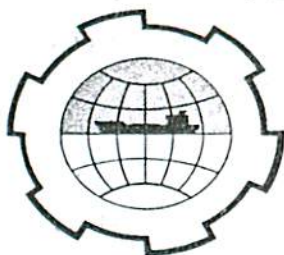


SECOND INTERNATIONAL CONFERENCE ON  
PORT AND OCEAN ENGINEERING UNDER ARCTIC CONDITIONS  
UNIVERSITY OF ICELAND  
DEPARTMENT OF ENGINEERING AND SCIENCE



THE SEARCH FOR A SUITABLE SITE FOR A REPLACEMENT  
TOWNSHIP AND HARBOUR COMPLEX FOR VESTMANNAEYJAR

W.J. Guckian, Chief  
Fishery Harbours Section

Food and Agriculture Organization Rome, Italy  
of the United Nations

1. BACKGROUND

The volcanic disaster in Vestmannaeyjar on 23 January 1973 has graphically illustrated, amongst many other things, the interdependence of the fishery harbour with the other elements of the fishery industry complex.

Within the well knit community of Vestmannaeyjar, with a population of nearly 6 000, a very prosperous fishery industry was established, where virtually all life depended on the catching of large quantities of first-quality cod and thereafter on the handling and processing of this fish in a manner acceptable to even the most fastidious consumer. That this had been accomplished successfully is readily seen with a cursory look around this most prosperous and well established township where, with less than 10 km of roadways, there were over 800 motor cars.

The establishment of this fishery colony, about the fifth largest population centre in Iceland, was due to two main factors, the presence nearby of the large winter cod stocks and the availability of the only natural harbour along the whole of the south coast of Iceland. While these facts promoted the ready growth of the industry along certain lines, it might also be said to add to the present difficulties. To overcome the full effects of the disaster and to continue the industry development will necessitate changes in the whole rhythm of the fishery operations, both in the long and in the short term.

The results of the eruptions to date are now well known, the island of Heimaey has been increased considerably in size; about one third of the township dwellings have been destroyed and many others damaged by lava or by volcanic dust (see Map 2); many of the public utilities and buildings have likewise been destroyed or damaged and, last but not least, a number of the main fish-processing plants have been destroyed and others are damaged or severely threatened by the wall of lava rock. At one time, in March/April 1973, it was feared that a further thrust of the lava might either block the harbour



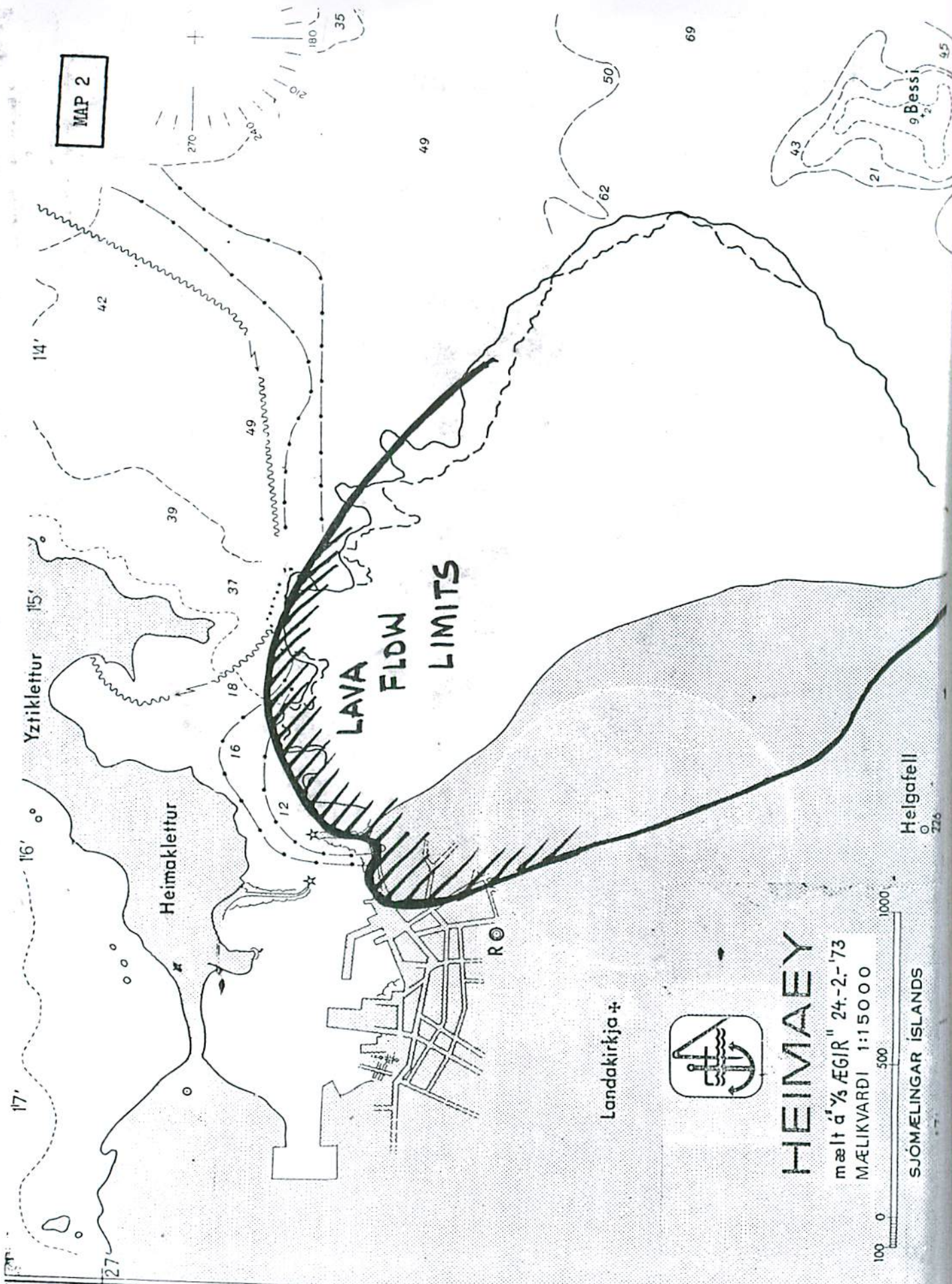
MAP 1

# ISLAND





MAP 2



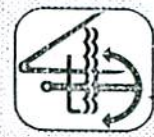
LAVA FLOW LIMITS

Heimaklettur

Yzirklettur

Landakirkja

Helgafell

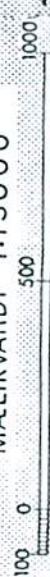


HEIMAEY

mælt á 1/3 ÆGIR 24.-2.-'73

MÆLIKVARDI 1:15000

SJÓMÆLINGAR ÍSLANDS





entrance or cover a major part of the harbour basins. Fortunately, neither of these events have, so far, occurred. The lava flow has stopped, whether permanently or temporarily, at the basin edge and has only partly filled the entrance channel. Should these be the final limits of the movement, it can be stated that the qualities of the harbour, as regards its vessel operation have been greatly enhanced. In the pre-disaster period, the only shortcoming in the natural provision of the harbour was a rather open outer approach with heavy swell in certain gale conditions. The lava rock deposits in the sea from the eruption have provided a most satisfactory wind and wave barrier.

At this point the happy picture ends, however, many of the fishery plants have removed much of their equipments, the necessary port services have been largely destroyed and the human element of the industry is not yet available in sufficient number to operate adequately the full handling and processing operations. The presence of toxic or suffocating gases may even make the return of more than a token percentage of the population improbable in the near future.

## 2. VESTMANNAEYJAR FISHING INDUSTRY

The bulk of the fish landings at Vestmannaeyjar are made in the period December to May. This covers the winter cod landing period and an ever-increasing capelin catch. The former is processed (mostly frozen) for export, while the latter is principally used for fish meal reduction, though a growing market for frozen capelin now exists in Japan. Total annual catch at this port approximates 100 000 tons of all species caught by 83 (home-based) vessels (20 to 300 GT) together with a number of visiting vessels during the peak seasons.

The processing industry prior to the eruption consisted of about 7 major processing units for both freezing and fish meal and up to 8 other smaller units mainly for cod drying. Vestmannaeyjar had the largest landings of any port in Iceland and contributed about 15% of the country's total landings. To man the processing factories in the peak seasons, most of the inhabitants of the town worked on a shift system and where even the young children contributed much to the success of the operation.

## 3. SOME CHARACTERISTICS OF THE NEW PORT REQUIREMENTS

A replacement port or, even if much of the original port facilities and services are restored, the necessary mainland satellite port, should fulfil a number of essential requirements which would greatly reduce the operational hazards frequently experienced in the region.

Wind records indicate that for the Vestmannaeyjar Islands area the average velocity is over gale force from the south-west through south-east directions frequently reaching force 16 to 18 of the Beaufort scale. Ocean waves in the region have correspondingly large amplitudes with over 15 metres experienced.



The first requirement for any new port in these conditions would be to choose a naturally protected bay, inlet or fjord, where sea conditions would be greatly ameliorated. Unfortunately no such site exists on the south coast of Iceland and protection must be obtained by the addition of artificial barriers to enhance any site with even a modicum of natural protection. To avoid inevitable comparisons of inferiority and the resultant dangers attached, it is essential that the developed port should have a comparable degree of safety to the existing port facility of Vestmannaeyjar. Other requirements include minimum sedimentation or coastal drift of beach material; the availability of a nearby township, or the possibility of developing a new town with all the necessary amenity services to cater for the maximum number of people likely to seek rehousing; moderate to good road facilities to serve the industry's needs; availability of a deep-water berth to provide facilities for direct export transshipment.

Since the fishery operations in Vestmannaeyjar are more or less fully based on processing and exports, little of the landed product is marketed fresh for local consumption - the total population of Iceland being merely 200 000. Certain differences therefore exist as compared with other major fishing ports.

The principal operations that must be catered for include:

- (i) Landings, with provision for sufficient vessel quaysage; plant and equipment to handle the various products; transportation to convey products to the plants (whether vehicle, pipeline, conveyor, etc.);
- (ii) Berthing with adequate quays to berth at least the full home-based fleet - since fishing is principally a one-day operation in peak seasons;
- (iii) Provisioning, separate quays should be available for fuelling and the servicing with water and ice - the latter especially in the summer months when longer, up to two week trips, are common.
- (iv) Vessel repair and maintenance. On the south coast, the only existing repair facilities are located in Vestmannaeyjar. Especially if this port is not fully usable, a vessel lift or slipway and a repair yard and workshop should be provided in each new project. The number of repair bays can vary in different circumstances from 1% to 10% of the fleet numbers, three to five bays might satisfy in the early stages of operation of the recommended new port.
- (v) A number of other miscellaneous facilities are required, electronic repair facilities, gear assembly, maintenance and repair and storage facilities for a multitude of vessel and crew requirements. Buildings and workshops are needed for the port authority, the fishery supervisor, the fleet owners and managements, etc. Water



supplies, adequate fire-fighting services, drainage and sewage services and adequate lighting and power supplies according to the various activities conducted at the various parts of the port area.

#### 4. POSSIBLE SOLUTIONS

There are a number of possibilities open for the further exploitation of the cod fishery in this region of Iceland. A final choice of site and form of development may be difficult either from political or technical points of view. The most acceptable one may include items from more than one alternative solution to suit the conditions applicable at the time the decision has to be taken.

The best solution will depend on future events but may come from one or more of the following:

4.1 An abandonment of the Vestmannaeyjar location (due to continuing disaster, e.g., harbour basins blocked) and the re-establishment of most of the industry and the population, together with all the necessary facilities and services at a newly developed fishery harbour and township at a selected site on the southern coast of Iceland. This would be costly, but in the special set circumstances would be the most economical and effective manner of catering for a proper continuity of the industry.

4.2 An abandonment of the Vestmannaeyjar location (due to continuing disaster) and the splintering-off of the population to other fishery centres throughout Iceland without major reconstruction of harbours or major extension to any processing units. This would not be a solution for continuing the exploitation of the rich southern shore resources and would also lead to probable over-exploitation in other waters and eventual loss of landings and a great reduction in fish exports - the life's blood of the Icelandic people. It would also involve the loss of a great fishery tradition evolved over generations.

4.3 Should the eruption cease and remain dormant, the gradual rehabilitation or reconstruction of most facilities at Vestmannaeyjar, together with some duplication and secondary development on the south coast of the mainland to cater for the short-term and eventually the spill over from a smaller Vestmannaeyjar unit.

4.4 With a cessation of eruption but difficulty still experienced in obtaining a return of the population for fear of further disaster. The mothers and young children might be most effected and this would eventually lead to a partial abandonment of Vestmannaeyjar by industry through lack of permanent workers.

4.5 Due to continuation of any of the eruption effects, which might reduce the capability of the entrance, or the basins to cater for the full fleets and industries which previously existed in Vestmannaeyjar. This could lead to a reduced size harbour at Vestmannaeyjar, perhaps only the establishment of an advance base with limited services for emergency use for fleets operating nearby.



There are a number of possible variants. All would require the establishment of improved facilities in the southern region for the short-term while more extensive development is being implemented for the long-term.

To understand the full needs, a brief description of the type of operation conducted may clarify the situation. It has been stated above that the island of Heimaey was chosen by this fishery colony because of its fine natural harbour and also because the cod fishery grounds were very close at hand, frequently less than one hours sailing time distance.

For the exploitation of these resources a fleet of over 80 vessels had developed at the time of the eruption, the great majority of which were under 60 GT and many were of an age at which they would be scrapped in other countries. By careful repair and maintenance, however, these vessels were operating on a daily trip basis with a high financial gain. They have been near their secure home base and at any sign of severe gale conditions have quickly reached shelter.

This type of operation, generally lasting 12 hours or less, has brought 10 tons or more of cod per trip to the processing factory with a very short steaming time. No ice or special preservation system for this brief trip is necessary. Boats can be small and yet effective in handling their gear - a form of bottom gillnet left in position and periodically emptied of its catch. This resulted in a very fine quality product, while the fishermen were able to return home each night.

Should the fleets have to change their base, the nearest location would, at best, be marginally less effective or, at worst, considerably less economic. Especially the smaller vessels would expend an additional 10 hours, or even much more, steaming from other ports and also negotiating some very treacherous sea regions on their voyages. Due to the extra time involved, quantities of ice would have to be carried on board consequently considerably reducing the already limited capacities of the fish holds, thus reducing further the financial returns of the fleet and the industry.

Any of the alternative solutions would be costly and on a basis of expenditure per head of the Icelandic total population (approximately 200 000) would be a tremendous burden for a number of years to come. However, with fish being the principal export item (74 percent of all exports) such an expenditure is necessary to take full advantage of the rich cod resources and an increasing capelin catch.

Within reasonable orders of expenditure, i.e., say less than \$15 million, excluding township development, two main channels of improvement are open. The first would entail an easement of the difficulties existing in the short term by providing as early as possible a noticeable improvement of the arduous conditions in one or more of the nearest existing ports or landing places on the south coast. The second would enable the majority of the fleets either to



transfer permanently to a fully developed new port on the mainland or, to base themselves temporarily at a facility which would meet their priority needs and which could thereafter be used as a satellite port in the long-term future for Vestmannaeyjar to cater for that percentage of the industry which could not be served by a rehabilitated, but somewhat restricted, harbour at Vestmannaeyjar. The full master plans and technical details, many of which are extremely difficult and complicated, remain to be worked out and will be subject to many modifications as time passes.

Some further recommendations have been made to the Government. The most suitable proposal to meet the immediate urgent needs of the fleets should be the continuation of an already commenced improvement at Grindavik. However, this will not meet the full requirements of the smaller, under 60 t, vessels and cannot cater for vessels larger than about 300 GT which were proposed for early use in the region.

If a good improvement of the port entrance can be attained in this scheme, the short-term needs of a limited number of the 60 to 250 GT fleet might be met nearly in full and a percentage of these might permanently base themselves and their families at Grindavik.

The main longer-term improvement and, if necessary, the replacement of an abandoned Vestmannaeyjar should be located more closely, however, to the fishing grounds which at present generally fluctuate within an area west or east of the Vestmannaeyjar Islands. The southern coastline of Iceland is an atrocious one from the engineer's viewpoint. Its up to 10 km wide sandy beach deposits, originating from the still massive glaciers, prevent extensive lengths of this shore from rational consideration. A number of proposals have been considered at certain places which in capital or recurring maintenance costs would have catastrophic effects on the financial standing of the Icelandic fishery or national economy. The only reasonable place, though not by any means an engineer's dream, is located near the small town of Thorlakshöfn at the western end of the sickle-shaped bay at the estuary of the Olfusa River. This location might minimize the occurrence of siltation from this heavily laden river which could occur at any other part of the 8 km-long sand spit.

## 5. IMPLEMENTATION

The implementation of such a programme of works would be an innovation in the fishery industry of Iceland and should be conducted with care, albeit with as much haste as possible to meet the emergency conditions. As much use as possible should be availed of from friendly neighbouring states to provide the expertise necessary for a development of this extent.

Iceland, a small country with little previous experience of major marine development works, requires some assistance and while working in conjunction with the chosen expertise they may be able to produce a solution which would be intrinsically Icelandic in its conception.



## 6. SOME SPECIFIC PROBLEMS TO BE MET WITH AT SELECTED SITES

Map 1 indicates the various locations mentioned in this paper and also details roughly the fluctuating cod fishery grounds during the past few years. It illustrates the benefits from, but impossibility of, finding a port sufficiently far to the east to replace the existing base at Vestmannaeyjar.

The ports mostly concerned in the provision of facilities must be south of the Reykjanes Peninsula since the treacherous seas to the west of this headland make it frequently difficult for the smaller under 100 GT vessels to negotiate them with safety.

On the whole south coast only Grindavik has a basin capable of berthing vessels. The problems lie in the depth of the basins and in the hazardous and tortuous rock bound approach and entrance channel.

Other locations, Thorlakshöfn, Eyrarbakki, Stokkseyri and Portland have no naturally provided safe refuge and extensive artificial works must be constructed for approach channel and berthing security. With its bay alignment at this point giving some measure of protection and its probable lack of extensive coastal drift, Thorlakshöfn seems to be the most suitable place for future development.

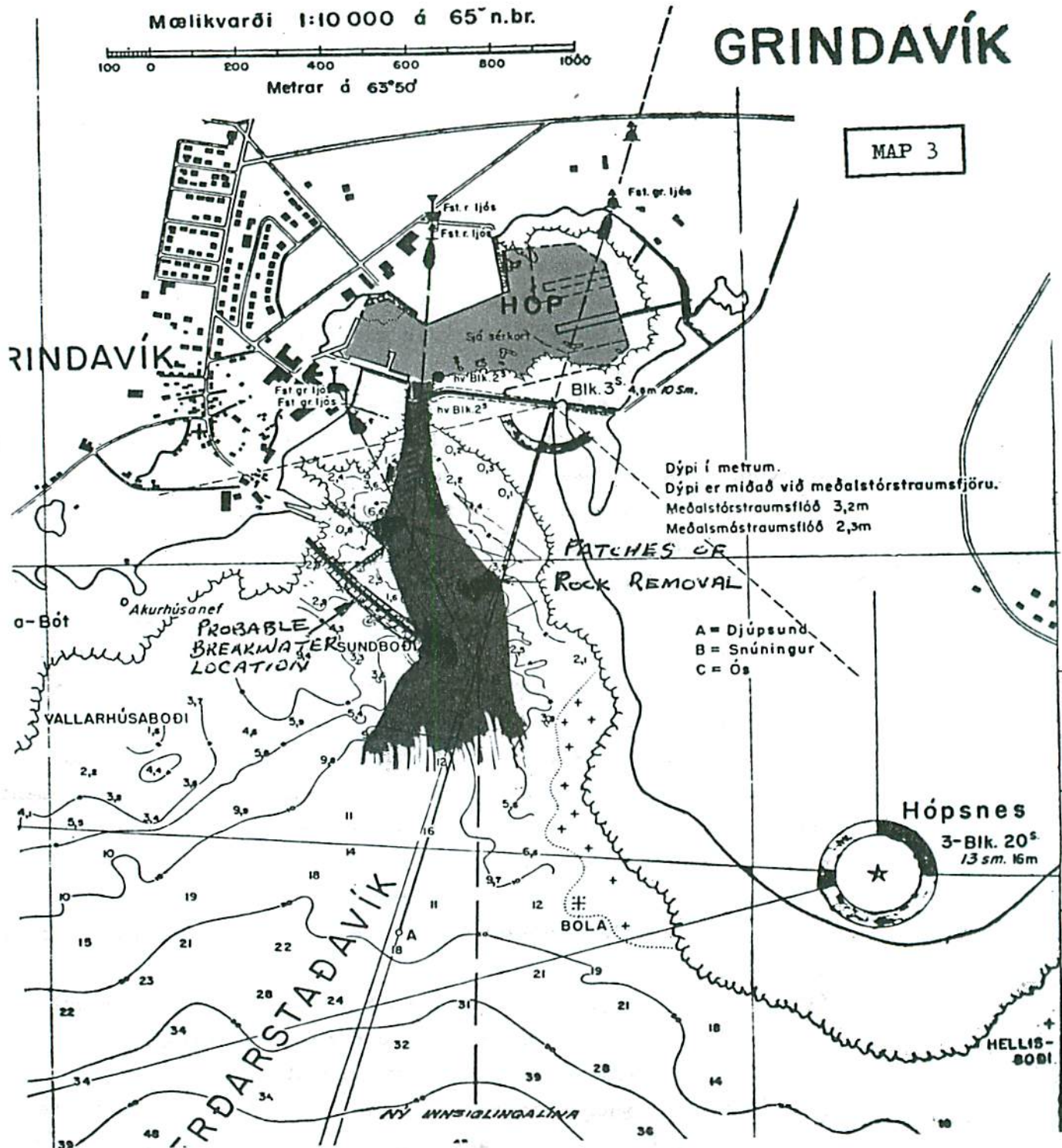
A further location which must be considered for some improvement is Hornafjörður (see Map 7), which lies on the extreme eastern flank of the south coast, very far from the winter cod grounds, but with definite nearby resources of winter capelin and summer cod amongst other miscellaneous species. This harbour is located in a relatively large and deep lagoon which is safe in all weathers once the extremely difficult entrance has been negotiated. The sand drift problem is of such dimension, however, that no great improvement to this entrance could be recommended and entrance to the port area will, therefore, remain very hazardous and even impossible under certain extreme weather conditions.

6.1 The sites recommended for more detailed examination and investigation are, therefore, Grindavik and Thorlakshöfn.

### a) Grindavik (Map 3)

Consists of a figure of "8" shaped basin, the western section being more or less circumscribed by development and restricted in dimension by existing quays and buildings. Its depth is also limited by rock layers on the sea bed. Smaller vessels could continue to use the quays for berthage and should be restricted to this usage. The larger basin section to the east is relatively shallow but can be dredged over most of its extent to a depth of about 5 m at low water level. This section contains a relatively new quay, intended for use as the main landing facility and an area is being reclaimed to its rear for quay extension and space for traffic movement and perhaps for some other port facilities. The







extension of this basin section is not limited by any surrounding buildings and great care should be taken to determine a long-term master plan for its eventual development before any permanent restrictions are placed there. An essential early addition for the effective operation of this port, catering for up to 70 or 80 vessels in normal seasons and over 100 vessels at peak periods, is a vessel lift and repair yard. This should be treated as a priority provision. Until the extremely hazardous entrance has been greatly improved, visiting skippers will show great unwillingness to use the basins however much they are improved. Great danger exists at night in foggy conditions, especially with high waves running from the southerly or south-west direction. It is necessary to remove much underwater rock to widen, deepen and straighten this approach channel. The provision of an outer breakwater might also alleviate the hazardous conditions still further but this can best be examined in a small-scale model test.

All such improvements will attract more vessels and increase landings but it will never make the small vessel (under 50 or 60 GT) operation as economic as it was in Vestmannaeyjar. This scheme is, therefore, recommended principally as a first phase emergency improvement of the existing unhappy conditions.

b) Thorlakshöfn (Map 4)

This small recently established town of about 700 people with a very small harbour basin could not be expected to provide any adequate facility for the Vestmannaeyjar fleet, industry and population without major expansion.

An attempt should be made to provide a layout proposal, phased as necessary, to cater first of all for the medium-term requirement and thereafter either as a full replacement or merely a satellite port for Vestmannaeyjar. Some such schemes as those indicated in maps 5 and 6 might fulfil these requirements.

A number of special comments could be made on the preparation of such proposals:

- (i) The first phase scheme must be capable of being readily expanded at a late date into a major facility, based on a long-term master plan development.
- (ii) Not too much notice should be taken of the existing facility otherwise it would seem that "the tail may wag the dog".
- (iii) If a satellite port is the final choice, a car/passenger ferry is a much sought after and reasonable provision for a once endangered population of Vestmannaeyjar.

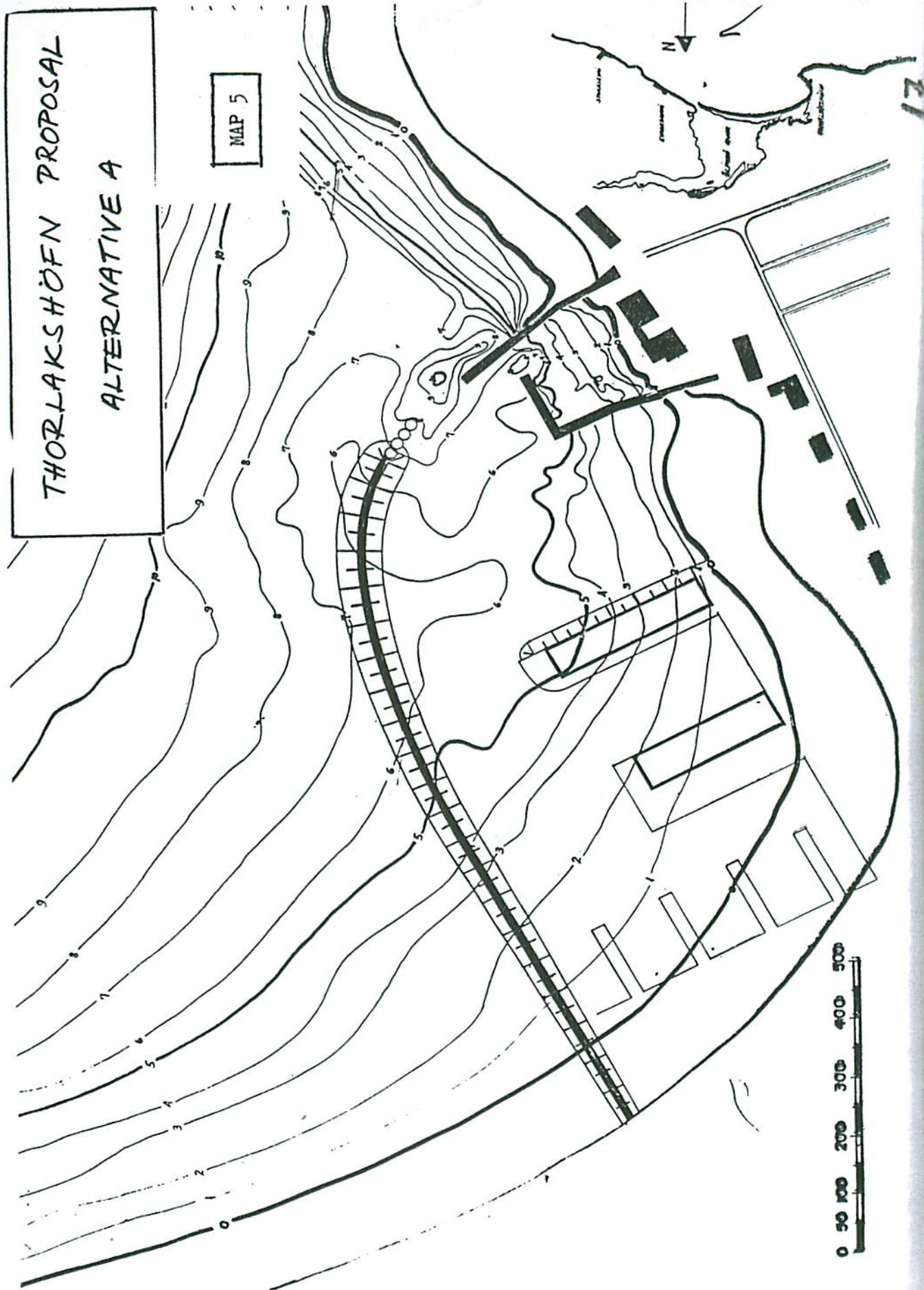


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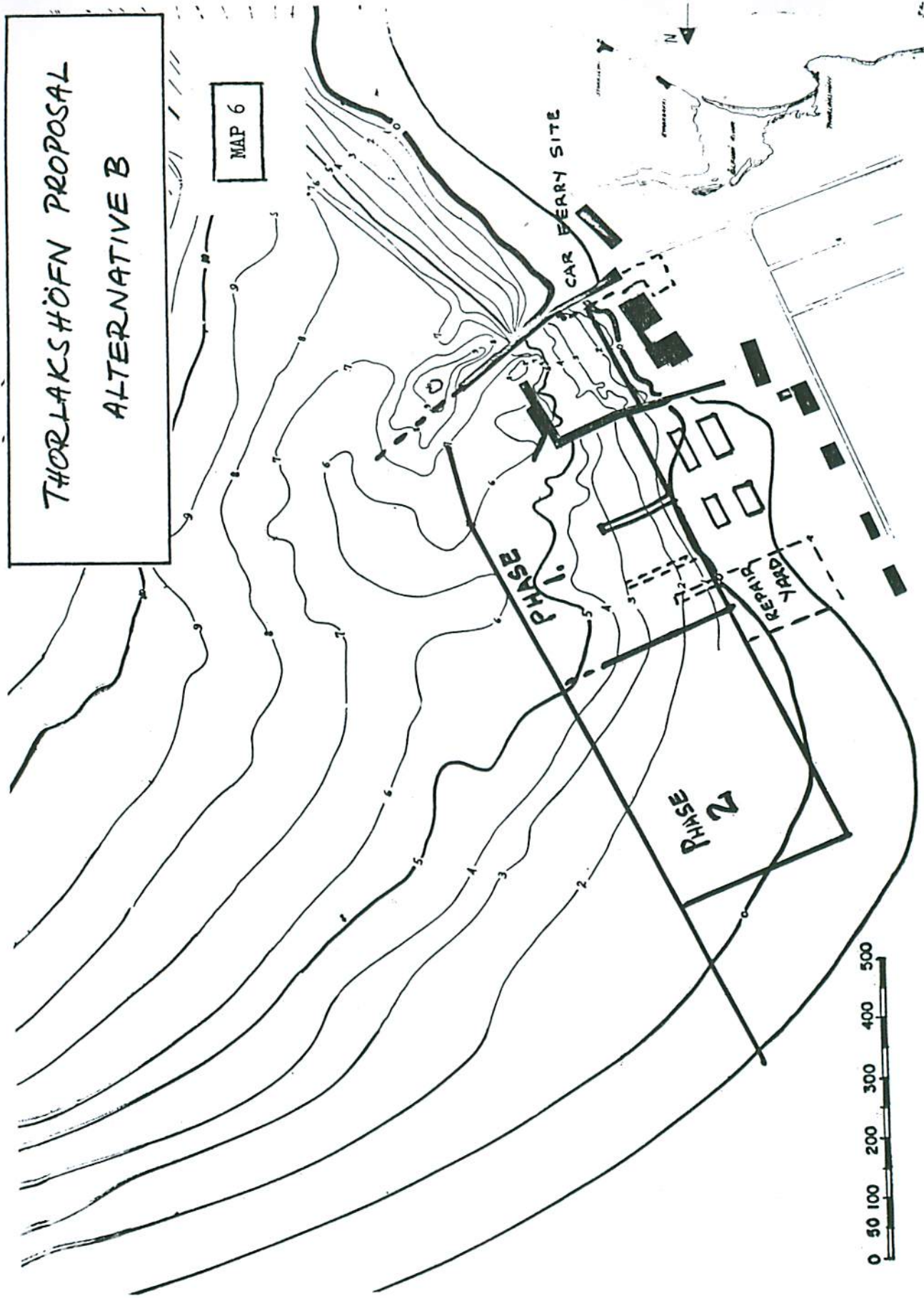
PORLAKSHOFN

Scale 1:50,000















- (iv) Great care should be taken in the outline plan to dovetail with the necessary and essential township development planning.
- (v) Many disciplines, apart from the harbour and fishery industry development engineers, should be integrated into one Authority to supervise such early planning as well as the final implementation and supervision duties.

7. CONCLUSION

It seems that Iceland cannot avoid preparing a major development plan for future industrial exploitation of its rich south coast fish resources. While the emergency calls for rapid action, this should proceed with caution under effective technical planning control. However it may proceed, it will be at high cost to the individual Icelandic taxpayer but since expenditure on the fishery ports of Iceland has for a long time been very limited - if not quite neglected - it may mean that a fair share of development attention will now be devoted to this sector of the fishery industry.

[The author wishes to acknowledge the use of Icelandic Government Departments' maps and plans used in the preparation of this paper]