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April, 1942.

BOURNE SOUTH FEN & THURLBY FEN PUMPING SCHEME.

In accordance with the Minute passed by the River Welland Catchment Board on April 16th, 1942, I have made a comprehensive examination of the Bourne South Fen and Thurlby Fen areas, together with the River Glen and all works appertaining thereto, and have given careful consideration to the various effects of pumping the fen water into the River Glen.

General. Before embarking on detailed remarks, it is as well to point out that the Bourne South Fen and the Thurlby Fen have been drained by means of an extremely antiquated and totally inadequate paddle wheel driven by a horizontal producer gas engine. A proportion of the discharge from this plant has been carried under the River Glen by means of an inverted syphon known as Heathcotes Tunnel. After this water has passed through the tunnel it gravitates to Counter Drain in the Deeping Fen Area, and is discharged by gravity, as and when levels permit, into the Vernatt's Drain at Podes Hole. A certain proportion of the discharge finds its way, by a devious route, back to the upstream side of the pumping station, owing to Heathcotes Tunnel being unable to deal with the total discharge without a greatly increased head (Further remarks in this connection will be made at a later stage of this report). The Bourne South Fen and Thurlby Fen pumping plant has, for many years, been suffering from a number of troubles, one of the chief being old age, and I am given to understand that the main fly-wheel shaft broke on Monday, April 13th. Members of my staff and I myself have visited this pumping station during operation and since the break-down, and, to be frank, I am agreeably surprised that a failure of a serious nature has not occurred previously. When the plant was in operation the whole foundation of the building "floated" to a very marked degree which was, of course, detrimental to any form of engine, both from

the point of view of maintenance and efficiency. It would appear, from an inspection I have made, that the shearing of the shaft has been caused by movement of the engine bed, resulting in whip or an internal strain being set up in the shafting. This theory is supported by the fact that considerable quantities of oil can be retained in the combustion chamber of the engine, indicating that the bore is no longer horizontal.

A 12" internal diameter centrifugal pump, which can be tractor driven, is mounted in the pumping bay, and given good weather conditions, it is justifiable to assume that the Bourne South Fen and Thurlby Fen can be kept reasonably drained during the summer period which is now approaching, but in view of the nature and condition of the present plant, it is not a feasible proposition to make economic temporary repairs. This, of course, necessitates the construction of a new pumping station which, it will be appreciated, is a major constructional operation and likely to take some considerable time under present conditions of labour and material.

Various suggestions have been made from time to time, as to the methods of dealing with the discharge from a new pumping station on this site, and it is in connection with these various possibilities that the investigations dealt with in this report have been made.

Present System of Land Drainage in the Districts concerned.

The River Glen from Surfleet Sluice to Kate's Bridge, a distance of approximately $15\frac{1}{2}$ miles, is to all intents and purposes, a high level carrier river. This section of the river runs through fens at a level some 10' higher than the general ground level in time of flood, and deals with virtually no local catchment, with the exception of the Spalding and Pinchbeck area which is discharged from the Blue Gout drain into the River at Surfleet Reservoir. This sub-catchment (Spalding and Pinchbeck area) in no way influences the length of the River Glen under consideration in this report in so far as variations to high flood levels are concerned.

The present function of the River Glen is to discharge the run-off from its catchment above Kater's Bridge. Definite information as to this catchment area is not available, but as far as can be ascertained from Ordnance sheets, this approximates

^{156 Sq. miles} 100,000 acres. The River is subject to a very rapid rise (to ^{Run off "} ~~to~~ ^{from 2/8} a high level) and fall and in ^{most} cases the effect of a big flood level is dissipated in a relatively short period. ^{These} ^{in addition 2 1/2 hrs "} ^{15 1/2 weeks} high flood levels will obtain until such time as works of a major character have been carried out in connection with the River. ^{for 4 hrs in 1880} ^{188 weeks}

The Bourne South Fen and Thurlby Fen area has a somewhat complicated system of drainage. In the past, various drains have been constructed in the lower part of the fen which involved with the pumping station near Fongue End. The water discharged by this pump eventually gravitating, by means of Heathcotes Tunnel, through the Deeping Fen district to the River Wolland at Surfleet.

At the upper end of the Bourne and Thurlby Fens (to the west) the Car Dyke acts as a catch water drain to an area of highland approximating 2,500 acres. The reputed function of Car Dyke is to prevent this highland water from reaching the Fen, and thus being pumped, by discharging it into the Bourne Eau at Eastgate. At times, when rainfall is moderate the Bourne Eau discharges by means of automatic doors into the River Glen at Tongue End, but as soon as the River Glen becomes swollen to any degree, as a result of floods, the Bourne Eau doors close and, after a variable reservoir capacity has been used, discharge is obtained by means of an overflow weir, set at approximately 14 O.D., into the Black Sluice Internal Drainage Board area.

The various Drainage Authorities concerned. A number of drainage authorities are concerned in this problem and their various interests are set out below.

The Bourne South Fen and Thurlby Fen is interested in so far as that they are at present unable to discharge their surface water in a satisfactory manner and some form of improvement must be carried out in the near future to alleviate the possibility

of a high water level throughout this area. Another point to be borne in mind in connection with this district, is that the Car Dyke in time of flood has on many occasions had its east bank breached, with the resultant increase of flood water in the Fen assuming serious proportions. In common with all Fen districts this area is also interested in the stability of the banks of the River Glen and the Bourne Eau during a time of flood.

The Black Sluice Internal Drainage Board and the River Witham and Steeping Catchment Board are interested in so far as they have to accommodate any water which is discharged by means of the Bourne Fen overfall. This overfall comes into operation when the Bourne Eau reaches a level of approximately 14 O.D., and any discharge passed by this weir has to be taken through the Black Sluice system in the Witham and Steeping Catchment area. It should be noted that this overfall only operates for relatively short periods of time and serves quite a small catchment made up of the highland to the west of Bourne and Thurby. The area concerned is rather more than 2,500 acres and allowing a very high figure for run-off calculation and spring water, it can be anticipated that the discharge, as an absolute maximum, would be something in the order of 40 cu.secs. These two Authorities are also interested in the stability of the north-west bank of the River Glen and the northern bank of the Bourne Eau as, of course, if either bank failed at high flood considerable flooding would take place within the area.

The Deeping Fen, Spalding & Pinchbeck Internal Drainage Board are interested in so far that, under the present regime, water is discharged from Tongue End pumping station via Heathcotes Tunnel and thus into the Counter Drain and Vernatt's Drain. This system is not satisfactory and previous reference has been made to this matter in a report on the Vernatt's Drain 1941 Improvement dated May 17th, 1941. An extract from that report reads as follows:-

" At present the banks of the Counter Drain allow seepage and when fairly high levels are maintained for any length of time this seepage assumes serious proportions". The level at which this

seepage becomes fairly serious is in the neighbourhood of 7 C.D. Assuming that the total run-off from Bourne South Fen and Thurlby Fen was discharged in a satisfactory manner into the Counter Drain, this seepage level could ^{not} be greatly exceeded unless some form of booster station was erected on the Counter Drain near Podo Hole. Suggestions have been made, in the past, that the Heathcotes Tunnel could deal with the Bourne South Fen and Thurlby Fen water in a satisfactory manner, in so far as transferring it from one side of the River Glen to the other is concerned, but, under certain conditions of pumping, calculations show that this Tunnel would be liable to failure due to hoop stress. If this Tunnel were to collapse at any point the results to the surrounding fen would be disastrous, as the whole of the foundation of the Glen banks in the vicinity of the fracture would become undermined with consequent failure, and ultimate flooding. This Board is also, in common with every other interested Authority, concerned with the general stability of the River Glen banks, as a considerable area is under the command of the Glen water levels at the time of flood.

A new Board is also being formed west of the Gravel Drain, and preliminary investigations show that it is possible that the extra water to be discharged down the Counter Drain from improved drainage in this area, may be dealt with by gravitation, but if in addition the Counter Drain also had to deal with the total catchment of the Bourne area a new booster station would have to be erected in the Counter Drain.

The River Wolland Catchment Board is interested in so far that they are the authority responsible for the maintenance and stability of the flood protection banks of the River Glen. The main function of the Glen, which is under the jurisdiction of this Board, is, as has been previously stated, the discharge of run-off from the area of approximately 100,000 acres above Kato's Bridge. A considerable amount of concern has been expressed by various people, from time to time, as to the effect on the behaviour of the River during a flood if additional water is to be carried.

*Wolland Fen
Bourne Fen*

Possible Sources of Discharge for Bourne South Fen and

Thurlby Fen Pumping Station. First - the present system with

various alternatives as to the capacity of the pumps and limitations of levels, would not prove an eminently satisfactory solution without the expenditure of a considerable sum of money within the Deeping Fen area, in addition to the apparent cost of the plant.

Second - a syphon could be constructed over the Glen or an inverted syphon could be laid under the Glen to discharge into the Counter Drain, but here again considerable sums of money would have to be spent in the Deeping Fen area to deal with the discharge in a satisfactory manner.

Third - mention has been made in the past of the possibility of dealing with the discharge from the Bourne South Fen through the Black Sluice and the Witham and Steeping Catchment Board areas, but an extremely involved and complicated survey would be necessary before any adequate opinion could be expressed on this solution, and in addition the position would be somewhat involved due to the combined interest of two separate Catchment Boards.

Fourth - from time to time the suggestion has been put forward that pumping into the Glen would prove a solution to all the problems of the Bourne South Fen, but concern has been expressed by numerous people as to the effect on the behaviour of the Glen during a flood, the stability of the Glen banks and the effect on the quantity of water to be dealt with by the Black Sluice Fen area from the Bourne Eau.

Suggestions Re Pumping into the River Glen. A great amount of anxiety is felt in certain quarters as to the effect on high water levels in the River Glen if pumping were to take place into a river, that is, to all intents and purposes, a high level water carrier, and I agree that totally unrestricted pumping would not be desirable in every respect.

I have made an inspection of the banks of the River Glen, and have the following observations to make. The banks are well