

Severnside of the future

A. V. HOOKER

Mr Hooker

There have been historic reasons for the decline in Bristol's trade relative to Liverpool and for the run down in the coal mining industry in South Wales. Both areas, which are now linked by the Severn Bridge and the M4 motorway, must be regarded as a single unit so far as economic planning is concerned and need positive measures to restore their former prosperity.

48. Further expansion of the steelworks at both Port Talbot and Llanwern is now planned and the provision of an ore terminal at Uskmouth would have a significant influence on the industry's future development in South Wales.

49. In connexion with the proposed airport, fast inter-city trains will soon be operating on the Bristol and South Wales services, and a Severnside airport, together with a STOL airport in central London, might well make it possible to defer construction of a third conventional airport to serve the metropolis.

Mr F. R. L. Barnwell, Chief Civil Engineer, British Rail, West Region

In the Paper there was not much mention of railways, but Mr Hooker has referred to 150 mile/h trains. This project is still in mind and active experiment is still going on, but probably closer to a more likely event is the active consideration of 125 mile/h trains, more or less conventional in form, which will run from South Wales and Bristol to London, and will, according to our calculations, cut the time from Cardiff and Newport by 25 min, and from Bristol by 18 min. This obviously should have a considerable advantage for the movement of passenger traffic.

51. In addition there is a station proposed at Stoke Gifford just beyond Filton, to be known as Bristol North, which will act as a junction between the Bristol and South Wales routes and will cater for fast trains from South Wales and 100 mile/h trains from Bristol; any passengers travelling from the development of the Severnside should have the advantage of both flows of train service. A start on constructing this station is being considered in 1971.

Mr D. G. McGarey, Chief Engineer, British Transport Docks Board

There is always a great temptation for engineers to draw lines on paper and to present our clients or prospective clients with a comprehensive scheme of development supported by plans that fascinate by their plausibility. So often there is then a very lengthy pause before anything gets done. What is lacking is usually conviction on the part of a number of diverse interests that severally and jointly they would find it a profitable investment.

53. Port works, for example, are more often put in hand when a single undertaking seeks to satisfy its own needs for such facilities, perhaps only for a single purpose. It may be that a fully planned research study is considered to be unnecessarily complex and costly; the scheme ultimately emerging then tends to be regarded by existing interested bodies with jealous eyes and to arouse emotions and objections of a more or less violent nature. Not least likely are claims that developments of a limited character on one site will cause deterioration, if not disaster, at other sites, and in many cases neither the claims nor their rebuttals are capable of clear and convincing proof. All this suggests that time and temper would be saved if a sufficient amount of preplanning were to be carried out before putting forward a particular scheme as the solution of problems that have not themselves been clearly stated.

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54. My own authority is endeavouring to do this for another estuary, the Humber, which is considered to have potential for development of a MIDA type, but where, it is true, we are virtually the only authority concerned. Perhaps I can use this as an illustration of what I have in mind. We are sure that the estuary must be studied as a whole, that physical effects of development in one area must be looked at not only in the immediate vicinity but at more remote places and after a lapse of perhaps quite a considerable time.

55. So, having selected a number of possible development sites, we put in hand an extensive series of field surveys for the purpose of amassing basic data relating to tides, velocities and directions of tidal streams, salt water and fresh water flows, silt in suspension, moving bed loads, wind, weather and waves. We have also built, with the advice of the Hydraulics Research Station at Wallingford, and at a capital cost of about £250 000, a large tidal model of the whole estuary on which a programme of experimental work co-ordinated with the field studies has been in hand for some time.

56. Beginning with a fixed bed, so as to ensure satisfactory reproduction of tidal phenomena, relevant parts will be changed over to mobile bed conditions for the better study of the effects of any works that may be proposed, whether for port purposes or otherwise. By such means, the merits and demerits of forming deep water channels, of constructing river training walls, reclaiming land, building jetties, breakwaters, etc., can be assessed; and assessed, as I have said, with some confidence that both local and more distant consequences will be recognized. A very valuable product of these studies is that after an initial period it becomes possible to draw up an appreciation of the amount of detailed research that would be required for evaluating any isolated or sectional development scheme. This in turn enables a close assessment to be made not only of the probable cost of such studies but of the time needed for their completion. With a measure of good fortune, which we all look for, this can perhaps be geared to the time when hardening of commercial demand for such a scheme brings it to the successive stages of actual design and construction.

57. May I now relate this to what has been put before us in this quite fascinating Paper, which tells first of an idea for an island to be built in the Severn Estuary, later changed into a massive reclamation scheme on the north bank. We are told of potential uses—docks, airport, reservoir, land for industry, and of the road and rail links that will be needed. All these certainly offer sufficient promise to justify feasibility studies being put in hand. When I try to learn, however, whether such studies have in fact been made, I do not find that anything corresponding to what has been done on the Humber is in evidence, and in view of this I feel it may be rather premature to say, as the Author does in § 43, that *his proposals are feasible from an engineering point of view* and are likely to present few major technical difficulties.

58. I am quite sure that the Author would be very ready to acknowledge that a full research programme of field and model studies is essential if a scheme of this character is ever to be more than an engineer's dream. I am sure, in fact, that this is what the Author had in mind in §§ 38 and 41, but I venture to doubt whether any firm of consulting engineers could themselves embark on a project of this magnitude without substantial backing from commercial interests.

59. As the prospective benefits range far beyond seaport facilities, which alone could never justify development on this scale, it would be fair, I suggest, to expect that the cost of research would be charged against the airport and water supply elements. The difficulty would then be to arrange for a sufficiently comprehensive programme of research to be mapped out and put in hand in good time, perhaps ten years before the ultimate clients could be brought together for effective joint action in proceeding to the design and construction stages.

Mr B. Rydz, Assistant Director, Water Resources Board

This scheme is one of a number that have been put forward in recent years for the

Severn estuary and, indeed, for others. Most of them contain the storage of fresh water as one element, which is my excuse for offering my few comments. Also I think they nearly all owe something to the notion which was called in the Halcrow Report on the MIDAS 'creative juxtaposition'.¹⁴ That is to say, if you put a lot of things together and spend a lot of money in one place, you will probably gain economies of scale and economies of association. Sometimes this is a calculated affair and sometimes, I fear, a matter of blind faith. The most striking thing about this situation, I think, is the number of proposals of this kind that have been made, and the most interesting question in the Paper is that in § 43 which is, in effect: 'Where do we go from here? What can we make of this scheme as from now?' This immediately pinpoints the greatest weakness. Engineers are not short of imaginative ideas of this kind (although these are sometimes mutually exclusive), and I do not think they would have any particular difficulty in solving the problems of engineering investigation, design or construction, but they are certainly at a complete loss as to what to make of these ideas and how to evaluate them, and the people who put them forward seem to be voices crying in the wilderness.

61. If this sort of scheme had been put up a century ago by Brunel, his problem would have been simply to find people with sufficient faith in it to part with their money and back their judgement, and, having constructed it, it would have been up to him to persuade the public that that was what they had always wanted—and usually he was successful.

62. But the problem is quite different today. Things of this kind are not likely to go forward without government money, or, if not government money, a great deal of government interest and support. The problem is to show, not that this or that is a good thing, but virtually that it is the very best thing that can be done with the nation's money. In other words, this sort of scheme is not likely to get off the ground unless it is justified by the very broadest comparisons with all other ways of spending money on this kind of service.

63. I question whether there are the means to do this sort of job. The investigation of the MIDAS is referred to in the Paper, and in connexion with that investigation a study group has considered the problem of whether it is conceptually possible to make a feasibility study of the merits of developing a great port complex in a particular place. It concluded that it was, but so far I do not think there has been progress very much beyond that point.

64. If the investment of some hundreds of millions of pounds in this sort of venture in the Severn Estuary precludes similar investment in the Wash, or at Solway, or a spread of this money around sites which have been developed in the past, how can the gain or loss to the national economy of the far-reaching things which flow from all this be compared?

65. At the WRB we have been trying to answer a very much simpler question. Assuming that water is a service which must be provided, and that certain demands can be estimated and must be met, which is a simple and convenient starting point, we have been trying to analyse how best to meet this requirement; what is the cost and what are the other advantages or disadvantages of meeting it in various ways? For this purpose we are presenting all the available or relevant water resources in the form of regional studies, and in the forthcoming study on Wales and the Midlands, something on the Severn Estuary will be mentioned and its cost will be scheduled. But I think it is fair to say that, with few exceptions, the storage of water in estuarine areas, considered by itself, is bound to be a somewhat less economic way of developing resources than storage inland. The difference may be outweighed by provision for other services as a part of an estuary development, but this remains to be seen.

66. In those cases where developments in estuaries have been examined there has been the problem of trying to assess their merits for water storage in combination with other possible developments, such as the provision of traffic crossings. Certain conceptual problems have been encountered, for instance, the type of question

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needing an answer. The question for the WRB is: where should water be stored—here or somewhere else? Other people may be trying to answer the question: shall we have a new crossing of the estuary, or shall we forget about it? It is rather difficult to run these two questions in harness to a common rational conclusion, and impossible, I think, unless they are asked in the right order.

67. Another problem is that of the different techniques used for the evaluation of deferred benefits; these possibly reflect the political pressures which have coloured the outlook of spending and sanctioning departments. The deferred benefits of road works, for instance, have been evaluated in the Ministry of Transport in quite a different way from that used to reflect 'time preference' in water benefits and in most other fields of public expenditure. To pave the way for rational decision making of the scope implied by the Paper, deeper study is needed of society's concepts of cost and benefit in various fields, perhaps at the expense of studies of the mechanics of cost and benefit assessment which have been so fashionable in recent years.

68. The estuary studies that have been made are costing sums of the order of £500 000 to establish the feasibility of a limited range of developments. Some will cost more. To investigate all the things which are involved in this Severn scheme would cost quite a lot. I suggest that before proceeding with cost-benefit studies of projects of this complexity, a cost-benefit study of the various cost-benefit studies must be made—that is to say, a preliminary comparison of the possible advantages to the economy of pursuing this or that bright idea—because in themselves the studies may involve millions of pounds as well as calling on expertise, some of which is very scarce.

Mr G. H. C. Cooper, Chief Planner, Welsh Office

The Author has done a valuable service to those who are interested in Severnside by demonstrating the possibility in engineering terms of large-scale developments on and off the Monmouthshire coast.

70. I speak as an official of the Government Department for Wales, but what I say is my own assessment of how I see the scheme put forward by the Author. It is the multi-purpose nature of this concept which gives it its particular interest—deep water port facilities, an airport, another road crossing of the Severn Estuary, water storage and a large area of land for industrial development.

71. The immediate appeal of this concept is its flexibility of composition and of scale. Each one of these components could be developed without the others, although their interrelationship is, of course, clear. I have been interested in the regional significance of these suggestions. An important part of regional planning is to identify an area's development potential and to keep the options open. Nowhere is this more important than on Severnside. An example of this stems from the preliminary report on the maritime industrial development areas in Britain.¹⁴ In that report the coastal strip from Cardiff eastwards to beyond Newport is identified as having particularly good physical characteristics for large-scale industrial growth. This evidence needs economic support, and until this is available planning decisions in this part of South Wales will continue to have regard for these possibilities for major development so as to avoid prejudicing them. We are keeping the land free from other developments. Road proposals are in close proximity to the area involved, and we look to areas where residential development and other associated developments could take place if, indeed, these developments came about.

72. The Author refers in § 8 to the publication in 1971 of the Severnside Study. This study is by central and local government officials. It would, however, be wrong, in my view, to expect such a report to provide an economic justification for developments of the scale and nature proposed in this Paper. Knowing what we do about the limited amount of mobile industry available to influence growth prospects anywhere and everywhere in Britain, it would be unrealistic to think of such dramatic changes. What is relevant is the trend of growth on Severnside. On the Bristol

side, this has been well above national average. On the Welsh side the amount of new industry coming to South Wales has been very considerable, but so far the economic impact has been largely absorbed in offsetting contraction in the coal industry and the effects of automation in steel making. Nonetheless, South Wales has proved attractive to large-scale investment in modern industries, and the Author rightly points out that the completion of the M4, M5 and M50 motorways will make Severnside a key location on the national motorway network. Add to this fact the scenic qualities of the estuary and its hinterland, the Mendips, Cotswolds, Forest of Dean, Wye Valley, Brecon Beacon National Park, the Gower and much more, the attractions of Severnside to business men is more likely to accelerate than otherwise.

73. There are, however, reservations about deliberately creating a growth point east of Newport. The most difficult problem in South Wales is to get industrial growth on a scale to match the job needs further westwards, particularly west of Bridgend. This is why major Government investment in new industrial estates is in that part of South Wales, and this priority will remain for some time.

74. Development on the Monmouthshire coast must be seen in this context. None the less, another road crossing of the Severn Estuary is probably inevitable, and the Author is probably right in assuming that this is likely to be downstream of the present bridge in order more conveniently to link the areas of major urban growth on either side of the estuary.

75. Mr Rydz has already referred to the forthcoming report of the Water Resources Board on Wales and the Midlands. In the meantime, the Welsh Council has recently published a report of its own consideration of water storage problems in Wales,¹⁵ and has expressed the view that serious consideration must be given to the practicability of estuary storage as well as to possible further regulating of reservoirs near the headwaters of some of the main rivers of Wales. It seems likely, therefore, that there will be further studies of the Severn Estuary in this sort of context.

76. Other contributors to this discussion will probably have more specialized knowledge than I have of port facilities. There do, however, seem to be particular difficulties of speculating about development at this point of time. The old-established ports of South Wales have considerable development potential, and the new harbour at Port Talbot can supply present importing needs of the major steel works at both Port Talbot and Llanwern. I understand that it remains to be demonstrated whether this harbour can meet the longer term needs, and this in turn will depend on British Steel Corporation's investment programme. This seems crucial to the Author's concept.

77. It is useful to consider what might trigger off the development of a complex of this nature. In similar circumstances in the Dee Estuary it was decided to carry out a feasibility study, but what triggered off this study was the need for better communications between Merseyside and North Wales. It was realized that such a study must embrace other developments which could come about as a result of a road crossing or which should be made to come about in order to maximize investment in the crossing itself. These are primarily water storage, extensive recreational facilities, urban growth in Flintshire, and reclamation of land in the estuary, notably for industry.

78. In many circumstances, the Severn Estuary is similar to the Dee, but there is an important difference in time scale. It would, therefore, be interesting to know whether the Author considers that his scheme could be developed in such a way that certain units of his general concept could take place considerably ahead of other parts of the scheme.

Mr W. S. Atkins, W. S. Atkins and Partners

One thing (quite apart from the Paper) that has impressed me over the years has been the ability of the Institution to adapt itself to present-day thinking and philosophies and its general acceptance of confirmed philosophies as they arise. That was shown

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up very clearly in the ICE Conference on the Welsh Valleys,¹ where the papers were philosophical, highly analytical and in their conclusions pointed quite factually towards the value of development of the valleys, and further to that, the coastal plain of the Severn Estuary as a whole, and touched on the development of the Severn Estuary in relation to the national scene.

80. The Welsh valleys in those papers presented a picture of population, amenities and certain industries that could not be forsaken. The developable land on the Somerset side and the huge area of little-used agricultural hinterland to the Severn Estuary on the Newport side were shown, with a range of ports, each with its attendant communication arteries. There was land for port-based industries, but the thing that was missing at that time was a deep water port to complete the whole of the maritime scene.

81. The Paper presents a solution to that possible omission. This in itself does not deny the deep water port at Port Talbot which is viable in itself in serving the adjacent steel works and its expansion programme, and indeed in serving the industries which are developing west thereof. The estuary itself penetrates an area of great scenic beauty. Climatically it is more attractive than the rather harsher north. It is a good place in which to live and work, and a good place for leisure. It is still a reservoir of water not taken up domestically or industrially.

82. That is the picture that the Conference on the Welsh Valleys drew. Of course, this is not the only place in Britain where a development of this sort could take place. But where are the developments likely to go? On the west side of England there is deeper water and poorer agricultural land. The SW of England is less congested than the SE, but whatever we proclaim and whatever we do, we are not going to stop the increase of the population in the southern half of Britain.

83. As to the amenities, £86 million has already been spent on the road communication to this particular area, and the Ministry of Transport has declared its intention of spending a further £200 million in the next five years. It is likely that faster coastal shipping will increase as rail freights rise, and this in itself gives a better avenue of ingress into the great waterway of the Rhine and the industrial areas of Europe—and this would be irrespective of a channel tunnel. One cannot help thinking that if there was a waterway link from the Somerset coast to the Devonshire coast, the whole picture of this area, the whole desirability of this area, would be changed. Of course, that is not economically viable under normal assessment methods, but it might have brought some dignity to the depressed period of the late 1920s and early 1930s. If it is accepted that the area under discussion is an area of development in the national scene, then a major airport becomes inevitable and necessary to balance the country, and we have already heard about faster trains, which make communication very much easier.

84. This is not a Welsh or a Bristol proposal. It is a national proposal, and should be examined from that point of view. It is a national proposal that happens to benefit both sides of the estuary, but it is a national proposal that may have some real effect in balancing the population and the development that must happen in Britain. We should also think of the links of communication already provided and which are further to be provided into this particular area which may be equal to, if not in excess of, those that occur elsewhere, and we must remember that the centres of arrival to Britain will be defined by the nuclei of communication available to those centres. We must be very careful in picking the centres of arrival to Britain if Britain is to remain important.

Mr D. Jones, Acting Chief Docks Engineer, British Transport Docks Board

A great deal of attention has been given in the last few years to the idea of developing huge industrial complexes in green field sites alongside brand-new docks. The Paper takes such an idea and allies it to a new airport, a reservoir, a road tunnel across the estuary and an industrial hinterland.

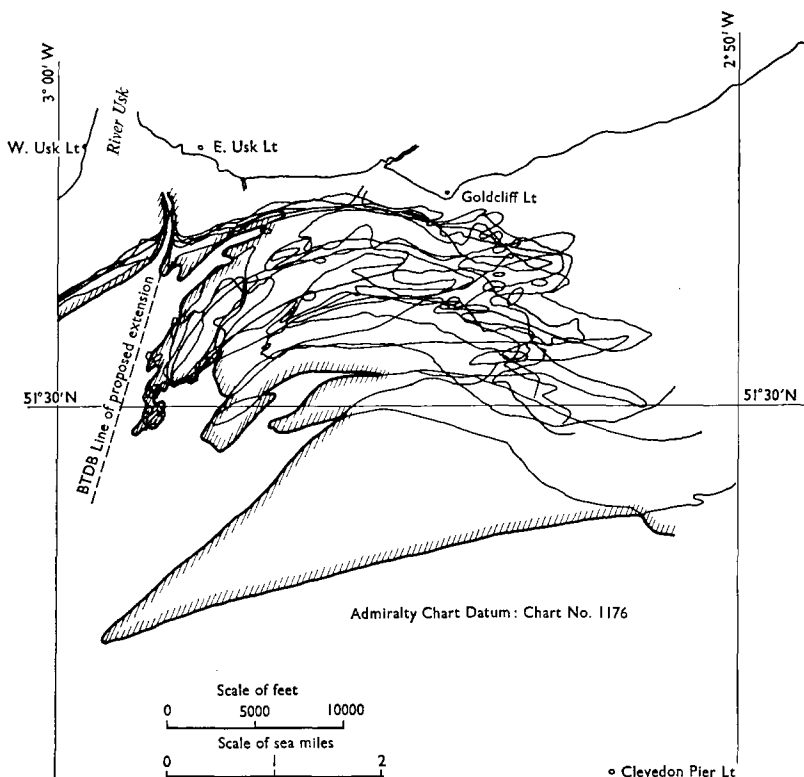


Fig. 7. Sandbank movements

86. My particular interest is in the proposed docks development. When Mr Hooker first presented his ideas for this complex I was not able to agree from the Docks Board's point of view that the port was well sited. The Docks Board has, in the course of investigating the site for an impounded basin to import iron ore for the Spencer Works, established the line of a possible approach channel, capable of being dredged to a depth suitable for 100 000 dwt ships. After a series of off-shore borings, a trial cut was dredged over the route of the channel and the rate of siltation was studied over a period of some years. The result of this was that the Board was reasonably satisfied that it was economically feasible to dredge and maintain the channel to a new impounded dock. For this reason, I found it hard at the time to agree that a scheme proposed for a dock some few miles further up the estuary, where little was known about the nature of the sea bed and where massive movements of sandbanks occur, was a suitable site for development.

87. The Board's proposed channel was in a suitable area of the estuary. Charts of 1867 showed that the Usk Patch, the sandbank nearest the proposed channel, was well clear of the line. Later charts show that the Welsh Hook moved considerably, eventually merging with the Usk Patch, but all these movements took place well to the east of the proposed channel (Fig. 7). The Author has now produced a revised proposal for his dock layout, which is in broad agreement with the Docks Board's own

proposals for dock development in this area and for the establishment of port-based industries within the MIDA area between Newport and Chepstow.

88. Having said this, however, one should be guarded in one's view of a scheme which proposes to make such a large encroachment on the estuary. The Board has established that the route of its own intended channel is in a reasonably stable area, subject to the rest of the estuary not being interfered with. However, while the site of the approach to the Author's scheme is the same as the Board's site, he is introducing very large changes in the configuration of the estuary, and a most thorough series of model tests would be necessary to test the effects of this.

89. It seems to me that ports in the future may play a much larger part in regional development than simply being interfaces for the transposition of exports and imports from land to water. Continental policy in the post-war period has been to use ports to assist in the expansion of industry, and by all appearances this policy has been very successful. If a similar policy were ever to be adopted in Britain, it would be a pity if the very scarce sites that meet all the requirements of this kind of development were not then available. The Author has taken a step forward and I hope that this will encourage the formation in the Severn Estuary, which has the second highest throughput of British estuaries, of a Severn Estuary Development Group, embracing port authorities, local authorities and regional bodies, to examine and consider the development of maritime industry and port development in the estuary as a whole.

Mr G. McLeod, Usk River Authority

I have had an interest in the reclamation of the Welsh Grounds for quite a long period, and I have been concerned with the maintenance and improvement of the adjoining sea walls. In fact, if this scheme proceeds, it will mean that a lot of the work I have carried out during the last 15 years would disappear and I would be able to say, like the doctors, that a lot of my best work is buried.

91. However, I should like to describe this work because it is of the same type, at least as regards the facing, as that proposed by Mr Hooker and it is on the same frontage, although the sea wall surrounding the enclosure would be carried forward several miles nearer to the Somerset side. In that respect it would be subject to less wave action because the fetch across the channel would be reduced. This raises some questions in my mind about the need for the asphaltic grout which Mr Hooker proposes to use.

92. Figure 8 shows an early stage in the construction of a sea wall with the earth bank formed, and the machine carrying out the stone pitching on the outward side. Fig. 9 shows a view of a completed length of the wall. It has the same slope as in the Author's proposal, the same size of stone, and is capped in a similar way with concrete.

93. I referred to the asphalt. Some trial lengths have been grouted with asphalt, but on the greater part of the reconstructed walls the stone has been left with open joints and there has been no displacement due to wave action. The asphalt has the effect of reducing the absorption of wave energy: a smoother and more waterproof surface is produced so that there is more tendency for the waves to sweep up it, and it increases the swash height and the tendency of the waves to reach the concrete coping at the top. The Author's wall would be to a slightly higher level than we have adopted because his wave wall is above the level of 33 OD, whereas the level of 33 OD is in our case the top of the wave wall. We have found this adequate. Some spray goes over the wall, but this is not significant in quantity of water, although it could be sufficient to cause some contamination of water in a reservoir. For that reason, it may be worth considering having a secondary bank, to set the edge of the actual water storage surface back from the sea wall itself, and to have a drain on the area between, to carry away any salt spray which might pass over the wall.

94. My Authority is interested not only in the sea defence side of the project but



Fig. 8. Stone blocks being placed as armouring to sea wall, fronting the Welsh Grounds



Fig. 9. Completed length of sea wall with stone pitching and concrete wave return wall

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in the scheme to provide a reservoir. We have been spending much time and energy in investigating reservoir proposals inland and have also discussed with Mr Hooker the proposals for a reservoir in the estuary. This could be a very valuable solution to the problem of finding water.

95. There are, of course, some difficulties. One of these is that the water would have to be brought from the Usk and the Wye, from points above that reached by salt water. This means that pipelines would be quite long. The tidal Usk is 16 miles long and although the pipeline, which would be more direct, would not be that long, it would still run to quite a few miles. It would also have to be of a considerable size, and would have to be fed by pumps again of considerable size.

96. The Author has referred to an output of 150 mgd, of which he suggests one-third might be derived from the Usk. The number of days on which there would be water surplus to the abstractions which are already proposed—and some of them are already taking place—may in a dry year be as few as 160; so that if there is to be an output from the Usk of even as much as 50 mgd throughout the year, considerable quantities of water would have to be pumped during the time this was available. This means large pumps, large pipes and corresponding high cost.

97. Some reference has been made to recreational use. I think that this reservoir, so near to large centres of population, would be of very great value for recreation, and this aspect of the matter should not be lost sight of.

Mr J. E. G. Palmer, Consultant

In changing the proposed dredged approach channel over to the Usk side of the Severn the Author has paid us the compliment of accepting the layout prepared by Mr Boyce and myself not long ago for the Docks Board. This was planned to provide one deep water berth, in an impounded basin, for 100 000 ton carriers bringing ore to the Spencer Steel Works: provision was made for one additional berth if required in the future for increased ore tonnages.

99. I cannot understand, therefore, why the Paper proposes some 18 000 ft of impounded dock wall, which would seem to require 16 or more bulk berths. It is improbable that new bulk handling facilities will ever be required so far up the estuary when better sites are available nearer to the mouth; in any case, it is probable that the majority of bulk handling berths of the future will be sited in tidal waters in order to save the loss of time locking into and out of a dock.

Mr B. J. Stops, Severnside Business and Consultancy Services

The feasibility of the picture which has been drawn requires an economic appraisal so that we can see what improvement we are going to have in the use of the resources which are available to us in this part of Britain. The Author has not portrayed a Brasilia, but a scheme which would fit well on to the infrastructure of roads, heavy industry, energy producing centres and population areas which history and past governments have given as a threshold.

101. I can vouch, from local knowledge and acquaintance, for the general support which Severnside and this type of proposal receives both in Bristol and in the eastern half of South Wales. I would underline the growing awareness in businesses that the completion of the M4 and the M5, and also the Monmouth to Newport road connecting with the M50, is making the Newport, Gloucester and Bristol triangle a most economic location for industry of all types. I know that Mr Cooper is aware that the number of applications for businesses to go into the Newport and the Bristol side, at a time when the Government were giving development grants and when this particular area was excluded, was higher than in the other parts of Wales.

102. There is no doubt also that the delay in publishing the Severnside Study and the announcement of the Bristol Docks expansion scheme indicates the political concern over the whole area.

103. A number of us in the Severnside area, on both sides of the estuary, have got

together and set up the Severnside Forum. Our aim is to draw together people of all disciplines and interests to consider Severnside and what it may become, and to collect and make available data and information so that plans and decisions may be based on relevant facts. Of course, the Government, both central and local, has a great number of statistics available also, and we have been told that we can expect co-operation. Also we think that proposals should be presented and supported because, whereas a civil engineer before needed a wealthy benefactor, nowadays he needs the strong and direct support of a comprehensive group of informed people who, if they see a right course of action for their part of the country, will go for it.

104. I commend the Paper as a valuable contribution to this process and look forward to seeing the scheme develop and grow into fulfilment. It does not matter what form it may eventually take but it will certainly complete the foundation work for a Severnside which, in economic and industrial wealth, and in technical efficiency based on the minimizing of the increasing cost of transportation which is becoming a greater part of the manufacturing unit cost, can surpass the present manufacturing and industrial centres and areas of Great Britain.

Professor A. L. L. Baker, Department of Civil Engineering, Imperial College

I want briefly to add a little emphasis to Mr Hooker's reference to the possible use of an immersed tunnel across the Severn. In his Paper he writes as though it might be considered, but a Dutch engineer would have no hesitation. The line is in Keuper marl, and it may be possible to halve the length of the tunnel, thereby simplifying the ventilation problem and about halving the cost. There might be trouble with the tidal current, but I think this could be overcome with a little ingenuity and thought.

106. Mr Hooker says in his Paper that such tunnels have been built. About 60 have been constructed in other countries, and very successfully. They have proved their efficiency over the past 20 or 30 years. Let us have one here if at all possible.

107. Mr McGarey referred to the Humber as though all the investigations had been completed there. If the possibility of an immersed tunnel from the industrial part of Hull to Immingham instead of the suspension bridge for a small amount of traffic was investigated, there might be an enormous amount of industrial traffic. The bed of the Humber is in gravel, which would suit an immersed tunnel very well. Britain is trading very closely with Rotterdam at present and there are two or three tunnels on that side. It seems a pity that Hull should be behind Rotterdam.

Mr R. A. Waller, W. S. Atkins & Partners

Figure 4 may need further explanation in order to fully appreciate the favourable situation with regard to noise which would exist at Severnside.

109. The contours are drawn in terms of the noise and number index (NNI). Clearly the annoyance due to aircraft noise increases both as the noise of individual aircraft increases and also as the number of over-flights increases. The NNI takes both these factors into account in proportions which result in the index giving the best correlation possible with the annoyance that people feel. The index was derived and calibrated as part of a survey carried out around Heathrow in 1961.

110. This survey and the conclusions derived from it are to be found in the Report of the Wilson Committee¹⁶ who sponsored this work. They concluded that the noise nuisance would be unreasonable above 50–60 NNI. However, this level, which approximates to living within 5 m of the edge of a motorway, is scarcely good enough as the basis for designing new airports or new residential developments. We need a level which would be generally acceptable and for this purpose I have proposed 35 NNI in urban areas.¹⁷ In the quieter suburbs and in the rural areas the background noise resulting from other causes, in particular traffic, is less, and a given level of aircraft noise more obtrusive. For this reason I suggest that a generally acceptable level in rural areas will be 25 NNI.

Messrs C. C. Marshall and A. J. Woodford, Sir Alexander Gibb & Partners

We should like to congratulate the Author on his very interesting planning exercise. There are some points on which it might be helpful to comment.

112. In § 40 the Author refers to the outward hydraulic gradient providing proof against saline contamination of the water in the storage reservoir from the sea. There are, however, two further sources from which significant amounts of salt would tend to contaminate the water. These are the sea water trapped during construction and the diffusion of salt from the sea water contained in the sands and silts in the bed of the reservoir. Whilst the trapped sea water could be drained or pumped out, the diffusion effects might take some time to diminish.

113. This problem has been encountered in the examination of possible water storage reservoirs in Morecambe Bay, some of which are of a size similar to that described by the Author. A mathematical model was developed for the Morecambe Bay reservoirs to simulate the daily fluctuation of reservoir salinity, taking account of the primary factors, trapped sea water, inflow from rivers, outflow, seepage and diffusion. The results of this work have shown that it should be possible to get the salinity of the stored water down to an acceptable level, say 100–150 mg/l as NaCl, within a year of construction being completed. However, very severe drought conditions in the early stages could lead to a reservoir being taken out of service temporarily. With a pumped reservoir, as described by the Author, the salinity of the stored water would continue to decline towards the salinity level in the river water, the rate of decline depending upon the rate of turnover of the reservoir.

114. It is noted that the abstraction points from the Usk and the Wye are proposed to be just above the tidal limits, where it is likely that the river water would be of the poorest quality. It would be interesting if the Author could give some indication of the quality of the river waters at the abstraction points proposed. It is, perhaps, possible that it might be advantageous to abstract water from higher up the rivers, in order to minimize enrichment of the stored water and consequent difficulties in reservoir management and water treatment. In this connexion, consideration might be given to the advantages of constructing two reservoirs in order to safeguard what is a large water source against breakdown due to these difficulties.

115. We doubt the wisdom of selecting a level of 17–22 ft AOD for the airport. The comparison with Schiphol, situated in a polder of considerable extent, is surely not valid. Finally could we ask for some approximate capital cost estimates? Reclamation is not cheap and could well exceed £2000/acre, compared with agricultural land of between £200 and £500/acre.

Mr R. W. Bishop, W. V. Zinn & Associates

The Author is to be congratulated on a most interesting Paper which focuses attention on a scheme which deserves more detailed consideration in view of the increasing volume of traffic to and from Britain by sea and air.

117. A somewhat similar scheme has been advocated for the Essex marshes, but it would seem more advantageous to site any new port in the Bristol Channel where, with a new road system which is already well advanced, it could serve the industrial areas of South Wales, Monmouthshire, the West Country and the Midlands. Furthermore, by berthing in the Bristol Channel, ships would be spared the hazards of the English Channel and their journeys would be shortened by at least a day each way. With vessels of up to 150 000 tons, this could be an important factor.

118. As the Author mentions in § 9, reclamation on the scale envisaged would undoubtedly change the regime of the estuary. A substantial training wall of some length may be necessary to maintain a deep navigable channel to the new berths and, in this connexion, the papers presented at the 1967 ICE Symposium on Dredging are interesting.¹⁸

119. A new international airport in the Bristol Channel is a most attractive

proposition—especially to Londoners—and it would be interesting to know what percentage of travellers at present using Heathrow, Gatwick and Luton for overseas flights begin their journeys west of Oxford.

Mr D. Plumley, Engineering Assistant, Technical Services Group, Swindon Borough Council

The scheme described by Mr Hooker (reclaimed land, away from centres of population, providing a transportation/industrial complex) is, in my opinion, the only civilized way to satisfy the requirements, in this particular field, of our (too?) rapidly expanding society. Accepting the desirability of the facilities that the scheme can offer, there are one or two requirements that need to be satisfied, in order to carry it off, either:

- (a) real, large commercial needs and/or prospects in a totally free enterprise environment; or
- (b) an effective, well thought out and adventurous (where necessary) directive from national government.

121. As far as I see it, Mr Hooker missed what may be a major problem—the disposal of sewage and refuse. The former problem is solved by the installation of a suitably designed treatment works, at no economic advantage. The solution of the latter problem is the main point I wish to make.

122. There is a need, as a matter of urgent national policy, to salvage as much of our waste as possible, because of a world-wide decrease in natural resources. The rate of this fall can only increase as the world population increases. A giant refuse incinerator, of the same size, or larger than, the one recently commissioned at Edmonton, located on Severnside, served by 'refuse trains' coming from the whole region (Cardiff's refuse on Monday, Swansea's Tuesday, Bristol's Wednesday, etc.) could help in this, providing the heat is successfully harnessed. Generating electricity is the first idea that comes to mind, but district heating and steam for industrial use (chemical plants, bakeries, etc.) would be equally beneficial.

Mr A. R. Ford (F), Wentworth, NSW

Some years ago much was heard of proposals to develop tidal power by the Severn Barrage Scheme.¹⁹ This scheme envisaged a barrage across the Severn about 2 miles downstream of the Wye River junction, and this would apparently be just above the Severn Tunnel.

124. Could the Author say if there is still any possibility of the tidal power scheme ever going ahead and if so whether it would have any effect on existing structures or on the proposals outlined so well in the Paper? For instance, would such a barrage alter the tidal range in the vicinity of the proposed docks and airport reclamation?

125. Referring to the Paper itself, it is pleasing to note the realistic attitude to ship sizes and channel depths; so far it has always been my experience that all estimates of channel depths are very soon proved to be too small.

Professor E. M. Wilson, University of Salford

Mr Hooker deserves credit for his original ideas on the development of the Severn Estuary and so one looked for a rather more detailed set of proposals than has appeared.

127. He has shown one combination of different uses that a multipurpose scheme in the Severn estuary might have. There are three main criticisms of this particular scheme in my view. The first is that it fails to capitalize on the estuary's most remarkable attribute—its extraordinary tidal range. The second is the inclusion of a long dredged channel in the approach to the proposed new dock and the third is the preference for a tunnel, as a road crossing, rather than a bridge or barrage.

128. Considering the first of these; the average tidal range provides a unique

opportunity to introduce into a multi-purpose scheme an important revenue-producing component: electrical energy generation by tidal water-turbines. Detailed analyses of available energy have shown²⁰ the opportunity that awaits. In the light of later work²¹ and Mr Hooker's latest ideas a revised layout as shown in Fig. 10 is now suggested. The provision of an energy-producing scheme not only assists the financing of such a project but, through the introduction of a barrage necessary for tidal energy production, provides an opportunity for a road bridge and a bulk-carrier port, probably without the necessity for maintenance of a dredged channel. The ebb-generation scheme illustrated would produce an annual output of about 5000 GWh of pollution-free energy without using existing land. The annual value of such energy would exceed £10 million.

129. The scheme is less ambitious than that I suggested for tidal-power development in 1966. Moving the barrage upstream from the Lavernock Pt-Weston line has two main advantages:

- (a) an increase in tidal range and shortening of the barrage structure giving a better economic return, which is reflected in energy costs; and
- (b) a sharing of the barrage costs with Mr Hooker's airport bund.

130. The second great advantage of high tidal range, which touches on my second criticism above, is that deep-draught ships can be brought into the estuary twice a day, provided there is somewhere to dock them as the tide ebbs. Mr Hooker's dredged channel shown in Fig. 2 will require maintenance dredging of indeterminate but almost certainly considerable magnitude. In addition his port will only serve the South Wales shore, which already has too much port capacity at lesser draughts and not the Somerset side which has too little. I suggest the port need not be far removed from the deep water channel and that the barrage road access would make it available immediately to both sides of the estuary, as shown in Fig. 10. The access to Avonmouth and the inner estuary would be assured by a number of navigation locks. These locks would give deep water access to the inner ports for extended time periods since the inner estuary would now have a limited 10 ft tidal range instead of 30 ft or more. This would have an annual monetary value to the *present* shipping using Avonmouth of not less than £½ million. A high-level road bridge is proposed over the three navigation locks to provide continuity of road travel at all times.

131. The third criticism, of a transestuary tunnel link, is the criticism of all road tunnels as long as 3 miles. Ventilation becomes a serious problem and any alternative which provides an open-air link, especially one that is a by-product of a money-earning component, must seem more desirable.

132. There are certain other points in the Paper which should be taken up; for example, I can see no particular advantage in the infilling of the airport area. If properly drained, the Welsh grounds need only be levelled. Seepage can be pumped out, and if the bunds are adequate to resist the highest levels (which incidentally would be lower behind a barrage), then the comparison is with the capital cost of infilling versus the maintenance cost of pumping. This would mean that the airport is below the water level in the neighbouring estuary for rather longer periods than the Author proposes, but the choice is an economic rather than an engineering one. Brief reference is made to rail connexion with Severn Tunnel junction. It is worth repeating a point made previously²⁰ that British Rail have estimated the total journey time for an APT from Severn Tunnel junction to Paddington to be 70 min (including contingency time). These immediate links to M4 and railways make the airport site exceptionally attractive by comparison with any other alternative. The Paper mentions costs in § 38 without, unfortunately, specifying of what order they are. This is an omission which it is to be hoped the Author can fill in his reply giving some figures, however qualified, to enable his scheme to be assessed in relation to other published estimates.

133. Despite my criticisms I wish to congratulate the Author on his work and on

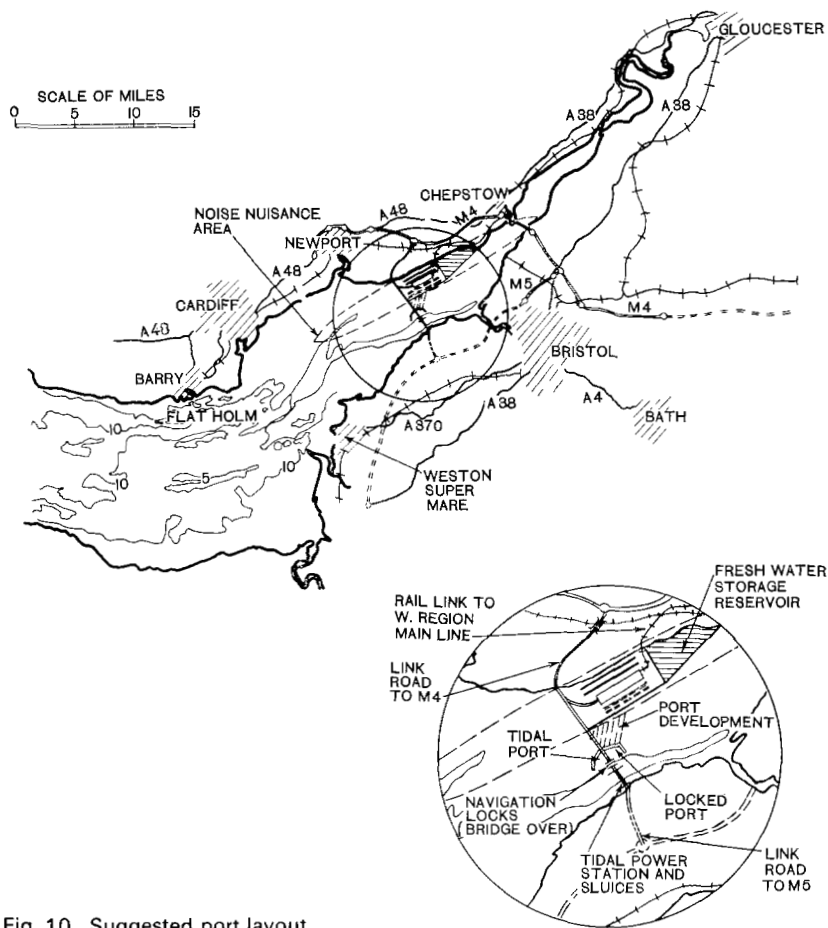


Fig. 10. Suggested port layout

drawing the attention of his profession to the manifest advantages of multi-purpose development in the Bristol Channel.

Mr E. N. Underwood, E. N. Underwood & Partners

Whilst Mr Hooker is to be congratulated on his scheme for harbour, airport and water conservation in the Severn Estuary, he does not, in his proposals, take full advantage of all the potential which is available.

135. There are very few locations in the world where the physical conditions are suitable for tidal generation of electrical power and of these most occur in isolated and unpopulated areas. The Severn Estuary has a high tidal range and has areas of dense population nearby. It is, therefore, ideally situated for a tidal power scheme, and as such no major proposals for the estuary should neglect this opportunity.

136. Many schemes have been produced for generation of electrical power in the Severn Estuary, most of which suffered from the difficulty of economic justification.

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The earlier schemes were based on single basin operation but current thinking is for a multi-basin operation which has enormous potential. Several reports on multi-basin schemes have been produced jointly by E. N. Underwood & Partners and Sir Frederick Snow & Partners, each successive report relating to a scheme having improved potential.

137. A scheme incorporating proposals for generating tidal power can readily accommodate provision for:

- (a) an airport to international standards
- (b) new harbour facilities
- (c) improvement of access to existing harbours
- (d) water storage related to the Severn, Wye and Usk
- (e) improvement of land drainage over a vast area
- (f) new communication links
- (g) reclamation of land for agricultural and industrial use
- (h) leisure and sporting activities

With the vast amount of power which can be generated at no fuel cost, and with small maintenance cost, these items could be considered as bonus benefits at minimal cost over that for providing the tidal power scheme.

138. The case for a feasibility study is very strong, but should take into account the full potential of the estuary.

Mr Hooker

The questions which have been asked reveal an encouraging interest both in the broad planning aspects of the proposals and in particular elements of the complex. Several speakers have asked for details of the cost of the proposals. So far the cost investigation has been limited to the civil engineering costs, which are estimated to be as follows:

	£ × 10 ⁶
Deep water port, including site preparation cost for operational land adjoining the dock	41
Airport, including two 12 500 ft long runways and central terminal	95
Reservoir	14
Road tunnel, including approaches and link with M5 motorway	76
Total:	£226 million

140. It was very encouraging to learn from **Mr Barnwell** that the introduction of trains running at 125 mile/h on the Bristol and South Wales lines is imminent. Having regard to inter-city distances in Britain, there must be a bright future for rapid rail transport and the introduction of these faster services will improve the already good accessibility of Severnside in relation to the rest of the country.

141. Many of the questions relate to the proposed deep water port, and I would agree wholeheartedly with **Mr McGarey** that a detailed study of the estuary as a whole is a necessary preliminary to any major Severnside development. Nevertheless, a great deal of work has already been done on hard bed models of the estuary and **Mr Jones** has referred to the work which the British Transport Docks Board has done in proving the stability of the Uskmouth Channel. In addition, Professor Anderson has carried out a good deal of work (to which reference is made in the Paper) on the geology of the estuary and the Sabrina Project Team at Bristol University also has in hand a great deal of work which is relevant to the proposals. A number of discussions have already been held between specialists on both sides of the estuary who would be in a position to make a useful contribution to a detailed study.

142. The layout of the proposed dock is not, in fact, the same as the two-berth impounded basin to which **Mr Palmer** refers. It is further away from Uskmouth Power Station, giving greater operational space, and at least six berths are proposed, two of which would be for iron ore. The number of berths provided would depend on a careful study of economic and other factors.

143. The Uskmouth site is within one of three areas in the whole of Britain particularly suitable for a MIDA development and I know of no better sites nearer the mouth of the estuary. A tidal basin at Uskmouth would entail some 40 ft of extra dredging compared with an impounded dock, and on the information so far available this extra depth would involve considerable excavation in rock. Siltation would also be a serious problem and it remains my view, therefore, that a wet dock is preferable at Uskmouth, having regard to all the factors involved.

144. **Mr Rydz** rightly draws attention to the necessity for a comparative evaluation of a number of possible MIDA schemes throughout Britain as an essential preliminary to a detailed study of any one of them. There could, however, be more than one such development if there is to be a serious attempt to achieve a better distribution of population.

145. With regard to the economy of estuarine reservoirs, Table 1 shows how the estimated cost of the proposed Severnside reservoir compares with a number of recent schemes.

Table 1. Comparison of reservoir costs

Reservoir	Completion	Capacity, <i>million gal.</i>	Yield, <i>mgd</i>	Total cost, $\pounds \times 10^6$	Capital cost per mgd, $\pounds \times 10^3$
Usk	1955	2 700	10	0.97	97
Selset (Tees)	1960	3 000	17	3.20	188
Llyn Celyn (Liverpool)	1965	16 400	65	2.50	38.5
Derwent	1967	11 000	27	5.20	193
Empingham	1976	27 300	50	17.00	336
Severnside (proposed)	—	25 000	150	13.95	93

146. **Mr McLeod** has raised the matter of asphaltic grouting. Asphalt grouted riprap is extensively used in Holland and was thought to be worth investigation as a possible alternative to heavier armouring, though there would be no difficulty in obtaining from local quarries the necessary blocks for armouring a sea wall in this relatively sheltered part of the estuary.

147. Messrs **Marshall** and **Woodford** refer to saline contamination and I can only agree with their opinion that the diffusion effects might take some time to diminish. With regard to the quality of the water, both the Usk and Wye are salmon rivers which run through sparsely populated areas. Discussion with the engineers of both river authorities confirms that the quality at the proposed points of abstraction would be satisfactory.

148. On the broad question of regional planning, I was most encouraged by **Mr Cooper's** views on the importance of keeping open the options for a major co-ordinated development on Severnside, but I must accept his view that the immediate priority is for industrial growth West of Bridgend. Nevertheless, a complex such as that outlined in the Paper could not be sited elsewhere along the Welsh coast and it is only these flat coastal lands on both sides of Newport which are really suitable for the establishment of major port-based industries on a MIDA scale. He has

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rightly emphasized the relevance of the British Steel Corporation's investment programme and there can be no doubt that a deep water ore terminal at Uskmouth would greatly improve the competitiveness and potential for further development of the Llanwern Steelworks.

149. It would be unfortunate if a lukewarm approach to the development of Severnside led to a MIDA development in the South-East, thereby adding to the congestion of that area and denying employment and other opportunities to an area that has greater need of them.

150. The question has been asked whether certain elements of the overall scheme could be carried out in isolation. I see no reason why this should not be done, provided the effects on the regime of the estuary at any interim stage (e.g. with the sea wall only partially completed) were properly studied.

151. Some seven years ago **Mr Atkins** put forward the view that an ore terminal at Uskmouth should not be considered in isolation but as part of the development proposals for the estuary as a whole and I should like to acknowledge the influence which these views have had on the formulation of the proposals put forward in my Paper. On the same theme, of planning for the estuary in the broadest possible sense, **Mr Atkins** has referred to a possible waterway link between the Bristol Channel and the English Channel. It is interesting to recall that a canal was actually planned more than a century ago from Bridgwater to Seaton by way of Chard, and a narrow boat canal from Bridgwater to Chard was actually built. The influence which a ship canal capable of taking 1000 ton coasters might have in opening up the South-West for industrial development is immeasurable and would make a very fascinating study.

152. Messrs Marshall and Woodford question the advisability of siting the airport below high water level, whereas **Professor Wilson** considers that no infilling of the airport area may be necessary at all, given adequate drainage. I am glad to find that I have suggested a middle course between these two divergent opinions.

153. **Mr Bishop** raises the question of London Airport's attractiveness to users west of Oxford. An assessment has been made of a possible redistribution of present air travel demand if major national airport facilities were available at Severnside in addition to London and Manchester. This assessment shows that a major airport at Severnside could have attracted 3.33 million passenger journeys in 1970, consisting of:

	<i>million</i>
British non-business journeys	1.44
British business journeys	0.89
Non-British residents' journeys	1.0

Severnside's share of the air travel market would grow by such proportions that the volume of passenger traffic by 1990 would equal that of Heathrow and Gatwick in 1970. Likewise the present day proportion of the national airfreight demand originating in the Severnside area (14%) would grow significantly in future, following the high general growth rate.

154. This assessment is based on the Severnside airport catchment area indicated in Fig. 11, with a population of about 8 million people. This area is derived on the basis of travel cost and convenience using present and future road and rail networks. With the Third London Airport located at Foulness, it is assumed that Birmingham would be served by Severnside.

155. **Mr Plumley** makes the interesting suggestion that an area of the reclaimed site might be suitable for a very large refuse disposal plant serving a wide area. This idea seems well worthy of further study but it would, of course, be impracticable to have a tall chimney anywhere near the runway paths.

156. As expected, the protagonists of a Severn barrage have put forward a case for tidal power generation. **Professor Wilson's** new proposals combine a barrage with the reclamation of part of the Welsh Grounds Shoal and provide deep water at

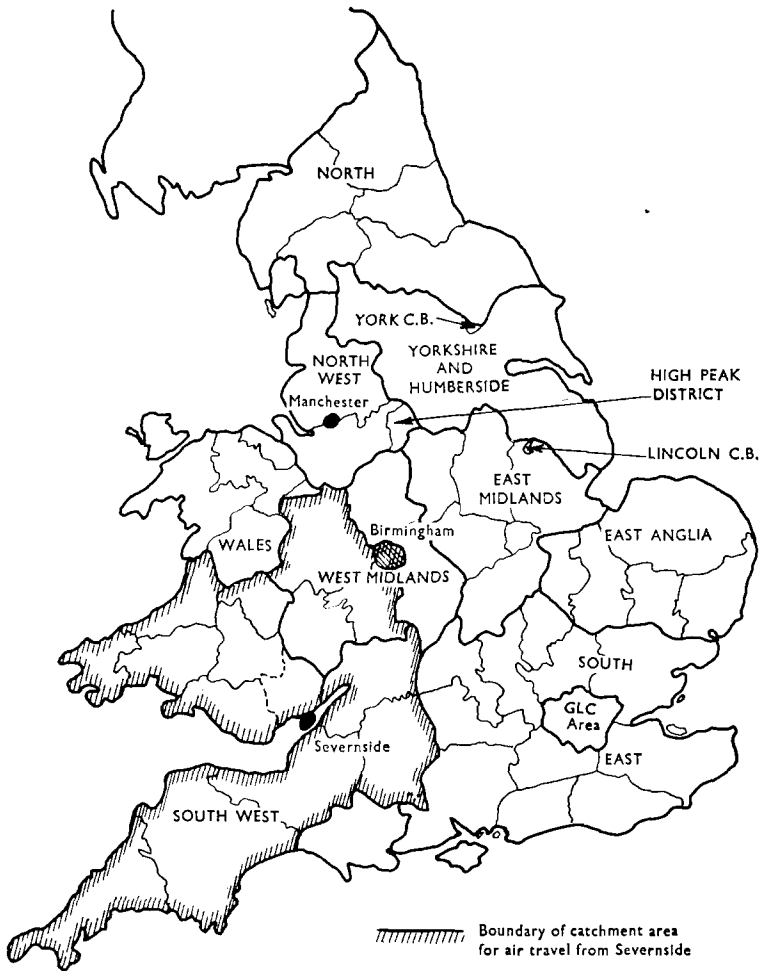


Fig. 11. Proposed Severnside airport catchment area based on travel cost and convenience

Avonmouth and Bristol. The area which he indicates for port development, however, suffers from the same disadvantages as our original proposals in being inadequate for major port-based industries.

157. I am familiar with the proposals which Messrs **Underwood** and **Snow** have put forward for a multi-basin barrage scheme but the cost of constructing a barrage in fast-moving water which is more than 10 fathoms deep in many places would be very high indeed. A barrage would also give rise to major siltation problems and considerable cost would also be involved in treating any sewage discharged upstream of the barrage to Royal Commission standards.

158. On the question of the proposed road link with Avonmouth, Professor Wilson prefers a bridge to a tunnel. Certainly a bridge would be cheaper, but a high

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level bridge (particularly a suspension bridge) might be a hazard to aircraft, and a low level bridge would prevent access by coastal shipping to the Gloucester and Berkeley Canal. I bow to **Professor Baker's** knowledge and enthusiastic support for an immersed tube type of tunnel, but with recent improvements in bored tunnelling techniques I feel that both alternatives would have to be studied before any decision could be made.

159. Now that the long awaited Severnside Study has been published it is possible to judge the extent to which its recommendations and the development proposals outlined in my Paper are compatible.

160. The study puts forward two possible areas for major industrial development, one on either side of the estuary, and they would be linked by the proposed tunnel. Two of the three urban sub-regions proposed in the study are also within easy commuter distance of the industrial sites on Caldicot Level.

161. With regard to water supply, more than half the estimated increased demand of 250 mgd to which the study refers could be met by the proposed reservoir.

162. It will be seen, therefore, that if the potential of the Severnside area to absorb a substantially increased population is to be fully exploited, developments such as those put forward in the Paper will be needed in order to provide the necessary opportunities for employment and amenity.

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