

Maintenance Methods and Strategy

11.1 Introduction:

11.1.1 Having considered and defined the standards of maintenance implied by the Board's various obligations we are now required by paragraph 9 of our Terms of Reference to consider the methods of maintenance, and the strategy for timing of maintenance which, in our opinion, would be most economical, and to give estimates of cost. It was made clear to us that these factors are to be in relation to normal conditions, and not to any existing arrears of maintenance which are referred to in paragraph 12 of the Terms of Reference.

11.1.2 The question of costs is also involved in the consideration of arrears of maintenance however, and various alternative programmes for dealing with such arrears are contemplated (TR paragraphs 13-15) which, we were instructed, are to be devised in accordance with the general strategy and principles evolved under paragraph 9, so far as they can be applied to an arrears situation.

11.1.3 In this context "strategy" is used in a wider sense, as although paragraph 9 mentions strategy of timing, it was suggested to us that consideration should also be given to the relative merits of:— "preventive" and "breakdown" maintenance; water-based and land-based methods; and bank protection as an alternative to additional dredging. In reaching conclusions on the most economical solutions the financial effects of deferring expenditure were suitably to be taken into account by discounted cash flow methods.

11.1.4 In these circumstances we shall discuss in this Chapter possible methods of maintenance which B.W.B. might adopt in order to meet their obligations, including those mentioned in the preceding paragraph, and their respective merits in relation to both normal conditions and an arrears situation. We shall then take up the question of costs in Chapter 12 and, after identifying existing arrears of maintenance, proceed to examine alternative programmes for dealing with them.

11.2 Elements of Maintenance:

11.2.1 The BWB system comprises several different types of waterway and each waterway contains many diverse structural elements. All these types and elements call for maintenance in a variety of ways, so that the very concept of maintenance needs to be examined with some care. It is certainly not a simple activity that can be subjected to treatment of a doctrinaire kind right across the board.

11.2.2 Consideration must be given to the practical needs of maintaining both artificial canals and river navigations, as well as canalised rivers which combine the characteristics of both. In any of these there will be works of a kind needing attention at regular intervals; perhaps annually but sometimes less and sometimes more frequently. Provision must also be made for the inevitable quota of unpredictable minor items that crop up from day to day — individually minor but amounting to an appreciable volume in total.

11.2.3 A few examples of typical structural elements will illustrate some of the different ways in which deterioration

occurs and maintenance works become necessary.

(a) *Dredging:* In all waterways there is a gradual accumulation of silt on the bed arising from bank erosion and the incursion of materials brought in by surface water. All this needs to be removed periodically in order that the required underwater profile may be restored. Provided that the deposits are cleared before the reduced depth of water impedes the movement of craft the timing of the dredging operation is not very critical; such an impediment may occur without notice, however, in the case of a large feeder carrying quantities of sediment into the water after a storm or as a result of floods.

(b) *Bank protection:* As initially constructed the banks of waterways were almost invariably protected on the towing path side by some form of revetment, with the object of resisting erosion from waves and the wash of craft as well as to give support to the path. This might take the form of masonry, stone pitching, timber piling etc. The offside bank would receive similar protection as a rule only where the depth of water or the nature of the bank made it necessary. Erosion of unprotected banks and disintegration of revetments is an inevitable consequence of water action after a longer or shorter period of time, calling for repair or replacement of revetment works or the construction of new types of work to ensure due protection of the banks. The consequences of failure to take proper and timely remedial action may include collapse of the towing path, leakage of water, increased siltation and even a complete breach with a major outrush of water.

(c) *Embankments:* A stretch of canal carried on an embankment may call for little special attention over a long period. If a leak should develop, however, it is important that it should be checked without delay; otherwise the bank material may become softened with the risk of a slip developing, perhaps of very serious proportion, or 'piping' could quickly result in a breach. The timing of remedial action is thus dictated by the event and cannot be deferred to suit the convenience of a programme.

(d) *Bridges:* Apart from any effects of overloading, a highway bridge will usually deteriorate slowly and in a predictable manner. Maintenance strategy for a number of bridges in a given area may, therefore, be planned to take account of the lapse-rate of condition, so as to optimise the overall programme of works at minimum total cost.

(e) *Lock Gates:* The life of a typical pair of lock gates may be some 30-40 years, but only if attention is duly given to remedying the effects of deterioration at appropriate intervals. Deterioration of working faces, sluices and gearing must be attended to if operating troubles are to be avoided. Damage caused by misuse or accident may give rise to excessive loss of water which, though not involving risk of failure or danger in itself, would necessitate the loss being made good at all the locks in the flight so as to keep the pounds up to level.

(f) *Routine Maintenance:* includes such items as weed clearance, hedge and grass cutting, needing annual attention. Less frequently, the painting of steelwork and docking of vessels must be undertaken. Unpredictable items may include the mechanical breakdown of plant, fallen trees, blocked culverts, damage by vandals, etc.

11.2.4 Whatever further connotation the term "Maintenance"

may have it at least implies the operational tasks involved in keeping all these manifold elements of the waterways in a proper and effective condition for carrying out their respective function whether by periodic works of repair or by renewal or replacement at the ends of their respective lives. In general industrial practice costs of repair are charged directly against revenue, under various maintenance headings, while renewals may be charged against capital or otherwise funded.

11.2.5 Renewals of component assets at the ends of their physical lives do not constitute a real increase in the value of the waterway as a whole, in the sense of being able to generate additional revenue, and there is no reason why the costs of such renewals should not be charged, directly or indirectly, against revenue in the year in which they are incurred. This is in fact the BWB practice and we see no objection to it.

11.3 *Preventive and Breakdown Maintenance:*

11.3.1 The concepts of "preventive" and "breakdown" maintenance may be regarded as the extremes of maintenance strategy taken in a broad sense. In the one case care is exercised to anticipate the effects of age and deterioration on the condition of various structural components and to safeguard their continued ability to meet requirements; in the other case little or nothing is done to carry out repairs until such time as a component fails and must be replaced. The risks in the first case are of doing work too far in advance of the optimum timing, and so incurring expense unnecessarily, and in the second case of a failure's having very serious — perhaps disastrous — consequences.

11.3.2 It is not difficult to appreciate the kind of consequences that could follow on the failure of some components. A lock gate, (or even its sluice gearing) becoming incapable of operation could cause a complete stoppage of traffic and, in some cases, a heavy loss of water from a key pound. Far more serious, from the point of view of public safety, would be the risk of a major breach of an embankment as the result of a neglected leak through a waterway bank or a structural failure of an aqueduct or culvert.

11.3.3 Different types of structural elements have, as already mentioned, different characteristics of deterioration; some age slowly and the effects can be foreseen and allowed for without undue risk. Others are liable to display a marked acceleration towards failure once a particular level of depreciation has been reached. In such cases either there must be a system of sufficiently early preventive treatment or frequent inspections must be instituted to detect and forestall incipient failure.

11.3.4 Where the rate of deterioration is likely to be reasonably uniform over the full life of a component the actual total costs of repair will be virtually unaffected by the timing of the work. Discounted cash calculations will in this case indicate a saving if the intervals between repairs are longer rather than shorter. Where, however, a slow initial depreciation may be followed by rapidly increasing decline, the total cost of repairs will be least if they are put in hand before the decline sets in.

11.3.5 Having regard to the need for BWB to be able to show, for example in the event of a major breach leading to heavy flood damage, that they have not been negligent, it is essential in our view that they should carry out inspections of the waterways and their component structures on a regular

and systematic basis. We deal more fully with what these inspections should comprise in paragraphs 11.4.1 and 3 below, but it is obvious that without them the risks attaching to a strategy of breakdown maintenance (financial even more than physical) would be immeasurably increased.

11.3.6 We were not, therefore, surprised to find that BWB do operate an inspection procedure and that they have been able, in consequence, to avoid the worst results of serious failures on numerous occasions. In our view such a procedure can provide the basis of a system of maintenance that is feasible and effective, and that avoids the disadvantages of either of the extreme practices. This system, which for convenience we designate by the term Programmed Maintenance, also has the advantage of allowing for careful scrutiny of competing claims when compiling annual works programmes. We therefore consider that programmes of maintenance works should be drawn up on this basis, as described in more detail in the following section.

11.4 *Programmed Maintenance:*

11.4.1 Programmed Maintenance in this context would include the following elements:—

- (a) The regular and systematic inspection of all works, structures and equipment at specified intervals, (which will differ according to the nature of the work, structure, etc.,) the results being reported through the supervisory chain to the appropriate engineer in standard form.
- (b) The carrying out immediately of any work of repair found to be necessary in the interests of public safety or the avoidance of major damage; the action taken being also reported.
- (c) The compilation by the engineer of schedules of maintenance works reported to be necessary, after confirmatory inspection by specialist officers if required, with estimates of cost and an assessment of the degree of urgency for attention.
- (d) The advance preparation of plans covering methods, labour, materials, plant, etc., required for various kinds of scheduled repair works, so as to allow for their allocation or ordering at the right time and to avoid conflicting demands for resources.
- (e) The drawing up of programmes (for say one year ahead) of specific maintenance operations and works to take account of both ascertained requirements and available resources in the most efficient manner. Estimates of cost would also be compiled at this stage.
- (f) The normal processes of obtaining authority for the necessary expenditure, arranging for the works to be put in hand and supervised and for control of costs, would then follow.

11.4.2 The main objectives of this method are that, while dangers and risks are detected in good time, work in general is not undertaken until inspection has shown it to be necessary and until there has been an opportunity of fitting it into a properly considered programme. It thus avoids expenditure being incurred unnecessarily, as may occur when maintenance

works are carried out to a rigid time-table. It is consistent with good managerial practice in allowing for budgetary control, flexibility of administration, etc., and also permits of whatever degree of delegation of responsibility is considered appropriate.

11.4.3 In considering the application of this method to the BWB system some general observations should be made as follows:—

- (a) The regular inspections should be carried out by an inspector having a close personal knowledge of a defined section of waterway and possessing adequate technical qualifications. The inspector must have the backing of a qualified engineer to whom he submits his reports and who, in addition to regular personal visits, can be called on at once in case of emergency. Major structures should be inspected by qualified engineers.
- (b) The knowledge, qualifications and delegated authority carried by the inspector must be sufficient to enable him to carry out at once all work of the kind referred to, subject where appropriate to his obtaining due instructions or authority from his engineer on matters of technical or financial importance.
- (c) In waterway maintenance, as with most fields of maintenance, there is a stratum of work that is very closely linked with the regular inspections. For example, the detection of leaks, incipient slips, damage to lock gates and gearing, checking of water levels, freeing of blocked weirs, etc., etc. — all these call for experienced and unremitting attention and cannot be dissociated from the consequent maintenance work entailed. Such work is not capable of being dealt with on a programmed basis and would be the subject of a general provision for routine maintenance before providing for the scheduled items.
- (d) There will be a considerable number of items arising from the inspector's and engineer's reports that require examination by those responsible for special services and departments, e.g., as regards workshop resources; the allocation of plant, equipment, and floating craft; mechanical and electrical techniques, etc. The results must be co-ordinated at the appropriate higher levels of the engineering organisation.
- (e) Many items of maintenance are of a recurring character and their demands upon labour, plant and materials will be accurately known. Others will require special consideration and planning in order that each item may itself be carried out efficiently and that it may also be fitted into a larger programme with maximum economy. Consideration will also need to be given, in the case of large works or those of an exceptional character, to the advisability of having them carried out by contract so as not to dislocate departmental resources unduly.

11.4.4 The compilation of annual programmes of maintenance works within the BWB commences with the submission to Area Engineers by Section Inspectors of particulars of works they consider should be included in the budget for the next year. Area Engineers coordinate the submissions, which are progressed to Principal Engineers, who then present to the Chief Engineer in the spring or early summer a budget submission for maintenance works required in the following year. From

this point on, however, it would not appear that the eventual programmes and the associated budgets take full account of the principles we have outlined. Processes of obtaining financial authority, authorising the execution of works and keeping account of expenditure fall within the managerial functions and, except to the extent that we comment on them in paragraph 11.4.6 do not call for examination under our terms of reference.

11.4.5 We feel it necessary, however, to comment on the way in which approval is given within the BWB for undertaking programmes of maintenance works year by year. The practice appears to be that proposals for the year's special maintenance expenditure (items over £2,000) are submitted to the Chief Engineer the previous April or thereabouts. After consideration at headquarters approval is given for a programme of special works with an intimation that further specified sums will be made available for general maintenance. On receipt of this information the Principal and Area Engineers proceed to consider how these respective sums should be expended, having regard to labour, materials and plant resources and to the possibility of placing contracts.

11.4.6 This procedure means that the items of work carried out are governed by the amount of money made available, rather than by considerations of maintenance standards or engineering criteria. We understand that in deciding what sums of money can be devoted to maintenance works the Board pay attention to the importance of any relevant considerations urged by the Chief Engineer but it seems clear to us that on any reckoning the content of the annual programmes can have no direct relation to any obligation to comply with and maintain specific standards.

11.5 *Operational Duties*

11.5.1 In addition to purely maintenance activities the engineering department is responsible for various operational duties. These include, particularly on the Commercial Waterways, the operation of swingbridges, locks and sluices, while on Cruising Waterways the general supervision of lock working, control of water supplies, emptying of dustbins and checking the depredation of vandals may be cited. There is a greater regularity of craft movement on the Commercial Waterways, so that labour engaged on operational duties cannot readily be switched to other work. With the Cruising Waterways, however, the season generally lasts from about Easter to Michaelmas (although there is a tendency for it to lengthen at both ends) and there is scope for using, for maintenance duties in the winter months, men who are required for operational duties in the season. Such duties are apt to involve regular overtime working at week ends throughout the cruising season.

11.5.2 There is some conflict of interest here, as the winter is not the best time to undertake many kinds of outside work. The cold weather and shorter hours of daylight militate against efficient working and, in any event, some maintenance operations, such as weed control and grass cutting, must necessarily be carried on during the summer months. Even after making the best arrangements possible on the foregoing lines certain types of maintenance works will necessarily involve complete cessation of navigation for a shorter or longer period; major repairs to locks, aqueducts, tunnels etc., are examples. Stoppages on Cruising Waterways must, as far as possible, be planned to avoid the peak holiday periods and the drawing up of a programme of maintenance works must,

in every part of the system, have due regard to the level of commercial and cruising activity to be expected (with a seasonal need for supervision of unskilled users of locks) and the numbers and calibre of staff available.

11.5.3 Provided that the essential regular inspections and attention to first aid repairs are not neglected, the expansion of a supervisory activity could not fail to be of benefit in conserving water supplies and reducing risks of accidental damage and vandalism. With the recent decline (and on many waterways the virtual disappearance) of the traditional trading boat and its experienced boatman, and simultaneously the rapid proliferation of other types of craft handled by relatively inexperienced crews, it is evident that the risks of misuse of the waterways, their equipment and their water supplies have increased very considerably.

11.5.4 It may be doubted if the additional cost of supervision could be justified at present traffic levels, except at a few locations where some degree of congestion is already evident in the season, but any considerable increase of traffic would make such a development more generally desirable, and indeed necessary. It will already have been noted in Chapter 9 (Water Supplies) that the conservation of water is, and will increasingly be, a consideration of the utmost importance in maintaining a viable waterways system. Having regard to the difficulties and cost of obtaining new or augmenting existing sources it is clear that the closest attention should be paid to the problems of maintaining supplies effectively in the drier seasons.

11.6 *Organisation:*

11.6.1 The maintenance and operating functions of the BWB are organised and administered under the Chief Engineer; a "family tree" is shown in Fig. 11.1.

11.6.2 While the responsibility for administering all the Engineering operations of the Board's Waterways rests primarily on the Chief Engineer at Headquarters, the Principal Engineers based on Leeds and Gloucester have direct responsibility for all Civil Engineering Works (including ordinary maintenance works, and approved special maintenance or capital works carried out by their Area Engineers) duly assisted by Area Inspectors and Section Inspectors on the waterways allocated to each.

11.6.3 At Headquarters, the Chief Engineer is assisted by the Deputy Chief Engineer and co-ordinates and controls activities of a specialised character such as Mining, Bridges, Water and Services. The Principal Engineer, Services, is responsible for mechanical, marine, construction and planning activities and through the Engineer, Mechanical, controls the Repair Yard and Plant Units.

11.6.4 Our terms of reference do not require us to examine and comment on this organisation as a managerial structure but we have given consideration to aspects having a possible bearing on the costs of maintenance, including in particular:—

- (a) the cost of the whole engineering administration in relation to the expenditure it controls and the probability of the control being efficient,
- (b) the extent to which the administration enables maintenance works and operations to be undertaken effectively by appropriate working relations between the various branches at Area and Section levels.

11.6.5 We have also examined the Board's practice in engaging the services of consultants or specialists for advising on and carrying out certain types of work e.g.:—

Inspections of reservoirs and the carrying out of works thereon under the Reservoirs (Safety Provisions) Act 1930.

Inspections of and the direction and supervision of contracts for major items of reconstruction or overhaul of structures and appliances.

Investigating circumstances (e.g. a breach of a canal bank) necessitating emergency action, including a geological survey or other specialised studies.

Research generally.

11.6.6 We shall comment in Section 11.9 on certain features where, in our view, modification of present practices could help to improve working relations between branches of the organisation. Some gain in efficiency would probably result but savings in cost would have no significant effect on the magnitude of expenditure required for maintenance now under examination.

11.6.7 In general, we find the managerial aspect of the engineering organisation to be well adapted to the nature of the tasks it is concerned with. The engineering staff is competent and keen, the proportion of specialists is appropriate to the required expertise and altogether we have been impressed with the professional skill which is brought to bear on the many problems that have to be dealt with in the context of restricted financial resources.

11.6.8 In saying this we do not imply that everything is perfect; we have already indicated above that the size of the establishment may be insufficient to cope with the number of inspections, and the financial provision inadequate for undertaking the full quota of works, that could be considered necessary.

11.6.9 Throughout the study we have taken note of the Board's accounting system and practices, with the object of determining how far they enable maintenance and operating costs to be identified under appropriate headings and to reflect significant items of receipt and expenditure. We have found the system to be capable of meeting all normal requirements of this kind, and no special difficulty has been encountered in extracting figures of cost needed for the purposes of our investigation.

11.7 *Maintenance in the Field:*

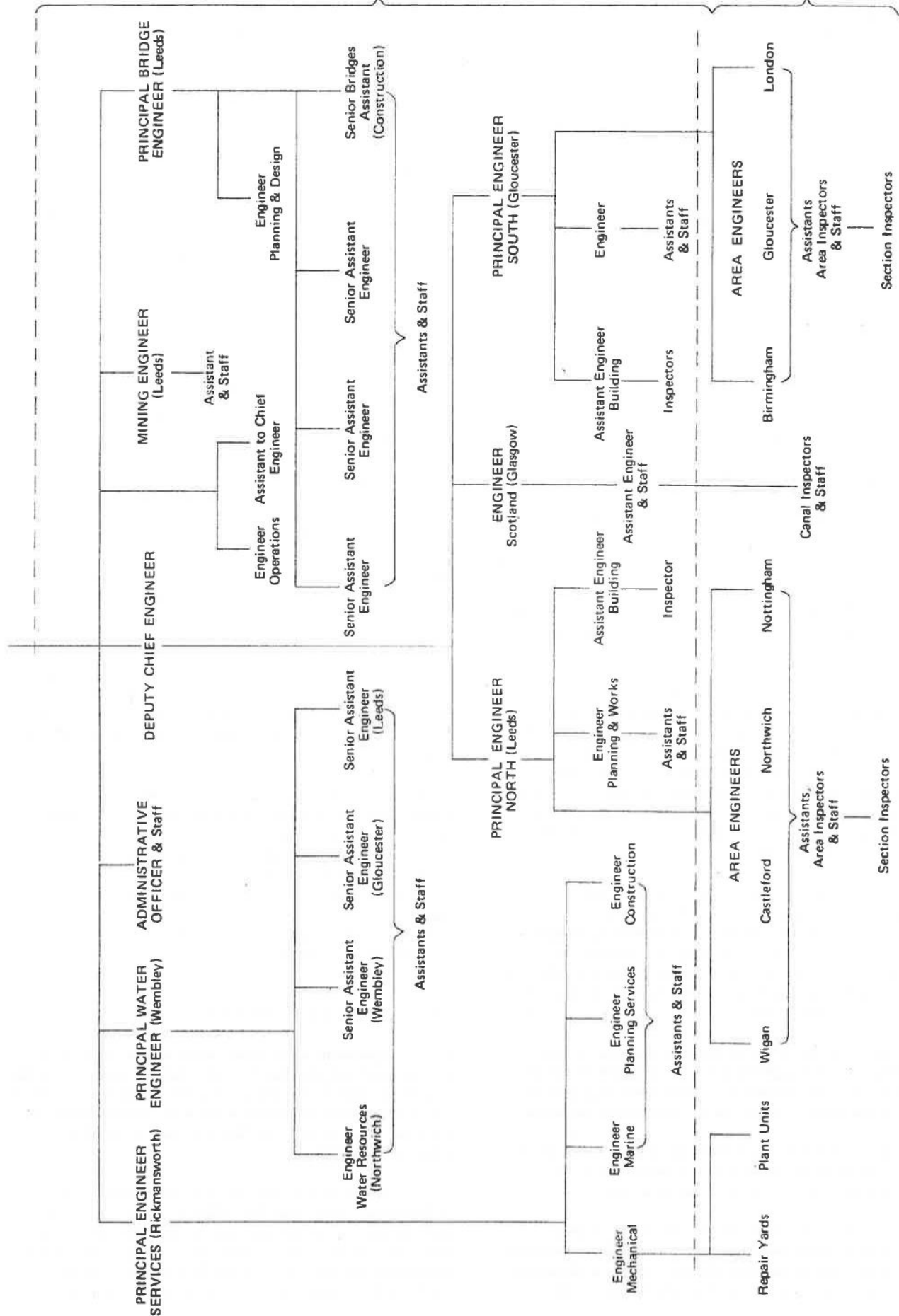
11.7.1 Passing from the upper levels of the organisation it will be seen from the "family tree" that the system is divided into Areas, each in the charge of an Area Engineer assisted by one or more Area Inspectors. Each Area is again divided into a number (four to eight) of Sections, each in the charge of a Section Inspector.

11.7.2 While some Areas may only cover 250 to 300 km of Waterway, others may have 600 km or more; of these, some Sections or lengths are maintainable to Commercial waterway standards while others are Cruising or Remainder waterways. Whatever his area the Area Engineer needs at least one Area Inspector whose function it is to act as liaison

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between the Area Engineer and the Section Inspectors, by daily contact with the Area Engineer and frequent contacts with each of his Section Inspectors.

11.7.3 The Section Inspector, with some 60 to 80 (but some up to 100) km of waterway to supervise is probably the key man in the maintenance organisation, having direct responsibility for an adequate and regular inspection of the waterways in his Section. He should be a qualified tradesman and must have a personal, complete and up to date knowledge of all structures and works in his Section, including bridges, sluices, gearing, etc., repairs of which would be undertaken by mechanical or electrical staff not under his direct control.

11.7.4 The Section Inspector should preferably have a close Assistant trained to have an intimate knowledge of the Section. He would share with the Section Inspector the regular daily tasks, both the site inspections and the supervision of the works in progress on the Section. He would deputise for the Section Inspector during times of absence and be trained for his own future promotion to post of Section Inspector. Failing such an Assistant, the duties described must be covered by foremen, and we find it is the general practice for each Section to have two foremen, one or the other of whom goes with the Section Inspector in alternate weeks.

11.7.5 First aid repairs are initially the immediate responsibility of the Section Inspector, whether they originate from his personal observation during his routine inspections or from a report received by him from one of his own staff or from a member of the public. In either case, he must immediately use his own initiative based on his local knowledge of the particular site of the incident. In some cases, he would notify the Area Inspector at once from the nearest telephone with a precise location of the site of the incident, a general indication as to the anticipated nature and extent of the incident and particular information as to the action which he will be taking with his own resources and the supplementary assistance required from Area resources and/or from the mechanical or other branch of the Board's organisation.

11.7.6 The Section Inspector will have a considerable amount of office work to attend to, including ordering materials, arranging plant hire, issuing permits of various kinds, etc. and must have the aid of an office man and/or clerk. As to the types and numbers of outdoor staff needed, the problem will vary between Area and Area and between Section and Section, taking into consideration the size of the normal maintenance programme, the availability of suitable labour for continuous operation or the desirability of using outside contractors and to what extent.

11.7.7 While each Section will probably include on its strength one or more bricklayers and joiners familiar with the particular structures on their Section, the winter works will possibly need some additional tradesmen, either drafted from a neighbouring commercial waterway or engaged on a temporary basis. Some labourers employed on the seasonal winter operations, will provide the hedge cutting and grass cutting gang, while others with seniority or residential convenience will undertake the seasonal control of locks, etc.

11.7.8 In former times any Section of 60-80 km would have had the maintenance of the hedges, towpath and banks undertaken by lengthsmen, each caring for his length of 5 to 6 km in the vicinity of his cottage, using only hand tools. Today, the change from isolated canalside cottages to central housing estates has resulted in the grouping of labour into

gangs, with mechanical transport from home to site, with mechanical appliances at the site and working through the Section instead of being confined to separate lengths. Conditions in this 20th Century have so changed family life that the canal employee will usually not accept an isolated canalside cottage but prefers his own (or Council) house with garden and garage close to the facilities of a town and situated conveniently in the Section.

11.7.9 The mobility of the motor vehicle, on the other hand, eliminates the necessity for resident reservoir keepers in lonely upland areas and has enabled one man to supervise two or three reservoirs and, during the summer, to control the distribution of the water from the reservoirs and to exercise some supervision over the operation of the locks, not otherwise manned.

11.7.10 If there is difficulty in obtaining and retaining staff, there could be a case for providing housing accommodation at a site or sites in the Section conveniently situated; but clearly the Board would have to be satisfied as to their ability to obtain possession if the tenant leaves their service. Such housing accommodation would enable the Section Inspector to have immediate contact by telephone with a nucleus of his men for dealing with an emergency. It could be accepted that at key points, flights of locks, etc., housing accommodation should be provided with telephone, etc., but it would appear that a general provision of housing accommodation for their employees could present the Board with certain problems and without equivalent advantages.

11.7.11 Having regard to the typical circumstances reviewed above we consider it essential that the maintenance strategy for the BWB system should be firmly based on an adequate cover of Section Inspectors supported by local staff competent to undertake both regular inspections and first aid repairs. Each would cover a specified length of waterway (including where appropriate reservoirs and other special features) and live close to that length.

11.7.12 Fundamentally, there are three ways by which the labour element of maintenance may be provided; (a) local, perhaps resident, staff able to perform a wide variety of tasks but with a basic reliance on their total responsibility for a given length of waterway, (b) roving gangs, based on a regional centre and equipped with transport and tools for their respective trades, who move from length to length and place to place according to needs and priorities and, (c) reliance in the main on outside contractors who may either be awarded specific items of work by competitive tendering in each case or may undertake a wide range of work in a given area for a limited time under a maintenance contract.

11.7.13 The choice between roving gangs and contract labour for carrying out programmed works will depend on a number of factors, e.g. the kind of waterway (river navigation, narrow artificial canal, etc.,) the feasibility of obtaining the right type of permanent tradesmen and semi-skilled men on BWB terms and conditions in the area concerned and, of course, on the size and character of the schedule of works contemplated. While we believe that a regular flow of maintenance work is most economically handled by competent direct labour methods, including of course adequate supervision, we accept that the contract alternative is unavoidable where an adequate labour force cannot be recruited.

11.7.14 All direct-labour staff must be properly supported not only by supervision and technical direction but by

appropriate tools, stocks of materials and depots. If the larger items of maintenance work are undertaken departmentally, there will be a need for workshops, powered plant and equipment at strategic centres. In the case of specialised work such as the manufacture of timber lock gates it is highly desirable that the expertise acquired by the Board's own staff should be made use of; manufacture by outside contractors unfamiliar with requirements can readily lead to unsatisfactory results.

11.7.15 In major items such as a bridge reconstruction, a new weir or extensive bank protection works, it would normally be quite satisfactory to engage outside contractors and a decision would properly be made on the basis of availability of labour and relative costs. A general tendency to employ contractors rather than departmental labour would have repercussions in reducing the demand for fixed workshops and floating plant, so reducing direct overhead charges and compensating for any additional supervision that may have to be given to contractors' operations.

11.7.16 A system based on the use of direct labour would tend to rely on work boats, floating cranes, etc., with workshops for upkeep and servicing; a contractor on the other hand would have his own plant and base and would naturally make use of them. So long as the work sites were reasonably accessible by road the contractor would no doubt be well placed, but a remote site might compel him to make at least partial use of water transport for plant and materials.

11.7.17 This raises the question of whether or not BWB's own maintenance resources would be better organised in these days on land-based units rather than the traditional water-based methods. We have considered this but do not feel that it is possible to give an answer of universal application. There is no doubt that it is possible nowadays to make much greater use of land transport for bringing labour, plant and materials to many sites. On the other hand many sites are not readily accessible by land; some particularly vulnerable banks for example can be reached more quickly and easily by water when it is necessary to drive piling or carry out other works in emergency.

11.7.18 An operation which traditionally was always carried out by water-borne units is dredging. Versatile mechanical appliances are now available, however, which allow for them to work either from suitable craft or from land and the BWB have a number of such units which have proved to be successful, within limits, on land. We have already pointed out in paragraph 10.4.17 that where their use on land is feasible quite substantial savings in cost can be made. Where the dredged spoil cannot be deposited immediately on adjacent land it may still be necessary, however, to place it in floating hoppers for towage to a tip site; there is often no feasible alternative to this water-based method.

11.7.19 It may be necessary at this point to emphasise that bank protection works should not be regarded as an alternative to continuing indefinitely with dredging operations. It is true that one effect of protecting continuous lengths of bank with a solid revetment is to prevent erosion and thus reduce the amount of material requiring to be dredged; the eventual costs of dredging a particular length of waterway, over a period of years, may thereby be cut quite appreciably. But the saving in such costs will seldom if ever suffice to pay for the bank protection works, and such works will usually have to be justified on other grounds.

11.7.20 With all these considerations in mind, we have studied

the practices of the BWB and find that, in general, they accord with the principles we have outlined. Major works are in all cases put out to contract but whereas in the northern areas direct labour is employed on all routine and medium sized works this is not so in the south. We were informed that wage rates are insufficient to attract and keep there a full establishment of lengthsmen and tradesmen, so that it has perforce become necessary to place contracts for such routine works as hedging and ditching. This, we feel, is unsatisfactory on the grounds of both economy and standards of workmanship; it is better that such work should be undertaken by those who have acquired the necessary skills in the appropriate environment and who do not need the same degree of supervision.

11.7.21 Further, the numbers of maintenance staff in general below Section Inspector level, now employed by the Board, are insufficient to meet all the requirements outlined above. While the engagement of contractors may enable specific items and categories of maintenance work to be carried out it can do nothing to meet the needs for regular, systematic inspections and for immediate availability of experienced labour in emergency. Some reasons for this shortfall have already been indicated and it may be that it could be remedied only if wage rates were to be raised and/or if recruitment of additional staff were to be authorised — either step would no doubt involve policy decisions at a high level.

11.7.22 Nevertheless, we are bound to draw attention to the situation. We are not able to identify precisely where and what other staff would be needed as this would depend on a number of factors, including the steps to be taken to deal with arrears of maintenance in addition to meeting the requirements of a normal maintenance programme, but we have made broad estimates, based on information obtained in the course of this Study, which will serve as measures of what is involved. These are detailed in the next Chapter.

11.8 *Ancillary Services:*

11.8.1 Having now dealt with the basic demands and resources of the maintenance organisation it remains to consider certain ancillary services necessary for the proper operation of the system as a whole. Reference to the "Family Tree" shows that in addition to the main chain of responsibility from the Chief Engineer through Principal and Area Engineers, to the Area and Section Inspectors, whose functions have already been discussed, there are other Engineers carrying responsibility of a specialist character which supplement and assist those of the line officers.

11.8.2 There are three Principal Engineers, dealing essentially with specific fields of a professional kind; one located at Wembley for all aspects of Water and the other two at Leeds for Mining and for Bridges respectively. The Principal Water Engineer in turn has four Assistants, one each at Northwich, Leeds, Gloucester and Wembley. Comments on the work of this Section have been made in Chapter 9 (Water Supplies) and it is not necessary to say anything further here.

11.8.3 The work of the Mining Engineer's department at Leeds is highly specialised, dealing with the effects of both coal mining and brine pumping together with any other problems where its expertise is required e.g. tunnels. The field of this department's responsibilities has been reviewed in Chapter 7 and in our opinion it is right that a separate, properly qualified and fully experienced unit should concentrate

upon problems of this kind.

11.8.4 The Principal Bridge Engineer similarly has a specialised function for the benefit of the whole system; the main objects of his responsibility were reviewed in Chapter 10. In any circumstances, the number, variety and importance of the bridges maintained by the BWB would indicate the desirability of confiding their problems to one suitably qualified unit. Since its inception the Bridge department has been wholly concerned with operation Bridgeguard and the balance of work yet remaining to do is likely to occupy at least three more years. By that time we consider that other related problems, which have had to stand over during preoccupation with the main exercise, will be calling for attention and although some of these could no doubt be attended to by the line engineers there is bound to be enough work coming forward to justify retention of the Bridge department for several years thereafter.

11.8.5 Each Section Inspector in an Area has his own Maintenance Yard where stocks of materials are stored and which acts as a depot and focal point for the activities of his staff. Road vehicles are provided for transport of staff, and work boats to facilitate site operations, but other items of small plant are usually hired as necessary. A parallel and supporting organisation provides and maintains the larger items of plant and equipment, floating craft, etc., which the Area Engineer needs for the effective carrying out of engineering works in the field. This supporting service is centrally managed and directed by the Principal Engineer, Services, through an Engineer, Mechanical, who controls the Repair Yards and Plant Units.

11.8.6 Repair yards, comprising mechanical engineering workshops, are provided at eight centres throughout the country, with subsidiary workshops at three other centres and a specialist mechanical workshop at one further centre. They are not all organised or equipped to undertake the full range of waterway requirements but generally provide specialised facilities such as dry docks, slipways, cranes, machine tools, and other resources necessary for maintaining the various kinds of craft and plant. These include large and small dredgers, hoppers, crane boats, tugs, suction discharge plant, excavators, pumps, general maintenance and other civil engineering plant. Separately managed plant hire units are located at seven of the Repair Yards to provide a service to the maintenance organisation. Work of an appropriate nature is undertaken for outside parties from time to time in order to maintain a balanced output and to assist in making the Yard self-supporting financially.

11.8.7 Lock gates are manufactured at four of the Repair Yards. Most workshops are able to build new craft of the special types required for maintenance purposes; they are also equipped to undertake where necessary the maintenance of the larger swing bridges carrying public highways and mechanised locks and sluices. Other duties include the maintenance of the fixed pumping plant (all of which is electrically driven) at reservoirs, wells, back-lockage and other pumping stations. The supporting organisation contains a staff of craftsmen and semi-skilled labour under the supervision of mechanical inspectors or of Workshop supervisors reporting to the Engineer, Mechanical.

11.9 *Co-ordination of Activities*

11.9.1 Having examined this organisation we see no reason to doubt that it is capable of meeting all technical demands

likely to be made upon it. At some Repair Yards it seemed clear that resources would support a much greater output, provided that labour could be obtained to cope with the additional work. Our main reservation concerns the very indirect control which the Area Engineer has over workshops and plant resources that he must call upon frequently to meet his own essential needs.

11.9.2 This kind of difficulty is, of course, to be found in any form of administration which delegates general responsibilities to local officers but reserves to a centrally controlled organisation certain functions of a specialised nature. It is precarious to object to such a policy on doctrinaire grounds as a good case can obviously be made in support of it from the benefits of economy and efficiency. We doubt very much if a more convincing case could be assembled — on paper — for an alternative such as the distribution of these ancillary services among the respective Area Engineers.

11.9.3 The suggestion has been made to us that these ancillary services should be brought under the jurisdiction not of the Area Engineers but of the Principal Engineers. At present the two Principal Engineers in England have large territories and it might be beneficial to divide each into two and so make four regions. Each could then comprise two Areas (assuming local adjustments to give eight Areas instead of seven as at present) but would comprise all services in a more direct chain of command. This is however only by way of comment; any such reorganisation would need to be studied carefully before deciding whether or not it would be worthy of adoption and we do not suggest in any case that significant financial savings would necessarily result from it.

11.9.4 To sum up this aspect of maintenance essentials and organisation it must be stressed that the most important factors in an undertaking such as a waterway, which has great length and very little breadth, are to obtain continuously a true appreciation of site conditions throughout the system and to transfer this knowledge quickly and reliably to the Area Engineer. The Section Inspector has the key role as he must know his Section intimately, be able to make regular inspections, be capable of deciding when and what should be reported and be alert to carry out first aid repairs immediately when necessary.

11.9.5 The Area Engineer should by regular meetings and systematic reporting procedures facilitate the flow of information to himself and correspondingly upwards to the Principal and Chief Engineers. By a proper extension of this procedure it will be ensured that full information on all outstanding items on every Section of the system reaches the highest levels at regular intervals, so enabling the Chief Engineer to be kept informed of any worsening or improvement in the overall situation.

11.10 *Summary*

11.10.1 Since it is clearly not possible, within the limitations of a report of this kind, to highlight every point of importance we feel it necessary to emphasise in conclusion that if the Board's statutory and other obligations are to be met there must first of all be a recognition and acceptance of what standards those obligations imply.

11.10.2 Where arrears of maintenance exist consideration must be given to the timing of remedial works (in the interests at least of public safety) and the consequences of undertaking

them either independently or in conjunction with a programme of continuing maintenance tasks.

11.10.3 There must then be a methodical approach to assessing, year by year, over a sufficiently long cycle of years, programmes and budgets for the categories of routine, special and nonrecurring maintenance works. These should be based on the system of Programmed Maintenance, with its essential foundation of systematic inspections, and should be supported by the knowledge that funds will be provided for carrying out all items properly included in each such programme and budget. The consequences of this procedure will now be discussed in the following chapter.