closed altogether. The most active area today is in west and south Yorkshire, with a large development in prospect near Selby. Fig. 7.1. shows the locations of the principal active and other collieries and their proximity to the principal waterways. The waterways most likely to be affected by current and future workings are the Sheffield and South Yorkshire Navigation, the New Junction Canal and the Aire and Calder Navigation and the Trent and Mersey Canal at Stoke and Rugeley.

7.2.8 In dealing with subsidence the essential point with respect to waterways is that in any pound the water will maintain a horizontal plane; this means that the banks and other works containing the water must be raised to keep pace with – or anticipate – the subsidence. Similarly bridges must be raised to maintain headroom. Complications arise when tunnels or weirs exist, each of which will require individual consideration as to what the most appropriate form of treatment would be. If a remedy by way of structural repair or alteration is not feasible then sterilisation of the relevant part of the coal seam may be the only possible course.

7.2.9 Even when the water level can be maintained by suitably raising the banks it will usually be necessary to form a revetment of piling, etc., to retain the deeper bank and to place clay puddle to ensure water-tightness against the greater head of water. With large movements the bed of the waterway must be filled in with suitable material to safeguard the banks from bursting under an abnormally great hydrostatic head. Where high embankments are thus formed it may be necessary to purchase additional land for their wider bases.

7.2.10 With key structures such as locks and aqueducts there is often a risk of distortion and structural failure as the subsidence develops and greater loadings have to be borne from the increased depth of water. In fact there is hardly any component of a waterway that will not call for remedial attention once subsidence begins. This is because the preservation of the original water level is essential, differing entirely from conditions on a road or railway where temporary changes of gradient and level may be tolerated without undue difficulty. On a long canal pound it may become necessary to construct stop gates (or stop grooves) in a mass concrete narrow section at intervals in order to divide a newly raised length into sections as a precaution against a breach.

7.2.11 In addition to deep mining coal is being worked by opencast methods; Fig. 7.2 shows nine sites affecting the BWB waterways. The BWB/NCB agreement does not apply and the legal position is different in these cases; rights of support for waterways are secured through the insertion of conditions for planning consent or by ad hoc negotiations. BWB have requested planning authorities to take account of the principles set out in the 1960 edition of "The Control of Mineral Working" prepared by the Ministry of Housing and Local Government. Extractions may be taken to great depths – perhaps 60 m or more – alongside the waterway; great care and frequent inspections are necessary to ensure that all risks are avoided. One proposal for opencast working would have involved the ground above Harecastle Tunnel where some 50 seams of coal are known to exist. Inspections and safeguards would be extremely difficult to enforce here and although the initial proposal was abandoned it may be revived if pressure to obtain more coal is again exerted.

7.2.12 While, therefore, the nature of the subsidence to be expected from opencast working is different from that due to deep mining (being due to risk of withdrawal of lateral rather than vertical support) the safeguards are perhaps less certain and the assurance of obtaining adequate redress – in the event of a breach for example – more problematical.

7.3 *Brine Pumping*

7.3.1 Brine pumping is undertaken by landowners in exercise of common law rights. "Wild" pumping is when a well or borehole put down on private land to the salt beds is used for pumping up the natural brine streams to the surface. The consequent subsidence does not occur in the same vicinity as a rule, but the rock salt may be dissolved and leave cavities several kilometres away which, on collapsing, cause subsidence and surface damage. Knowledge that brine pumping is taking place, therefore, calls for constant vigilance by the Board's outdoor staff so as to detect and deal with the first sign of incipient movement.

7.3.2 Brine pumping occurs almost exclusively in Cheshire; there are five sites on the Trent and Mersey Canal there where subsidence has led to the need for urgent remedial attention. An extreme case, at Thurlwood, resulted in the construction in 1957 of a unique steel framed lock, capable of adjustment to compensate for any further subsidence, in replacement of the original brick chamber which had suffered severe damage.

7.3.3 As an alternative to wild pumping newer methods of controlled pumping comprise the drilling of bores into the rock salt beds and injecting fresh water: the extraction of the saturated brine results in a minimum loss of water in the substrata so that little or no subsidence is experienced. If there were to be a general changeover from wild to controlled pumping the often serious effects of brine subsidence would be eased very considerably. Sites currently affected by brine pumping are shown on Fig. 7.1.

7.3.4 At Winsford salt mining is carried out in the dry by a "pillar and stall" method. This method was formerly used at Marston but subsequent flooding resulted in the salt pillars dissolving away. The resultant subsidence made it necessary in 1958 for the canal to be diverted laterally by more than 100 m over a length of nearly one km. Controlled workings are currently designed to avoid possible risks of subsidence but it would not seem feasible to guarantee that future incursion of water, or changes in the flow of underground streams, will not ever cause some ground movements to occur. The consequences would then be akin to those now resulting from wild pumping.

7.3.5 Under an Agreement of 1930 (subject to annual review) between the Board's predecessors and the Wild Brine Pumping Association the BWB received repayment of part of the cost of remedial works; originally two thirds the proportion has gradually been reduced to less than 10%. The difficulty, from the BWB's point of view, is to establish which of the five pumping stations worked by British Salt and the one by B.P. Chemicals could be held responsible for any particular damage. The British Railways Board are in fact concerned with problems affecting their installations to a much greater degree than BWB, and have for many years played a leading part in negotiations with the Association. A firm of mining consultants is at present engaged on a survey on behalf of the two Boards jointly but their report is still awaited.

7.3.6 The present position with regard to brine pumping may be summed up by saying that there are no material arrears of remedial works outstanding as a result of past

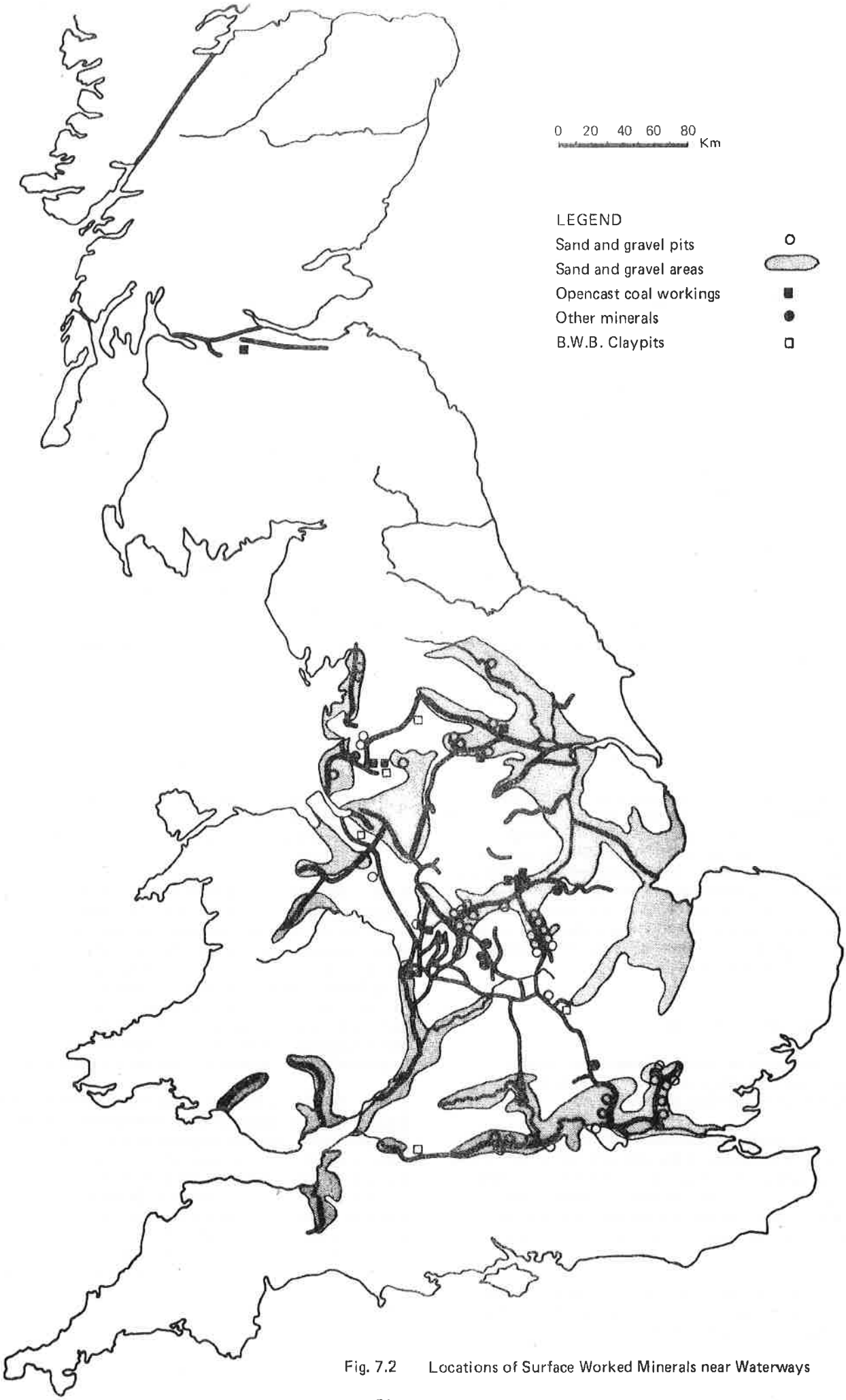

Fig. 7.2 Locations of Surface Worked Minerals near Waterways

subsidences but that constant vigilance is necessary to anticipate, detect and deal with current movements. Costs to the BWB are of the order of £20,000 p.a. at present, of which less than £2,000 is recovered, but they may vary considerably and unpredictably in the future.

7.4 *Sand and Gravel Extraction*

7.4.1 The output of this industry within the country is very large – approaching that of the National Coal Board – and as many waterways are located within river terraces the BWB is being increasingly affected by new pits coming into production and by the extension of existing workings. There are at present some 32 sites near their waterways, as shown on Fig. 7.2, and as these are worked out others will take their place.

7.4.2 The danger from these workings – as with opencast coal working – is the possibility that withdrawal of lateral support may cause a breach, perhaps with disastrous consequences. Because of the complex nature of the legal situation regarding rights of support it is the Board's policy to ensure clarification of their rights by obtaining the insertion of suitable conditions before planning consents are given; this avoids any difficulty of having to pay compensation for the sterilisation of minerals. In one case BWB obtained an injunction against an abstractor.

7.4.3 The broad position appears to be that Planning Authorities are willing to respect and protect rights of support in this way and it is their practice to invite observations from BWB on any application to work minerals alongside a waterway. On the advice so given they would then stipulate, for example, that an undisturbed margin should be left adjoining the waterways and that a specified angle of slope for the limit of the workings should not be exceeded. The size of the margin, and angle, would depend on the local conditions.

7.4.4 So long as protection of this kind can be relied upon the BWB is unlikely to be put to any considerable expense in consequence of sand and gravel extraction workings. It is, however, essential that regular inspections of such workings should be made from time to time to ensure that the planning conditions are being complied with. This will be easier where gravel workings are in the dry, as they often are in the north, than with the wet pit workings common in the south; it may be extremely difficult to be sure of the amount of support being left below the water line.

7.5 *Other Mineral Workings*

7.5.1 There are a few instances where other mineral workings affect the Board's waterways, either by mining or by excavation at surface level alongside.

7.5.2 In Scotland partial extraction of fireclay takes place east of Glasgow by mining on the pillar and stall system. There has been no subsidence to date and no remedial works have been required. It is necessary, however, to establish bench marks in the areas concerned in order to provide evidence of subsidence and so establish a basis for determining any claim for compensation.

7.5.3 In the midlands in particular marl has been worked in deep pits for brick making over a long period of years. Apart from a little overburden the whole depth of the working face is good material, so that backfilling of waste material against excavated slopes is not possible. There is no general agreement covering this situation and the Board must seek by persuasion or negotiation to ensure that desirable support is provided by the method of working. Right of action against the pit owner arises only when actual damage occurs, or is immediately threatened, but the Board would seek recourse to this procedure only when negotiations fail to produce the necessary safeguards.

7.5.3 Other minerals less frequently encountered include granite, chalk, gypsum etc. – only a few sites exist throughout the whole system. Generally the principles of action outlined in paragraph 7.4.3 and 7.4.4 apply in these cases also.

7.6 *BWB Mining Section*

7.6.1 In view of the highly specialised nature of the several tasks described above the Board has provided from its inception for their being supervised by a separate section, under the Chief Engineer, headed by the Mining Engineer who, with his staff, is stationed at Leeds.

7.6.2 The basic duties of the Mining Engineer include the following

(a) to be fully informed of mineral workings near and under the waterways, current and projected,

(b) to ascertain the proposed method of working, establish rights of support, predict and advise the Area Engineers of the location and rate of subsidence to be expected,

(c) to collaborate with the Area Engineers in advising the Chief Engineer on the policy to be adopted (e.g. accept, sterilise etc.),

(d) to undertake, in conjunction with the Estate Officer where appropriate, valuations of minerals, assessments of land purchases, way leaves, licences and royalty payments.

7.6.3 All these, and the many auxiliary functions, involve frequent consultation with officers of the National Coal Board, Brine Pumping Association, Planning Authorities and many individual undertakings. Expert knowledge of mining operations and their consequences is essential, together with an appreciation of the legal questions that arise from time to time. Inspections of workings, examination of proposals and in some cases the preparation of evidence to be given in planning appeals and actions for damages, etc., also call for wide experience of all aspects of the Section's responsibilities.

7.6.4 The Mining Engineer is required to advise the Chief Engineer on those aspects of BWB development schemes (e.g. for commercial freight carrying improvements) which are likely to be affected by prospective mining operations. Similarly he will be called on to advise where bridge reconstruction plans (e.g. under operation "Bridgeguard" as described in Chapter 10) would be influenced by current or future mining. Not the least difficult of other problems of this kind will be where mining operations are likely to cause subsidence at or near the site of a reservoir headbank.

7.6.5 Having considered the importance of all this specialised work, and the possible financial consequences to the

Board of a lack of expert advice and attention, we are quite sure that the decision to confide it as a whole to one specialist Section is the right one.

7.7 *Future Trends*

7.7.1 As was said at the beginning of this chapter, BWB have relatively little control over the expenditure arising year by year in preventing and remedying the effects of mining, pumping and similar operations. Past experience is an unreliable guide to the future as Government policy is now tending to encourage the exploration and exploitation of minerals and the national output, taking all kinds together, is likely to increase. If this means, as seems to be indicated by the new Coal Industry Bill, that there will be increasing pressure to extract the highest possible yield of mineral from every hectare of land, then there will be an increasing reluctance to sterilise minerals for the sake of giving better support to the waterways.

7.7.2 Modern methods of coal mining utilise mechanised equipment which work on rapidly advancing faces; they tend to cause widespread surface damage and to be intolerant of diversion or modification for the formation of support pillars. Opencast coal production is increasing because of its high profitability and technological advances have made ever deeper excavations feasible. Sand and gravel production is intensifying because of the ever widening use of concrete in roads, buildings and structures. It would therefore appear to be certain that the Board's liabilities will increase, rather than decrease, in the future and we shall accordingly make a notional provision for future expenditure in the estimates presented in Chapter 12.