*. By C. Tate, with a Scheme for Draining by Messrs. Grundy & Smeaton, 1764; BM, MCL, RS.

41 HRO, DCMO 1/1, Minute Book of Holderness Drainage Trustees, 1764-68.

42 RS, Smeaton collection 5 f. 51. The drawing of Holderness Sluice by Grundy 1764, sent by him to Smeaton for comment.

43 *Smeaton's Reports*, op. cit., pp. 90-98.

44 *Report in Consequence of a View of the Works for the Drainage of Holderness Level*, by J. Grundy, 1765; HRO.

45 Holderness Drainage. Commissioners' Award. Printed 1781 with a folding engraved map by Anthony Bower, HRO.

46 *A Plan of the River... from Mr. Milborn's Survey and also a Scheme for making a Navigation from Driffield to the River Hull* by John Grundy, 1766, MCL.

47 *Mr. Grundy's Observations... and his Report, Scheme and Estimate for making a Navigation between Great Driffield and the River Hull*, 1766; HRO, MCL.

48 HRO, DDX 40/1, Driffield Navigation, Minute Book of Commissioners 1767-1824.

49 *Report Book*, pp. 338-53.

50 *Smeaton's Reports*, op. cit., pp. 199-206.

51 Adlingfleet & Whitgift Drainage Commissioners, Crowle, Minute Book 1767-1823.

52 MS report by John Grundy, 1768. Institution of Civil Engineers Library.

53 *A Plan of the Ings, Meadows, Marshes and other Low Grounds in Laneham, etc.* Surveyed by John Grundy and George Kelk 1769. LCL. BM, MS 54784. MS report by John Grundy, 1770.

54 *Mr Tofield's Report on a Survey of Deeping Fen*, 1768; LAO.

55 The correspondence is printed in *Min. Proc. Inst. C.E.* 4 (1845), 205-9.

56 LAO, Deeping Fen 1/2, Adventurers' Minute Book 1756-76.

57 Market Weighton Drainage Board, Pocklington, Weighton Drainage & Navigation Trustees' Minute Books 1772-1838, Treasurer's Accounts 1772-84, Contracts 1772-80.

58 *The Report of John Grundy respecting the Drainage and Navigation proposed for Walling Fenns, &c.* 1772, with annexed engraved section. HRO, Hull University Library.

59 A copy of the lock and sluice foundation plan is in Yorkshire Water Authority, Beverley.

60 HRO, DDMW/7/404, MS Section of Weighton Canal, June 1781; Luke Holt.

61 Hull University Library DDLA/16/3, MS report by Grundy of site visit July 1773.

62 M. W. Baldwin, 'The engineering history of Hull's earliest docks', TS in Science Museum Library. An abridged version in *Trans. Newcomen Soc.*, 46 (1973) pp. 1-12.

63 *The Report of John Grundy, Engineer, respecting Quays or Wharfs on the West Side of the River Hull*, 1772, HRO, Hull City Archives.

64 *The Report of John Grundy, Engineer* [on Hull Harbour and proposed Dock], 1773, Hull City Archives. *Smeaton's Reports*, Vol. 3, pp. 157-62.

65 This information is given by the Dock Company Chairman, William Hammond, in *Remarks on a Publication intitled 'The Case of the Merchants of the town of Kingston-upon-Hull' with Additions*, London, 1787. Hull City Archives.

66 J. Timperley, 'An account of the harbour and docks at Kingston-upon-Hull', *Trans. Inst. C.E.*, 1 (1836), pp. 1-52.

67 Hammond, op. cit., gives the area of the dock and quay as built and as in 'Mr. Grundy's Plan, which was that directed by the Act'.

JOHN GRUNDY: Works & Selected Reports

	Planning		Works		
	Report	Plans	Construction	Engineer in Charge	Resident Engineer
Pinchbeck Sluice [design by Grundy sen.]		1739	1739-40	Grundy sen. (contractor)	? Grundy
Newark Navigation	<i>1741</i>	<i>1741</i>			
Osbaston dam	1741	1741			
Norfolk sea wall [scheme by Grundy sen.]	1743	1743	1742-43	Grundy	
R. Witham (with Grundy sen.)	<i>1744</i>	<i>1743</i>			
Grimsthorpe Great Water dam		1746	1746-48	Grundy	
Grimsthorpe water supply		c.1748	1751	Grundy	Jos. Smith for engine & pump
Deeping Fen: various works			1748-64	Grundy	Jos. Featherstone
Stallingborough Sluice	1749, 1751	1751	1751	Grundy	Wm. Hodgson
R. Dee, Chester	1750-59*				
R. Witham	<i>1753</i>	<i>1753</i>			
Romney Marsh, sea wall	1755	1755			
Louth Navigation	1756	1756*		see below	
Eastoft Drainage	1759				
R. Witham (report with Edwards and Smeaton)	<i>1761</i>	<i>1762</i>	[1763-67	Langley Edwards	?
Louth Navigation	<i>1761</i>	<i>1761</i>	1765-67	Grundy	Jas. Hogard
Fosdyke (with Smeaton)	1762				
Holderness Drainage	<i>1763</i>	<i>1764</i>	1765-67	Grundy	Jos. Page
Driffield Navigation	<i>1766</i>	<i>1766</i>	1767-70	Grundy	Sam. Allam
Swale & Cod Beck Navigations	<i>1767</i> <i>1767</i>	<i>1767</i> <i>1767</i>	[not completed	John Smith	?
Thorney Fen bank		1767			
Adlingfleet Drainage [scheme by Smeaton]			1767-69	Grundy	Dav. Buffery
Misterton, Gringley & Everton Drainage	1768*				
Laneham Drainage	1769*	1769	1770-72	?	?
Deeping Fen & Welland outfall	1770	1769			
Chesterfield Canal variation	1770	1770			
Weighton Drainage & Navigation	1772	1772	1772-75	Grundy	Sam. Allam
Hull Quay	1772, 1773				
Hull Dock	1774*	1774*	[1775-78	Henry Berry	Luke Holt
Hedon Haven	1774	1773			
East Fen Drainage	1774	1774			
South Holland Fen Drainage	1774*	1775			
Wells Harbour (with Thos. Hogard and Jos. Hodskinson)	1782				

italic: printed report, engraved plan

* not found

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The Society for Lincolnshire
History and Archaeology

The Society was formed in 1974 by the amalgamation of the Lincolnshire Local History Society and the Lincoln Archaeological Research Committee.

Aims

To promote the study of history, archaeology, industrial archaeology, family history, topography, architecture, dialect, manners and customs and other similar subjects of local interest in the historical county of Lincolnshire, i.e. Lincolnshire and South Humberside.

Activities

Meetings, lectures and conferences are held during the year including a full day annual meeting in May. Visits and tours (frequently to places not open to the general public) are a regular feature of the programme.

Publications

The journal *Lincolnshire History and Archaeology* is published annually. In addition the Society produces a series of occasional papers and quarterly newsletters for the Family History section of the Society.

Cover illustration: John Grundy, 1719-1783. Portrait painted c 1770 by an unknown artist, now the property of Mrs. Margaret Thompson of Langham. Photograph © Museum of Lincolnshire Life.

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