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HYDROGRAPHY IN BAHRAIN

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INTRODUCTION

Bahrain is a small island State located on the southern shores of the Arabian Gulf, sandwiched between its large neighbour Saudi Arabia to the west, and Qatar to the east. Although the State of Bahrain comprises many islands, most of them are small and uninhabited, with the majority of the nation's population to be found in the north of the main island. The capital, Al Manama, is linked by causeways to the nearby islands of Muharraq and Sitra, and recently a vehicular causeway has been opened to Saudi Arabia.

The State covers some 300 square miles in land area, but by virtue of its island status, claims ten times this area as an Exclusive Economic Zone. Agreements delineating these off-shore boundaries have been concluded with Saudi Arabia to the west and Iran to the north, whilst the eastern boundary with Qatar is subject to ongoing negotiations. The majority of the waters within the EEZ are shallow, with numerous reefs and sandbanks, but there is a relatively deep water channel to the north east.

Prior to the establishment of the Bahrain Hydrographic Department, apart from a few commercial surveys for specific developments and some excellent exploratory survey work by BAPCO, (the Bahrain Petroleum Company), the Admiralty, or more accurately MODUK (Navy) had been the major charting authority for Bahrain waters. Naturally these surveys were confined to areas of specific interest to commercial and naval shipping and were concentrated to the north and east of Mina Salman, but they did provide sufficient coverage of the main approach channels. Other areas remained relatively unsurveyed and, indeed, it was not until as recently as 1967 that a detached survey party from Her Majesty's Surveying Ship VIDAL carried out a survey at a scale of 1:75,000 of the southern waters from Zallaq around the southern extremity of the main island

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at Ras Al Bar to Askar. Even then this survey only extended some four to five miles offshore.

The Bahrain Hydrographic Department in its present form dates back to 1982 when a clear requirement for modern and up to date nautical charts of Bahrain waters was defined by the Bahrain Government. Yet some five years earlier there was a national requirement for hydrography within the existing port limits, as the Port of Mina Salman was undergoing development and expansion. Steps were taken then in 1978, to ensure that the Government was able to monitor the progress of construction within the port and that the specifications regarding dredged channels and land reclamation were being met. It was also recognised that regular surveys of the jetties, turning basin and approach channels would be required in the future to ensure that local pilots and the masters of visiting merchant ships were supplied with the latest hydrographic information.

ESTABLISHMENT OF THE BAHRAIN HYDROGRAPHIC DEPARTMENT

Bahrain, in common with the majority of the Gulf States embarked upon an intensive period of construction and development during the 1970's, and the port of Mina Salman, Bahrain's only deep water port was no exception. Development involved land reclamation, the construction of new jetties and the dredging and marking of new navigable channels — what better basis for the establishment of a national hydrographic capability?

Bahrain was fortunate in that by 1978 a Surveying Department with geodetic and cadastral responsibilities was already well established within the Ministry of Housing and it was therefore a relatively simple matter to nominate a specific surveyor to shoulder the additional responsibilities that hydrography within the port would demand. (Even more pertinent was the fact that the 'nominated surveyor' was an ex-Royal Navy Chief Petty Officer Survey Recorder, who was ideally suited to the task!).

Surveying within the port began with the majority of the equipment required, being 'hired-in', but fortunately this state of affairs did not persist for very long, and, in 1979, the Department acquired its first survey launch, SURVEYOR, which was purchased from Cheverton Boats in the UK. Basic equipment such as an echo sounder, current meters and an accurate short to medium range positioning system (Trisponder) were added and surveying began in earnest. The results of this early work were forwarded to Taunton in order that the current BA Chart No. 3796 (scale 1:17,500) could be corrected. At roughly the same time work began on the first Bahrain Chart No. 1501 at a scale of 1:15,000.

In 1982, however, it became apparent that there was also an urgent requirement to survey waters further afield than Mina Salman and Sitra. This by definition meant all remaining areas except the north-east approaches (at least for the time being), and included those which had either never been surveyed, or which had received only sketch surveys dating back in many cases to pre-first world war. These old surveys were conducted using the traditional lead and line,

yet in spite of these limitations the information obtained by the early surveyors was remarkably accurate and even today provides the only source of information in many areas. Copies of most old surveys are held in the Hydrographic Office archive and provide a most interesting record of the development of Bahrain.

Consequently, in 1982-83 an expansion programme was devised whereby a second survey launch would be purchased together with additional equipment, and extra staff recruited. It was at this time also, that guidance was requested from the Hydrographic Department, Taunton, on how best the Department should evolve, bearing in mind the limited funds available and the diversity of interest in hydrography amongst the various Government Ministries.

These interests were identified as follows:

The Ministry of The Interior — Coastguard Directorate; who were directly responsible for policing the 3000 square miles of the Exclusive Economic Zone.

The Ministry of Defence — Navy Department.

The Ministry of Finance and National Economy — Ports and Harbours Directorate; who under the direction of the Harbour Master were responsible for pilotage and all matters relating to merchant shipping, including the local flow traffic and associated small craft harbours.

The Bahrain Petroleum Company — under the Harbour Master at the Port of Sitra, with its deep water jetties, sea island oil loading terminal and associated tanker traffic.

The Ministry of Housing — with the already established survey data base and its hitherto limited experience of hydrographic surveying.

After much discussion, in which no doubt, financial and administrative constraints were considered it was decided that the responsibility for hydrographic surveying should remain with the Ministry of Housing, but that the other interested parties should be consulted on a regular basis, in order that both the long and short term charting plan should consider all Government requirements.

This was certainly advantageous from a hydrographic point of view as it ensured continuity and access to the geodetic survey base, but it did involve the Ministry of Housing in marine matters of which it had no administrative expertise or experience. These shortcomings though, were amply compensated for by the encouragement and material support of both the Harbour Master's Office and the Director of Coastguard Operations, both of whom were fervent supporters of the hydrographic task. Indeed, it is difficult to imagine how a National Charting Plan would have progressed without the close liaison and co-operation of other Government Departments.

THE NATIONAL CHARTING PLAN

The Bahrain 'National Charting Plan' which was devised in 1982 and agreed within the Ministry of Housing, envisaged a series of four charts drawn and published to full international standard at a scale of 1:50,000. Numbered

5001 to 5004, they would provide coverage clockwise around the main island, but exclude the main shipping channel to the north east. This decision was based upon the fact that there was no detailed chart coverage of these waters other than the north east approaches, indeed some of them were totally unsurveyed, and the Government of the day were anxious that full coastal chart coverage should be provided as soon as possible. It was also decided at this time, that the production, printing and distribution of all charts should be undertaken in Bahrain.

Naturally, if the charts were to be published at a scale of 1:50,000, then the surveys themselves had to be conducted at a scale of 1:25,000, and so work was started on the east coast to the south of Mina Salman and Fasht Al Adham, a large coral reef which extends eastwards some fifteen miles towards Qatar.

This plan was undoubtedly extremely ambitious, but thanks to the foresight of the Governemnt, extra finances were approved and the Department embarked upon an expansion programme. This entailed not only the recruitment of experienced surveyors, technicians and a draughtsman, but also the purchase of a second survey launch and additional equipment, with separate office space being provided which was set aside from the Ministry building in Manama and located at Juffair, near to Mina Salman.

A total hydrographic staff of twelve was authorised, comprised as follows:

1 Head of Department
1 Chief Surveyor
2 Surveyors
3 Survey Technicians
1 Boat Mechanic
1 Draughtsman
1 Boatman
1 Office Secretary
1 Office Assistant (Farash)

Although the authorised personnel strength of the Department was not fully achieved, encouragement was given to Bahrain University Graduate already employed within the Ministry of Housing, to spend time with the Hydrographic Department. Consequently, there were generally sufficient personnel available to man the boats which meant that work could progress. This policy introduced the local training scheme, whereby Bahraini surveyors who wished to specialise in hydrography and who had gained sufficient practical experience, could expect to be sent to the United Kingdom to attend professional training courses. By the end of 1990, four Bahraini surveyors had been trained in this way.

On the equipment side, a second Trisponder system, a Waverley Sidescan Sonar and an Atlas Deso 20 echo sounder were purchased and were fitted to the second boat which was acquired locally. Three tidegauges were also purchased with a view to expanding the tidal data base which was already in existence and which, owing to the complex nature of the tidal regime around the island, was considered essential in establishing the necessary chart datums. To assist with the survey planning, use was made of the existing geodetic base, with additional stations being co-ordinated jointly with land survey personnel. Finally, Trisponder range-ring charts were produced within the Ministry, as funding of the Department did not include the luxury of any automated systems, either 'on' or 'off' line.

DEVELOPMENTS SINCE 1985

The author arrived in Bahrain during the summer of 1985, by which time the Department in its present form was well established and much survey work had been undertaken. Unfortunately, the publication of the envisaged 1:50,000 scale chart series was well behind schedule, but the existing hydrographic base was firmly established. The reason for the slow progress can in retrospect be attributed primarily to the unsuitability of the second survey launch which had been purchased specifically for the National Charting Programme. Unfortunately, this vessel was plagued by mechanical and electrical defects and had insufficient endurance to operate away from base for any length of time.

It was felt that a new approach had to be made to the surveying plan, taking into account a wealth of administrative and practical factors. Clearly, the first requirement was to obtain a new boat, one that had sufficient endurance, reasonable sleeping and messing facilities, together with a reliable air-conditioning system (essential in the summer months, with temperatures in the high 30's Celsius!), and most importantly of all, a vessel that could provide a suitable platform for surveying in the relatively shallow waters which are often affected by sudden shamal winds which whip up a short but sharp sea. Additionally, a routine maintenance and refit plan was formulated, which reflected as far as possible the personnel leave and training programmes.

Another factor which had to be considered was the priority of each individual survey task. In the case of Bahrain, this was of paramount importance, bearing in mind that although the Ministry of Housing was the charting authority, the users, and hence those most interested in hydrographic matters, were the Port, Coastguard and Navy departments. It was also deemed necessary, to incorporate numerous smaller tasks within the overall survey programme. Of these, the regular bi-annual surveys of the shipping channels and turning basin within the port took the most concentrated effort, particularly as hand plotted surveys were conducted at a scale of 1:2,500!! Also was the unpredictable, yet important demand for other minor surveys such as small jetty or causeway development, and the occasional sonar searches which were required at the scenes of marine accidents, particularly collisions and sinkings.

The new plan was formulated and submitted for approval in late 1985 and although it was approved in principle, finance did not become available until 1988. In the meantime, work progressed and the first two 1:50,000 scale charts were published together with a 1:25,000 chart which was intended primarily for recreational and small boat use.

The new plan envisaged, was based upon the original four chart scheme, but extended to comprise six charts at 1:50,000, one at 1:25,000, two at 1:12,500 and one at 1:150,000, together with the publication of a tidal stream atlas and tidetables of selected Bahraini locations on an annual basis. (See Charts and Publications).

On the vessel and equipment side, the following had been acquired and was operational by 1989:

Vessel	Length	Propulsion	Equipment
AL MIYANA	60 ft	2 GM8VTI Diesels	Atlas Deso 10. Waverley Sidescan Sonar (*). Loran C RX. Trisponder 540 System. Associated Radar and Radio Systems, plus one cellnet phone. 1 Zodiac Dinghy and Outboard Motor.
SURVEYOR	45 ft	1 Perkins 6 cyl Diesel	Atlas Deso 20. Loran C RX. Trisponder 540 System. Associated Radar and Radio Systems. 1 Zodiac Dinghy and Outboard Motor.
ESKAN	18 ft	1 4 cyl Diesel	Raytheon Portable E/S. Trisponder 540.

(*) Interchangeable with SURVEYOR.

Other Surveying Equipment

7 Trisponder Remote Units
2 Spare Trisponder Master Units
2 Spare Trisponder DDMU's
3 Portable OTT Tidegauges
2 Current Meters (DRCM's)
1 Sound Velocity Probe
Miscellaneous Battery Chargers and Solar Panels.

SURVEYING OPERATIONS

It can be seen from the vessel and equipment summary that the Bahrain Hydrographic Department has sufficient vessels and equipment to undertake survey work in all Bahrain waters except those of the central Gulf, which for the time being remain in a low priority category. Although it is not possible to operate all vessels simultaneously, due to a shortage of qualified personnel, there is no requirement to do so. In general terms, two vessels normally operate together, with the larger AL MIYANA providing messing and sleeping facilities

as well as conducting survey work of her own. The optimum manning level has been set at three personnel for AL MIYANA and two for either SURVEYOR or ESKAN. This does preclude any form of 24-hour operation, but again due to the nature of the shallow coastal waters being surveyed, only daylight operations are envisaged, at least for the time being. Normally two boats will spend up to four days away from base at Mina Salman, thereby keeping the steaming time to and from the area of operations to a minimum. Shore support is provided as necessary by a driver using one of the three vehicles allocated to the Department.

For survey work within port limits, SURVEYOR is the dedicated boat, with ESKAN being used from time to time in areas of extremely shallow water where drying soundings are required. These surveys are supplemented by engineering surveys for industrial and commercial development, especially land reclamation and new jetty or highway projects. Where possible surveys of this nature are undertaken during leave periods, thereby making the best use of manpower and minimising the effects of interruption to the National Charting Programme.

At present all plotting and the 'inking-in' of soundings is undertaken by hand. Traditional sounding sheets are used and it is from these that compilation tracings are made for the final chart cartography. Consequently there is no requirement for a 'fair chart' to be drawn as each compilation tracing is reduced photographically to the required scale by the photographic department of the Ministry of Housing. Block corrections for published charts are also produced in this way.

CHARTS AND PUBLICATIONS

As at 1st April 1990, the following charts and publications were either available, or proposed:

12,500 Scale	**Publication Date**
(See below)	
15,000 Scale	
1501 Mina Salman	(Dyeline only)
1502 Sitra Anchorage to Salbah	June 1984
25,000 Scale	
2501 Al Manama to Umm Jalid	August 1987
50,000 Scale	
5001 Sitrah to Tighaylib	January 1987
5002 Hadd Al Jamal to Janan	May 1986
5004 Approaches to Bahrain	October 1988
5006 Hayr Shutaya to Khawre Fasht	April 1989
100,000 Scale	
5005* Qit'at Jaradah to Gulf of Bahrain (* To be re-numbered 1001)	December 1987

Proposed

5003 Jiddah to Ras Al Bar (1:50,000)
5005 North East Approaches to Bahrain (1:50,000)
1251 Mina Salman (1:12,500)
1252 Port of Sitra (1:12,500)
1002 The State of Bahrain (1:150,000)

PUBLICATIONS

P700 Tide Tables	Annually
P701 Tidal Stream Atlas	June 1988

CONCLUSION

During the short period that Bahrain has been engaged in hydrography, a great deal has been achieved. Not only are there currently seven charts and two nautical publications on sale, but the department itself is well established with a comprehensive data base and archive. These contain details of all known wrecks, lights, buoys and dangers to navigation, together with tidal stream and tidal height information which is considered essential to any Hydrographic Office. By 1990 a start had been made in transferring this wealth of data on to a computer data base not only to improve means of access, but also to reduce the space required for the storage of data.

A chart agent has also recently been appointed, thus making both charts and publications available to the public at the modest cost of four Bahraini dinars each (approximately five pounds twenty pence). This has provided a modest revenue, but more importantly has helped considerably in promoting hydrography generally. The annual publication of Tide Tables is particularly popular with three hundred copies being sold locally each year.

There remains (in the view of the author) a great deal to be done in the years ahead; the surveying of new areas and the production and printing of new charts is likely to continue for at least another five or six years. Even when the full chart series which is envisaged is published, there will be an ongoing requirement for re-surveyed of some areas to ensure that all charts are maintained and corrected up to date.

The move towards some form of automation also requires careful consideration as this would certainly assist in the gathering, processing and publication of data, particularly in those areas which are subjected to regular and large scale surveys. There is also a requirement to expand and improve the chart correcting capability, so that not only are chart corrections issued as soon as practicable, but that the stocks of printed charts themselves can be corrected by office staff prior to sale or issue.

In conclusion therefore, it can be seen that over the past decade, not only has Bahrain identified a requirement for a national hydrographic capability, but it has funded and established a small but effective department which is well to the forefront of hydrographic surveying in the region. The department is firmly established and the results to date are most encouraging.

Footnote: It is emphasised that the views and opinions expressed in this paper are purely those of the author, and that they do not necessarily constitute the official hydrographic policy or practices of the State of Bahrain.