

TPT 02/2001

**Analysis of the Economic Benefits of the Provision of  
Hydrographic Services in the APEC Region**

**Summary Report**

July 2002





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### **Attachments:**

Attachment 1: Hydrographic Audit

Attachment 2: Economic Analysis



## 1 EXECUTIVE SUMMARY

### Introduction

The project and report have been completed under the guidance and oversight of the APEC Transportation Working Group (TPT-WG). The objectives of the project and report are to provide Governments in the APEC region with:

- i. An “in-principle” analysis of the economic benefit and value of hydrographic services to APEC member economies, and
- ii. Policy guidance on appropriate levels of investment in hydrographic services, to ensure the safety and improve the efficiency of shipping while meeting international obligations.

The results of the project are intended to assist APEC maritime administrators to ensure that maritime trade will reap the efficiency benefits that flow from provision of comprehensive and accurate hydrographic services for regional and domestic seas.

### Rationale for Hydrographic Services

Hydrographic services survey sea areas and provide nautical charts and other information that are essential for safe and efficient navigation. Without such charts vessels cannot know of or avoid the subsurface dangers that threaten their safety, nor can they plan and execute the shortest and most convenient voyages between two ports. Hydrographic services are an essential component of the national transport infrastructure, since they greatly facilitate the vital economic activity of import and export by sea. Shipping is a global activity, and the global delivery of services requires a significant degree of international and regional co-operation. Over 95% of international trade by volume is carried by sea.

The provision of good quality charts is also an important aspect of national programmes for the protection of the marine environment, since safe navigation helps to avoid shipwrecks and the pollution that often results from them. Prevention of pollution has economic as well as environmental benefits, because of the other communities and industries that depend upon clean seas, for example fishing, tourism, and desalination.

The Safety of Life at Sea (SOLAS) Convention of the International Maritime Organisation (IMO), requires contracting governments to provide hydrographic services.

There are other economic, social and legislative benefits that flow from a national hydrographic programme. Hydrographic information is a fundamental data set that informs decisions about the delineation, establishment, administration and sustainable development of the national maritime and coastal zones and resources.

There is much that APEC can do to promote the delivery of high quality hydrographic services on a regional basis.

## APEC Region Hydrographic Services

The report contains details of the status of regional hydrographic services, compiled from the responses to a questionnaire.

Almost all of the APEC member economies have long coastlines and extensive EEZs. They have significant economic dependence on maritime trade, and extensive offshore economic interests in fisheries, minerals and oil, tourism, etc.

Many economies have not yet completed the surveying and charting of their coastlines to an adequate standard to support the safe navigation of modern ships, or the sustainable development of their EEZs. There are also some areas of international waters in East Asia [outside EEZs] where surveying and charting is unsatisfactory.

Some economies confine their hydrographic activities to support of the transport and defence sectors. If the full economic benefit of investment in hydrographic services is to be realised, it is important to extend the provision of services across as many economic sectors as possible.

These deficiencies are the result of the generally low level of annual hydrographic budget allocations in relation to the high cost and lengthy time requirements for the completion of hydrographic surveys and the publication of nautical charts.

In many economies the quantity of material resources, particularly the number of survey ships, appears to be small in relation to the unfinished tasks. However in most economies the ships and equipment in use are of high quality.

Most economies have only small numbers of skilled and experienced survey and cartographic personnel to undertake the tasks. The shortage of expertise inhibits the hydrographic agencies in completing their tasks on schedule.

Several economies are improving the cost effectiveness of hydrographic services through technology development, greater utilisation of assets, and outsourcing.

There is useful international co-operation within the region aimed at overcoming problems of surveying capacity and training. There is potential for increased regional co-operation in advancing the surveying and charting of poorly surveyed but heavily used sea lanes in East Asia and the South China Sea.

## Economic Benefits

The analysis of economic benefits of hydrographic services in the APEC region has focused on the evaluation of navigational impacts of hydrographic services on one of the primary beneficiary groups, the commercial shipping sector.

An assessment model has been developed to allow direct evaluation of the impact relationship of hydrographic service expenditure on commercial vessel voyage duration and associated vessel-operating and passenger-time costs. This is illustrated through evaluation of an example APEC economy, that of the Philippines. This primary case study has then been utilized to infer relative economic sensitivity to hydrographic service investment for other APEC economies that responded to the hydrographic audit.

The economic assessment indicates that the entire national expenditure on hydrographic services in the Philippines can be justified exclusively from the navigational-related benefits accruing to the commercial shipping sector in terms of savings to vessel-operating costs and passenger-time costs. Furthermore, the benefits justify an increase in expenditure by approximately 70 percent of the current level.

Since there are many other benefits in addition to commercial navigational benefits, the cumulative economic benefits from the current hydrographic expenditures are substantially greater. The Philippine hydrographic service is therefore a considerable asset to the Philippine economy, and there is substantial potential for increased investment to yield even greater benefits.

The results have been extrapolated to those APEC member economies that responded to the questionnaire in order to assess their relative economic sensitivity to the impact of hydrographic service expenditure on their economies. The results of the assessment indicate three broad classifications of APEC economies; (i) where benefits from increased expenditure are considered to be of substantial value (Philippines, Indonesia and Mexico); (ii) of medium value (Canada, Australia, USA, New Zealand, Chile, Japan and Peru, and; (iii) and of lower value (Hong Kong, Korea and Singapore).

### Recommendations

The report recommends that economies;

- Carry out an audit of their individual hydrographic department, in order to define aspects of the hydrographic programme that need attention, and to identify and establish priorities and time frames for completion of outstanding tasks.
- Carry out an economic analysis for their individual hydrographic requirements, using the model proposed in this report, in order to derive an optimum level of investment and budget for the hydrographic service.
- Ensure that necessary development of the hydrographic department is included in national or ministerial development plans, including development of human, material and financial resources, and administrative arrangements, appropriate to the national survey and charting plans.
- Ensure that national five-year plans for survey and charting are in place.
- Review the work practices of the hydrographic department in order to identify the potential for improving cost effectiveness.
- Review the institutional and co-ordination arrangements for hydrographic activities, and consider the benefits of establishing high-level formal arrangements.

And that APEC;

- Consider the economic and safety benefits of increasing co-operation in hydrography, especially in the South China Sea, and in the major straits and sea-lanes of East Asia.

- Consider undertaking research to provide data on the volume and characteristics of international shipping making transit voyages through the major straits and sea-lanes of the region.
- Consider undertaking research to provide some possible models for navigation levies on ships transiting the major sea-lanes and straits.
- Consider organising some technical assistance programmes in hydrography for those economies of the APEC region that are not currently APEC members.

## **2 INTRODUCTION**

### **2.1 Background to the Project**

The project '*Analysis of the Economic Benefits of the Provision of Hydrographic Services in the APEC Region*', was endorsed by the APEC Transportation Working Group meeting (TPT-WG-17) in Singapore in March 2000, and by the APEC Ministerial meeting of 12 - 13 November 2000 in Brunei. The project was conducted under the guidance and oversight of the APEC Transportation Working Group (TPT-WG). Australia provided the Project Overseer. The United States co-sponsored the project.

The project was executed through a partnership between two companies, APP Technology of Australia, and GlobalWorks of USA, APP being the prime contractor. The project has been supervised on behalf of APEC by the Australian Department of Transport and Regional Services.

### **2.2 Project Objectives**

The objectives of the project are to:

- Provide an "in-principle" analysis of the economic benefit and value of hydrographic services to APEC member economies, and to
- Provide Governments in the APEC region with policy guidance on appropriate levels of investment in hydrographic services, to ensure the safety and improve the efficiency of shipping while meeting international obligations.

The results of the project will assist APEC maritime administrators to ensure that foreign and domestic maritime trade will reap the efficiency benefits that flow from provision of comprehensive and accurate navigation services for regional and domestic seas. It will provide a tool to determine an appropriate level of investment in hydrographic services, related to projected trade patterns.

It will also provide benchmark information regarding the present status and resources of regional hydrographic services, which will assist policy makers in coming to investment decisions.

It will provide information relevant to future hydrographic co-operation between APEC members.

It may also assist shipping and insurance companies to understand the real value of a government service provided as a public good.

### **2.3 Project Structure**

The project is a desktop study conducted in two phases.

- Phase 1. Economic Benefits Analysis, and
- Phase 2. Audit of the Status of Regional Hydrographic Services.

The Project Report is in eight parts:

Part 1 Executive Summary.

Part 2 The Introduction contains a summary of the objectives and structure of the project. It also provides a statement of the rationale for the work of government hydrographic services.

Part 3 The Overview of Hydrographic Services describes the in-principle functions, capabilities, and services provided by a national hydrographic service. It also touches on institutional arrangements and comments on international co-operation. The objective of this part is to provide policy makers with benchmark information.

Part 4 APEC Hydrographic Service Status reviews the present status of the hydrographic services in the APEC economies, based on information obtained during the audit. It also provides some comment on options available to improve the performance of hydrographic agencies. The objective of this part is to provide policy makers with current status information to assist policy development.

Part 5 The Analysis of the Economic Value of Hydrographic Services focuses on the evaluation of navigational impacts of hydrographic service provision on one of the primary beneficiary groups, the commercial shipping sector. This is illustrated through evaluation of an example APEC economy, that of the Philippines, which has then been utilized to infer relative economic sensitivity to hydrographic service investment for other APEC economies who responded to the hydrographic audit.

Part 6 The Key Issues and Recommendations draw together the findings of the Hydrographic Audit and the Economic Analysis.

Part 7 Policy Implications suggests policy directions and actions that may be considered by maritime administrators.

Part 8 Attachments contains the detailed reports from the Hydrographic Audit and the Economic Analysis.

### 3 OVERVIEW OF HYDROGRAPHIC SERVICES

#### 3.1 Rationale

The provision of an adequate coverage of high quality nautical charts is essential for safe and efficient navigation. Without such charts vessels cannot know of or avoid the subsurface dangers that threaten their safety, nor can they plan and execute the shortest and most convenient voyages between two ports. A good system of charts is essential to the efficient operation of the maritime transport infrastructure, in the same way that a good system of roads is essential to the efficient operation of the terrestrial transport infrastructure. Nautical charts are an important component of the national transport infrastructure, since they greatly facilitate the vital economic activity of import and export by sea. Over 95% of international trade by volume is carried by sea.

The provision of good quality charts is also an important aspect of national programmes for the protection of the marine environment, since safe navigation helps to avoid shipwrecks and the pollution that often results from them. Prevention of pollution has economic as well as environmental benefits, because of the other communities and industries that depend upon clean seas, for example fishing, tourism, and desalination.

So important are the safety and environmental aspects of national charting programmes that the International Maritime Organisation (IMO), in revising the Safety of Life at Sea (SOLAS) Convention, has mandated that all contracting governments should provide hydrographic services.

It is also important to recall that shipping is an international activity, and that the provision of hydrographic services to support shipping has an essential international dimension. International delivery of services requires a significant degree of international co-operation. There is much that APEC can do to promote the delivery of high quality hydrographic services on a regional basis.

In the modern world there are numerous other benefits accruing from the provision of hydrographic services. These include;

- (i) for the commercial fisheries sector, improved resource location, economic zone maintenance, regulatory enforcement and reduced equipment losses;
- (ii) definition and maintenance of sovereign zones;
- (iii) enhanced coastal resource management;
- (iv) assistance in the exploration of minerals;
- (v) improved emergency response;
- (vi) contributions to national defence;
- (vii) assistance to the recreational boating and fishing sector; and
- (viii) overall environmental protection.

The hydrographic programme is also of great importance to the defence of the realm, since comprehensive charts are essential to the successful conduct of maritime military operations.

It should be noted that, in economic parlance, the national hydrographic programme is regarded as a "Public Good". That is to say that the necessary services required in the public interest will not be supplied at optimal levels by market forces alone. In every IHO Member State the provision of hydrographic services is a function of central government.

## **3.2 Principal Functions of the Hydrographic Service**

### **3.2.1 Nautical Cartography**

The principal service offered by the hydrographic department is the national chart series. It is the general practice of hydrographic offices to publish their charts in three groups.

Small Scale charts are provided for passage planning and for navigation out of sight of land. Medium Scale charts are provided for making landfall and for passage along the coast. Large Scale charts are provided for the approaches to ports, internal waters of ports, and other areas where navigation is constrained by land formations, navigational hazards, traffic density etc. The number of charts in the national chart series will depend upon the length of the national coastline and the extent of the national EEZ. For planning purposes it is usual to publish a national chart scheme, illustrating the chart coverage at each scale. The national chart series meets the requirement of Regulation 9 of Chapter V of the SOLAS Convention that Contracting Governments undertake “to prepare and to issue official nautical charts.”

The national chart series must be supported by a means of supplying mariners with Maritime Safety Information. This is rapid advice about new dangers to navigation and other information such as failure of navigation aids, temporary obstructions etc, in order to keep the charts up to date. This meets the requirement of Regulation 9 that Contracting Governments will “promulgate notices to mariners”

A high quality nautical charting service must be underpinned by an appropriate data management system, so that all necessary information may be easily accessed for compilation of products and services, and for quality assurance processes. Databases must also be able to provide data into the national spatial data infrastructure for research, administration and development. This meets the requirement of Regulation 9 that contracting governments will “provide data management arrangements”

The charting service also requires effective distribution arrangements to ensure that mariners may easily and conveniently access the services provided by the Hydrographic Office. Distribution has national and international components.

### **3.2.2 Spatial Data Services**

An increasingly important function of the hydrographic department is to ensure that hydrographic data are available in the national interest to researchers, administrators and producers working in the national exclusive economic zone, who require comprehensive data to support complex decisions. Increasingly this is being achieved through the contribution of meta-data to the national spatial data infrastructure. This procedure allows users to discover the availability of data sets, whilst allowing government agencies to retain control of access and distribution.

Many advanced hydrographic agencies are restructuring themselves and their priorities in order to provide more effective service to this new and very large community of users. On a regional and global scale, nations are co-operating and co-ordinating their activities to provide regional and global spatial data infrastructures.

### **3.2.3 Hydrographic Survey**

The facilities for hydrographic surveying are the most expensive facilities in the hydrographic department, since they involve the use of research vessels that have high capital and operating costs.

Generally it is necessary to have, or to have access to, vessels that are capable of operating for long periods in the national offshore areas, and in shallow coastal waters. A combination of ocean going ships and inshore vessels is effective, or ocean-going ships fitted with embarked survey launches. A wide variety of vessels are described in the book "Jane's Research Ships". Aircraft fitted with lidar (laser) systems may also be used.

The number of vessels required will depend upon the size of the survey task. This in turn depends upon the length and characteristics of the coastline, the size of the unsurveyed areas, the need for resurvey in some places, and the timeframe for the completion of the work.

The survey vessels should be fitted with the equipment necessary for them to execute surveys to the standards laid down in IHO Publication S-44, IHO Standards for Hydrographic Surveys. The duty of care imposed on the hydrographic department requires the use of appropriate modern equipment.

This meets the requirement of Regulation 9 that Contracting Governments will "carry out

## 4 APEC HYDROGRAPHIC SERVICES - STATUS AND POTENTIAL

This assessment of the hydrographic capabilities in APEC Member economies is based on responses to a questionnaire that was sent to the principal hydrographic agency in each economy. Thirteen of the twenty-one member economies responded to the questionnaire. The questionnaire was designed to provide information about the status of each hydrographic agency, in order that the results might provide some benchmarks for decision makers. The questionnaire asked for details of the:

- Geographic Fundamentals;
- Institutional arrangements and legislation;
- Status of Surveying and Charting;
- Material and Human Resources;
- Budget;
- Future developments;
- Innovation in process and service;
- Co-operation;
- Strategic Issues.

### 4.1 Conclusions of the Hydrographic Audit.

The conclusions that follow are reproduced from Attachment 1 to this report. This attachment contains the details of the responses to the questionnaire, and a detailed analysis of those responses, upon which the conclusions are based. The principal conclusions of the hydrographic audit are as follows;

#### 4.1.1 Geographic and Economic Circumstances

Almost all of the APEC member economies have long coastlines and extensive EEZs. They have significant economic dependence on maritime trade, and extensive offshore economic interests in fisheries, minerals and oil, tourism, etc.

#### Fundamental Geographic Data

Country	Coastline [km]	EEZ km <sup>2</sup>	Major Ports
Australia	59,736	8,941,759	12
Canada	244,000 <sup>1</sup>	6,500,000 <sup>1</sup>	9
Chile	84,000	1,576,886	8
Hong Kong	1140	N.A.	
Indonesia	80,570	2,692,762	4
Japan			
Korea	11,542	376,000	27
Mexico	11,208 <sup>1</sup>	3,150,000	17
New Zealand	18,252	4,000,000	
Peru	3,080	800,000	6
Philippines	31,800		21
Singapore	495	Nil	6
USA	152,950 <sup>1</sup>	11,533,395 <sup>1</sup>	9

1. Includes Atlantic coasts for Canada, Mexico and USA and Arctic coasts for Canada and USA.

#### 4.1.2 Status of Activities and Services

##### Status of Surveying and Charting for Marine Navigation

Many economies have not yet completed the surveying and charting of their coastlines to an adequate standard to support the safe navigation of modern ships, or the sustainable development of their EEZs. In the case of navigation some economies are not yet fully compliant with the requirements of the SOLAS Convention. This is the most important conclusion of this audit.

This is because incomplete surveying and charting of the national maritime areas results in inefficiencies in ship operations, affecting the competitiveness of trade. It inhibits decision making for national development in maritime zones. It also exposes the economy to risks of pollution from accidents that could cause significant damage to the coastal environment and the coastal economy.

##### Status of Services to Users Outside the Transport Sector

The hydrographic agencies in a few economies are extending their services to provide information to the many users who are not navigators through the national spatial data infrastructure. However several economies continue to confine their hydrographic activities in support of the traditional transport and defence sectors. If the full economic benefit of investment in hydrographic services is to be realised, it is important to extend the provision of services across as many economic sectors as possible. This is another important finding of this audit.

##### Status of Activities and Services

Country	Status of Surveys			Status of Charts			Spatial Data Services
	% Adequately surveyed	% Requiring re-survey	% Un-surveyed	Paper Charts Required	% Paper Charts Available	Digital Charts Available	Number Available
Australia	32	44	24	752	51	Yes	1
Canada	45	30	25	672	60	Yes	2
Chile	No Data	No Data	No Data	721	75	Yes	3
Hong Kong	100	0	0	12	66	Yes	0
Indonesia	25	60	15	520	89	Yes	4
Japan	100	0	0	1050	100	Yes	1
Korea	60	40	0	258	100	Yes	3
Mexico	23	2	75	406	22	No	3
New Zealand	No Data	No Data	No Data	175	94	No	1
Peru	80	10	10	205	58	No	1
Philippines	20	55	25	212	100	No	0
Singapore	100	0	0	24	100	Yes	0
USA	No Data	No Data	No Data	1025	100	Yes	1

### 4.1.3 Status of Resources

#### Budget

The situation in many economies described above is the result of the generally low level of annual hydrographic budget allocations in relation to the high cost and lengthy time requirements to complete hydrographic surveys and to publish charts. One major economy [USA] has recognised this situation and has recently significantly increased the budget allocation of the hydrographic programme. One economy [Peru] provides the majority of its hydrographic budget from shipping charges under a user pays regime.

A major strategic concern of the agencies that responded to the questionnaire is the size of the budget and the consequent limitations on obtaining capacity and expertise to adequately discharge the agencies' responsibilities. The budget is used to purchase material and human resources.

#### Material Resources

In many economies the quantity of material resources appears to be small in relation to the unfinished tasks, particularly the number of survey ships. However in most economies the material resources are of high quality. The majority of economies are using modern equipment appropriate to the achievement of international standards for hydrographic surveying and nautical charting. Most economies are making the difficult transition to electronic media for the management of data and the provision of navigation services.

#### Human Resources

Most economies have only small numbers of skilled and experienced survey and cartographic personnel to undertake the tasks. It is clear that such expertise is in short supply, and much sought after. The shortage of expertise is a threat to the ability of hydrographic agencies to complete their tasks on schedule. In seeking to meet their responsibilities many economies will require to make a significant investment in personnel training and development.

#### New Resource Developments

A number of economies reported significant plans to finance new initiatives. Several of these were related to the introduction of electronic chart services. Others were for the introduction of spatial data services outside the marine navigation sector. Some noted recent investments in new ships and digital navigation services.

#### Cost Effectiveness

A few economies are improving cost effectiveness via technology development, for example by using lidar survey techniques in appropriate circumstances. Some economies are also improving cost effectiveness via greater utilisation of assets, particularly by introducing dual or rotating crew arrangements for their survey ships, which has the potential to double available sea time.

Outsourcing is an avenue to improve performance without major capital expenditure and without increases in staff. A few economies are using outsourcing to good effect for the provision of equipment and expertise, and this practice is worthy of consideration by all economies.

### Status of Resources

Country	Survey				Charting			Spatial Data Services	Budget \$ US M
	Ships	Boats	Survey -ors	Tech-nicians	% Digital Equipment	Carto-graphers	Drafts -men	Extra Staff	
Australia	6	10	56	130	95	35	na	0	20
Canada	4	50	100	0	98	100	na	5	38
Chile	1	1	21	29	90	10	9	0	No Data
Hong Kong	0	3	20	29		No Data		No Data	No Data
Indonesia	7	1	242	237	60	10	25	10	2
Japan	5	7	90	60	50	30	15	No Data	27
Korea	6	0	4	26		No Data		7	1
Mexico	4 + os	2	11	22	90	5	6	0	No Data
New Zealand	os	os	os	os	os	os	os	os	No Data
Peru	3	1	58	190		No Data		0	1
Philippines	4	4	12	24	60	10	2	4	3.5
Singapore	1	4	12	8	90	1	9	0	0.5
USA	7	0 + os	28	4	100	107	na	4	71

Note: OS indicates work is outsourced

#### 4.1.4 Status of Institutional Arrangements

##### Co-ordination Arrangements

In order to achieve optimum value from the Hydrographic Service it is desirable to have some formal co-ordination arrangements across government departments. Co-ordination arrangements in several of the economies that responded to the questionnaire are formal in nature, but others are informal and it would seem useful to formalise them.

All economies appear to have legislation or statutory instruments in place to mandate the activities of the hydrographic service.

##### Regional Co-operation

There is useful international co-operation within the region aimed at overcoming problems of surveying capacity and training. It would be advantageous to increase the amount of co-operation and development aid between hydrographic programmes in the APEC region, including extension to those economies that are not yet APEC members.

There is currently some good regional co-operation in surveying major straits and sea-lanes that carry large volumes of international shipping in transit, but there appears to be potential for further co-operation. Increased regional co-operation in advancing the surveying and charting of poorly surveyed but heavily used sea lanes in East Asia and the South China Sea is regarded as particularly important. The need for this could be further assessed, based upon a study of movements of ships in transit, and the nature of the charting requirements of those international sea-lanes.

### Status of Institutional Arrangements

Country	Responsible Ministry	Law or Decree	Co-ordination Arrangements	Regional Co-operation
Australia	Defence	Decree	MOUs/Informal	Yes
Canada	Oceans	Law	MOUs	Yes
Chile	Defence	Law	Informal	No
Hong Kong	Planning	-	-	No
Indonesia	Defence	Decree	Decree	Yes
Japan	Transport	Law	-	Yes
Korea	Maritime	Law	Law	No
Mexico	Navy	Law	MOU/Formal	Yes
New Zealand	Land	Law	Informal	No
Peru	Defence	Decree	-	No
Philippines	Environment	Law	MOUs	Yes
Singapore	Communications	Law	-	Yes
USA	Commerce	Law	MOUs	Yes

#### **4.1.5 Key Issues and Constraints**

The responses to the questionnaire exposed a large number of strategic issues and concerns. The most often repeated include:

1. Value of the budget;
2. Surveying capacity;
3. Surveying expertise;
4. ENC production capacity;
5. ENC compilation expertise.

Given the responses concerning the status of the national chart series, it is surprising that chart production capacity and expertise were not so widely mentioned.

Several developing economies suggested that some of these difficulties could be resolved through international and regional co-operation, and this is worthy of further examination.

APEC member economies should review these important issues and take action to ensure that they do not compromise the safety and efficiency of navigation.

## Key Issues and Constraints

Country	Budget Value	Chart Status	Survey Status	Surveying Capacity	Surveying Expertise	Carto Expertise	ENC Capacity	ENC Expertise
Australia		Yes				Yes		Yes
Canada		Yes	Yes	Yes	Yes	Yes		Yes
Chile	Yes							
Hong Kong								
Indonesia		Yes					Yes	Yes
Japan		Yes					Yes	Yes
Korea								
Mexico	Yes			Yes			Yes	
New Zealand					Yes	Yes		
Peru								
Philippines								
Singapore								
USA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

### **4.2 Future Potential**

Based on the results of the audit, we make some suggestions for the improvement of the services and effectiveness of the APEC hydrographic services.

#### **4.2.1 Improvement of Services**

##### Navigation Services

All of the economies that responded to the questionnaire are producing charts and other services for navigation. However it is clear that, while the chart series of some economies are complete and up-to-date, the chart series of others are incomplete, and some have reduced utility because of age. If the full economic benefits of hydrographic services are to be recognized, it is most important that an appropriate level of resources be provided so that the deficiencies can be rectified.

It is also apparent that a few APEC economies have not progressed far along the path to the production of charts and services in digital media. These new services offer significant benefits for the improvement of safety of navigation and the protection of the environment and coastal economies from the pollution that may result from marine casualties.

We are concerned that some economies that did not participate in the audit, and some small regional economies that are not yet APEC members, may not yet have effective hydrographic services. We hope that this report will provide some guidance and assistance if needed.

##### Spatial Data Services

We consider that the provision of data and services for administration and sustainable development of the maritime zones, within the national spatial data infrastructure, will be of great economic value in the immediate future. Indeed, based on the very large numbers of potential users, it seems likely that they will be of greater economic benefit than services to navigation. However it is clear that, with a few exceptions, the hydrographic services of the APEC economies have not yet made any significant commitment to the provision of these new services. This is another deficiency that needs to be addressed.

## Resource Implications

We suggest that economies should carry out an audit of the status of their hydrographic services, and publish a strategic plan with time frames for completion of high priority requirements. As a result of this process it may be necessary to improve the resources and budgets of the hydrographic services.

Consideration should be given to the potential of introducing a levy on shipping to help pay for improved hydrographic services.

Consideration should also be given to increasing regional co-operation.

### **4.2.2 Improvement of Effectiveness**

We believe that there is some potential to improve the effectiveness of the regional hydrographic services. Improvements could include:

- a. Increasing the operational availability of ships by augmenting crew numbers and using crew rotation;
- b. Utilising new technology, for example Lidar survey systems, where appropriate;
- c. Outsourcing some appropriate functions to the private sector.

The potential for improving outcomes as a result of increased effectiveness deserves attention.

## **5 ECONOMIC VALUE OF HYDROGRAPHIC SERVICES**

### **5.1 Sector Contribution**

The economic benefits to marine transport from sustainable hydrographic services are numerous, including direct navigational improvements to vessel movements in terms of safety and efficiency. Safer, faster and shorter voyages, coupled with increased voyage flexibility, yield sustainable economic benefits not only to individual APEC economies, but also to the APEC region as a whole. Indirectly, hydrographic services also support the use of larger vessels, deeper drafts, and greater load capacity by providing the navigational tools to optimise channel movements.

Most mariners would consider a world without such services unthinkable, with the negative consequences to safety and efficiency, and the corresponding economic, social and environmental impacts.

### **5.2 Quantifying the Contribution**

Quantifying these benefits in economic terms however presents several challenges; firstly the complexities involved in defining and developing appropriate economic assessments; and secondly in obtaining reliable analytical base data. This may explain why few economic assessments have been attempted, and even fewer incorporating accurate, quantitative analysis. Although maritime and oceanographic communities appreciate the tremendous value of hydrographic services, actual quantification of their value remains illusive.

This has ramifications for sector development. Since hydrographic benefits are not quantified, the precise economic value of these services is not known. And if the value is not known, APEC member economies cannot, with reliability and confidence, set appropriate development and investment levels to optimise sector performance. There is a pressing need not only to ascertain economic viability of existing hydrographic services within APEC economies, but also to develop reliable planning tools in order to more accurately define future investment levels.

### **5.3 Economic Assessment Rationale**

This assessment evaluates hydrographic service viability and recommends policy directives for future sector intervention for the APEC region. It focuses on evaluating the navigational impacts of hydrographic service provision on one of the primary beneficiary groups, that of the commercial shipping sector. This is of key interest to the APEC Transportation Working Group and represents one of the major beneficiaries of hydrographic service provision due to the magnitude of maritime trade within the APEC region.

The assessment evaluates potential impacts and costs to commercial vessel voyage duration from variations in hydrographic service provision and expenditure. It is based on the hypothesis that the reduction or cessation of hydrographic service provision within an APEC economy will have a direct navigational impact on commercial vessel voyage duration, due to one or several of the following;

- (i) Reduced vessel speed (slowing in “poorly charted” waters and areas of complex navigation);

- (ii) Increased voyage distance (taking conservative routings away from complex navigation areas or missing opportunities to develop shorter routes); and
- (iii) Reduced sailing flexibility (such as restrictions on night sailings, or during times of poor visibility).

The assessment assumes that increased voyage duration due to hydrographic service degradation will result in corresponding increases in voyage costs encountered both by vessels (vessel-operating costs) and, in the case of passenger vessels, by passengers (passenger-time costs). In addition to increased vessel voyage duration, hydrographic service degradation or cessation may also result in constraints to vessel draft in certain channels, or compromise the manoeuvrability of larger vessels. This may lead to future limitations on the size, draft, and carrying capacity of larger vessels, resulting in the need for more voyages of smaller ships, thereby increasing shipping costs in general.

## **5.4 Economic Assessment Methodology**

### **5.4.1 Introduction**

This assessment considers these impacts in real terms. It directly assesses the relationship between hydrographic service expenditure and the navigational impacts on commercial vessel voyages in terms of vessel-operating costs and passenger-time costs. This is illustrated through evaluation of an example APEC economy, that of the Philippines, which is an archipelagic economy comprising of over 7,000 islands. The Philippines currently spends approximately US\$ 3.5 million annually in hydrographic service provision.

The assessment evaluates this cost-benefit relationship by considering two scenarios. The first scenario assumes that hydrographic service expenditure is maintained at the current level, which in the case of the Philippines is approximately US\$ 3.5 million per year. As a consequence of this expenditure, the commercial shipping sector benefits from the level of navigational assistance attained from the expenditure. This scenario is referred to as the “tendency

The second scenario assumes, theoretically, that hydrographic service provision ceases immediately and permanently from this day forward. For this scenario, a given APEC economy will therefore receive a “benefit” when compared with the tendency scenario equal to the hydrographic expenditure, which in the Philippine example is US\$ 3.5 million annually. In other words, the economy “saves” this amount which otherwise would be spent every year on hydrographic services. As a consequence however, commercial shipping will begin to suffer due primarily to the progressive degradation of hydrographic charts, resulting in increased vessel voyage duration and consequential increases in vessel operating costs and passenger time costs. This scenario is referred to as the “counter-factual scenario”.

The assessment evaluates these two scenarios in detail, comparing the costs and benefits of the tendency scenario with the costs and benefits of the counter-factual scenario. It assesses whether the additional vessel-operating and passenger-time costs incurred by commercial shipping as a result of cessation of hydrographic services are greater, equal to, or less than the “savings in expenditure” that would be achieved if hydrographic services cease from this day onwards (US\$ 3.5 million annually in the Philippine example).

In this way, current hydrographic expenditure can be justified, or otherwise, since the cost of maintaining hydrographic expenditure (US\$ 3.5 million annually) can be compared directly with the cost of not maintaining the expenditure (increased vessel-operating and passenger-time costs). In elementary terms, for the Philippine example, if the costs incurred to commercial shipping by hydrographic cessation are greater than US\$ 3.5 million annually, then the current hydrographic expenditure level is justified on the basis of this one benefit alone. However, if the costs incurred by commercial shipping are less than US\$ 3.5 million per year, then this benefit alone does not justify the current level of expenditure.

The assessment therefore focuses on the estimation of vessel-operating and passenger-time costs associated with the immediate and permanent cessation of hydrographic services. These estimates are derived through an iterative process, utilizing actual data for a given economy, in this case the Philippine economy, and over a pre-determined planning horizon, which in the Philippine case is 25 years (2003-2028).

#### **5.4.2 Methodological Steps and Results**

The methodology detailed in the attached Economic Assessment utilizes the following procedure of eight steps;

➤ **Step 1 : Defining Potential Commercial Shipping Sector Users**

Three potential commercial shipping sector users have been identified.

These are:

- (i) foreign trade shipping services;
- (ii) domestic trade shipping services;
- (iii) passenger shipping services.

➤ **Step 2 : Forecasting Future Demand of Potential Users**

Based on the evaluation of existing national economic data and utilizing economic assessment methods, estimations of existing and future demand for each of the three user classes have been estimated for the 25-year planning horizon (2003-2028). These demand projections are summarized as follows;

### Commercial Shipping Demand Projections

Year	Values (P billion at Constant 1985 prices)	Maritime Foreign Trade Volumes (Tons)		Domestic Trade Volumes (Tons)	Maritime Passengers (No)
	GDP	Exports (Tons)	Imports (Tons)		
1993	734	15,037,783	35,486,553	31,933,441	37,873,205
1994	766	14,515,625	38,183,499	35,554,196	40,043,006
1995	802	16,657,559	42,418,302	34,050,327	41,414,647
1996	849	15,687,040	51,829,760	35,776,468	44,141,572
1997	893	16,670,940	51,666,207	38,075,021	43,228,478
1998	888	16,154,116	46,134,026	37,422,615	44,371,866
1999	917	15,270,683	45,307,131	38,704,193	43,463,039
2000	960	15,735,037	50,481,620	38,827,360	45,222,044
2001	994	13,198,770	50,568,107	41,326,709	46,558,062
2002	1,039	13,114,661	52,780,152	42,868,826	48,262,159
2003	1,099	13,223,279	55,694,912	44,790,083	50,385,221
2004	1,165	13,414,684	58,937,443	46,809,568	52,616,828
2005	1,239	13,700,454	62,604,106	48,959,592	54,992,685
2006	1,321	14,774,680	66,623,881	51,174,702	57,440,465
2007	1,379	15,604,307	69,438,500	52,667,058	59,089,575
2008	1,440	16,480,518	72,372,026	54,159,415	60,738,686
2009	1,503	17,405,931	75,429,483	55,651,771	62,387,796
2010	1,569	18,383,308	78,616,106	57,144,128	64,036,907
2011	1,638	19,415,566	81,937,353	58,636,485	65,686,017
2012	1,710	20,505,788	85,398,911	60,128,841	67,335,127
2013	1,771	21,474,676	88,256,459	61,327,823	68,660,048
2014	1,833	22,489,343	91,209,624	62,526,805	69,984,968
2015	1,897	23,551,954	94,261,605	63,725,787	71,309,888
2016	1,964	24,380,982	97,579,613	64,924,769	72,634,808
2017	2,033	25,239,193	101,014,416	66,123,751	73,959,729
2018	2,105	26,127,613	104,570,123	67,322,733	75,284,649
2019	2,164	26,863,366	107,514,818	68,285,214	76,348,226
2020	2,225	27,619,839	110,542,435	69,247,694	77,411,804
2021	2,286	28,376,311	113,570,052	70,184,167	78,446,642
2022	2,347	29,132,783	116,597,669	71,096,000	79,454,252
2023	2,408	29,889,256	119,625,287	71,984,457	80,436,030
2024	2,469	30,645,728	122,652,904	72,850,707	81,393,268
2025	2,530	31,402,201	125,680,521	73,695,832	82,327,164
2026	2,591	32,158,673	128,708,138	74,520,839	83,238,827
2027	2,652	32,915,145	131,735,756	75,326,662	84,129,293
2028	2,713	33,671,618	134,763,373	76,114,175	84,999,524

#### ➤ Step 3 : Estimating Existing Vessel Voyages and Shipping Patterns

Existing shipping data has been utilized to estimate the current pattern of annual shipping movements (vessel voyages) within the Philippine economy. This has included analysis of data provided by the Philippine Ports Authority for approximately 120,000 port calls (vessel movements) within the Philippines, and

extrapolating this data to estimate vessel voyages for the entire economy. The analysis has considered four types of vessels (bulk cargo, break-bulk cargo, containers and passenger vessels), and fourteen vessels size categories of each<sup>2</sup>. The total number of domestic passengers has also been estimated from existing records. This data has then been utilized to estimate the overall shipping pattern of domestic and foreign cargo for the Philippines. This is summarized as follows.

#### Distribution of Cargo Volume by Vessel Types

Vessel Type	Distribution of Cargo Volume By Vessel Type (Percent)			
	Imports	Exports	Domestic	Total
Bulk	73.78	62.08	48.89	59.60
Break Bulk	17.11	24.12	26.61	22.72
Container	9.11	13.80	24.51	17.68
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>
<b>Total Share (%)</b>	<b>38.85</b>	<b>7.92</b>	<b>53.23</b>	<b>100.00</b>

The data has also been utilized to estimate average volumes of cargo and passengers transported by each vessel size category for domestic shipping, and average volumes of cargo for imports and exports, as follows.

#### Average Cargo and Passengers Transported by Vessel Size

Vessel Size (GRT)	Average Cargo and Passengers Transported Per Vessel By Vessel Size			
	Passengers (Number)	Domestic Trade (Tons)	Imports (Tons)	Exports (Tons)
< 200	95	65	185	160
200 - 400	110	141	281	338
400 - 600	125	509	589	488
600 - 1,000	160	595	971	938
1,000 - 3,000	256	931	1,320	871
3,000 - 5,000	405	1,039	2,545	1,861
5,000 - 10,000	447	638	2,447	1,484
10,000 - 15,000	416	1,145	3,038	1,270
15,000 - 20,000	681	1,764	3,852	1,080
20,000 - 30,000	64	3,850	19,697	9,350
30,000 - 50,000	322	47,410	36,051	9,338
50,000 - 75,000	2,181	7,509	64,483	58,178
75,000 - 100,000	100	81,119	104,681	97,129
> 100,000	3,671	58,272	241,408	11,933
<b>Average</b>	<b>144</b>	<b>362</b>	<b>7,281</b>	<b>2,284</b>

<sup>2</sup> Vessel size categories analysed include < 200 GRT; 200-400 GRT; 400-600 GRT; 600-1,000 GRT; 1,000-3,000 GRT; 3,000-5,000 GRT; 5,000-10,000 GRT; 10,000-15,000 GRT; 15,000-20,000 GRT; 20,000-30,000 GRT; 30,000-50,000 GRT; 50,000-75,000 GRT; 75,000-100,000 GRT; and > 100,000 GRT.

➤ **Step 4 : Estimating Future Vessel Voyages**

Utilizing the demand forecasts (Step 2), existing vessel voyage data (Step 3) and assuming that the shipping patterns (developed in Step 3) remain constant over the 25 year planning period (2003-2028), estimates have then been made of the total annual number of vessel voyages for each of the fourteen size classifications of the four types of vessels analysed (bulk cargo, break-bulk cargo, containers and passenger vessels). These are presented in the attached Economic Assessment and are relatively voluminous. As an illustrative example however, data from a portion of the vessel voyage projections (2003-2006) for bulk cargo vessels is presented as follows.

**Bulk Cargo Vessel Projections:  
Voyages (Ship Calls) Per Vessel Size (2003-2006)**

Vessel Size (GRT)	Voyages Per Vessel Size			
	2003	2004	2005	2006
< 200	9,651	10,088	10,554	11,036
200 - 400	33,261	34,759	36,354	38,002
400 - 600	21,493	22,462	23,494	24,557
600 - 1,000	11,137	11,638	12,173	12,725
1,000 - 3,000	12,347	12,903	13,497	14,118
3,000 - 5,000	5,920	6,184	6,471	6,794
5,000 - 10,000	1,681	1,745	1,819	1,939
10,000 - 15,000	957	999	1,046	1,106
15,000 - 20,000	735	758	786	840
20,000 - 30,000	721	747	779	834
30,000 - 50,000	179	187	197	210
50,000 - 75,000	35	37	39	41
75,000 - 100,000	56	58	61	64
> 100,000	91	96	102	108
<b>TOTAL</b>	<b>98,264</b>	<b>102,662</b>	<b>107,372</b>	<b>112,376</b>

The principal outputs of Steps 1 to 4 of the assessment therefore are estimations over the 25 year planning period (2003-2028) of the number of annual vessel voyages for the entire Philippine commercial shipping sector, divided into fourteen size classifications for the four main vessel groups (bulk cargo, break-bulk cargo, containers and passenger vessels). In addition, the number of passengers has been estimated as previously presented in Step 2, in the table entitled "Commercial Shipping Demand Projections".

➤ **Step 5 : Estimating Vessel Operating Costs**

Since the benefit analysis utilizes vessel operating costs (as described later), the next step in the analysis has been to estimate vessel operating costs for the fourteen size classifications of the four vessel groups (bulk cargo, break-bulk cargo, containers and passenger vessels). These have been estimated by a

specialist maritime consulting group using proprietary models, and adapted to local Philippine conditions, summarized as follows.

Estimated Hourly Operating Costs Per Vessel Size and Type

Vessel Size (GRT)	Hourly Operating Costs Per Vessel Size and Type (US\$ Per Hour)			
	Bulk Cargo	Break Bulk	Container	Passengers
< 200	38	40	40	62
200 - 400	54	57	57	86
400 - 600	68	73	73	130
600 - 1,000	84	87	139	211
1,000 - 3,000	138	152	193	419
3,000 - 5,000	198	190	251	547
5,000 - 10,000	261	284	327	720
10,000 - 15,000	327	320	451	936
15,000 - 20,000	432	423	585	1,260
20,000 - 30,000	541	528	758	1,598
30,000 - 50,000	643	643	985	1,826
50,000 - 75,000	774	774	1,482	2,041
75,000 - 100,000	1,004	1,004	1,505	2,390
> 100,000	1,308	1,308	1,961	3,631

➤ **Step 6 : Estimating Passenger Time Costs**

Since the benefit analysis also utilizes passenger time costs in the overall assessment (as discussed later), these have also been estimated. Passenger time costs relate to the economic cost of “time loss” for an employed person, in this case for example through time delays to maritime passengers caused by increased maritime voyage duration. These costs are calculated by assuming the annual GDP per employed person (for the Philippines, this is equivalent to approximately US\$ 2,642), converting this to an average hourly rate (for the Philippines equating to approximately US\$ 1.25 per hour), and expressing the time value as a percentage (assumed as 25 percent, in accordance with generally accepted practice) of the hourly GDP. For the Philippines, the time value of an employed person therefore equates to approximately US\$ 0.3127 per hour.

➤ **Step 7 : Assessing Voyage Duration Increases**

This analysis is based on the hypothesis that hydrographic service cessation will increase average vessel voyage durations (sailing times), due to one or a combination of reduced sailing speed, longer routings and more voyage restrictions. For an entire economy such as the Philippines, there will naturally be a multitude of impact variation relating to this, ranging from zero impact for some voyages to significant impacts to others. For the purposes of this analysis however, assumptions have been made in order to estimate a scenario of impact over the planning period. This includes the following assumptions;

- (i) Navigational impacts to commercial shipping from the cessation of hydrographic services will occur incrementally over time. Initially, the impacts would be minimal, as hydrographic charts would have relatively high accuracy and usefulness. Over time however, and without revision, the charts would gradually deteriorate, eventually reaching a point of uselessness; and
- (ii) Larger vessels will be impacted sooner and to a greater extent than smaller vessels.

Based on these assumptions, the following estimates have been developed regarding the impacts to average voyage duration over time for various size classifications of vessels. These estimates have been developed from the subjective assessment of both hydrographers and transport economists, and are presented as follows.

Average Voyage Duration Increases Due to Cessation of Hydrographic Service Provision

Vessel Size (GRT)	Average Voyage Duration Increase (Minutes Per Voyage)				
	Year 5	Year 10	Year 15	Year 20	Year 25
< 1,000	1	2	3	4	5
1,000 – 5,000	3	6	9	12	15
5,000 – 20,000	5	10	15	20	25
20,000 – 100,000	8	16	24	32	40
> 100,000	10	20	30	40	50

As an illustrative example, a 15,000 GRT vessel is estimated to endure an average voyage duration increase of 5 minutes per voyage following 5 years of hydrographic service cessation, increasing to 10 minutes after ten years. In comparison, a larger 75,000 GRT vessel is estimated to endure an average voyage duration increase of 8 minutes after five years, increasing to 16 minutes after ten years.

➤ **Step 8 : Quantifying The Impact of Hydrographic Service Cessation**

The impacts have ultimately been quantified in terms of actual cost increases for both vessel-operating costs, and passenger-time costs due to the cessation of hydrographic services. For vessel-operating costs, this has included the estimation of vessel-operating cost increases for each of the fourteen individual size categories of the four vessel groups (bulk cargo, break-bulk cargo, containers and passenger vessels) and for each year of the 25 year planning horizon. For each vessel size category of each vessel group and for each year, this has included multiplying the number of vessel voyages (Step 4) by the incremental voyage duration increase (in minutes) for each voyage (Step 7) by the average vessel operating cost (Step 5), thereby equating to the total increase in vessel operating cost for a given size category. This has been computed individually for each of the vessel size categories for each group, and for each year of the 25 year planning period.

A similar process has also been utilized to estimate passenger-time costs. This has included the estimation of passengers for each size classification of passenger vessel for each year of the 25 year planning horizon (2003-2028). Associated costs for each vessel size classification have then been derived by multiplying the number of passengers by the incremental voyage duration increase (in minutes) for each voyage (Step 7) by the average passenger time cost (Step 6), thereby equating to the total passenger-time cost for a given passenger vessel size category. This has then been computed individually for each of the passenger vessel size categories, and for each year of the 25 year planning period.

The results of the assessment are presented in the following table.

Cumulative Costs of Navigational Impacts From Hydrographic Services  
Cessation on Philippine Commercial Shipping (2003-2028)

Year	Vessel Operating Costs					Passenger Time Costs	Total (US\$)
	Bulk	General Cargo	Container	Passengers	TOTAL		
2003	101,717	50,725	52,224	258,609	463,275	78,000	541,275
2004	212,163	105,739	108,759	540,126	966,786	172,684	1,139,470
2005	332,810	165,861	170,437	846,772	1,515,879	288,048	1,803,928
2006	468,452	234,126	240,585	1,179,283	2,122,446	427,636	2,550,082
2007	558,114	279,552	287,288	1,393,532	2,518,487	527,562	3,046,048
2008	664,703	333,710	342,969	1,645,423	2,986,805	650,331	3,637,136
2009	791,398	398,272	409,351	1,941,412	3,540,433	801,079	4,341,512
2010	941,974	475,234	488,488	2,289,046	4,194,742	986,081	5,180,823
2011	1,120,919	566,976	582,828	2,697,137	4,967,860	1,213,002	6,180,862
2012	1,259,001	638,519	656,415	2,998,404	5,552,338	1,407,826	6,960,164
2013	1,404,680	714,038	734,131	3,315,666	6,168,515	1,611,588	7,780,103
2014	1,567,066	798,452	821,013	3,665,132	6,851,664	1,844,154	8,695,817
2015	1,748,081	892,815	918,148	4,049,980	7,609,024	2,109,525	9,718,549
2016	1,946,113	995,892	1,023,953	4,473,693	8,439,651	2,412,249	10,851,900
2017	2,115,897	1,084,926	1,115,278	4,825,079	9,141,181	2,693,300	11,834,481
2018	2,300,258	1,181,842	1,214,665	5,202,395	9,899,160	3,006,130	12,905,290
2019	2,487,719	1,280,265	1,315,608	5,588,350	10,671,942	3,320,082	13,992,024
2020	2,690,309	1,386,839	1,424,890	6,001,773	11,503,811	3,666,110	15,169,921
2021	2,920,280	1,507,842	1,548,967	6,470,319	12,447,408	4,063,612	16,511,021
2022	3,121,346	1,614,136	1,657,911	6,871,057	13,264,451	4,436,810	17,701,261
2023	3,334,683	1,726,992	1,773,573	7,294,897	14,130,144	4,843,141	18,973,286
2024	3,560,990	1,846,786	1,896,339	7,743,112	15,047,228	5,285,478	20,332,706
2025	3,801,009	1,973,919	2,026,617	8,217,045	16,018,590	5,766,935	21,785,525
2026	4,055,519	2,108,809	2,164,836	8,718,109	17,047,273	6,290,895	23,338,168
2027	4,325,344	2,251,899	2,311,451	9,247,794	18,136,488	6,861,025	24,997,513
2028	4,611,350	2,403,659	2,466,939	9,807,669	19,289,617	7,481,304	26,770,921

## 5.5 Evaluation

The Philippines currently spends approximately US\$ 3.5 million annually in hydrographic service provision. It follows that if the hydrographic activity is suspended, the economy will “save” the current hydrographic investment (US\$ 3.5 million per year). But for such a scenario, the economy will also progressively suffer additional costs in terms of increased vessel operating costs and passenger time costs. These costs are estimated on the table above, for example US\$ 541,275 for the year 2003, rising to US\$ 26,770,921 for the year 2028.

Conversely, if the current hydrographic investment (of US\$ 3.5 million annually) is maintained, the cost to the economy will be US\$ 3.5 million annually when compared to the above scenario. However, the economy will also benefit because it will not incur vessel operating cost and passenger time cost increases as shown on the table, for example, US\$ 541,275 for the year 2003, rising to US\$ 26,770,921 for the year 2028.

According to this scenario, it is also possible to evaluate the sustainability of hydrographic service annual expenditure for the Philippines. Utilizing these results, the annual expenditure flow of US\$ 3.5 million represents a Net Present Value (NPV) at a 12 percent discount rate of US\$ 19.2 million, and an Internal Rate of Return (IRR) of 23.6 percent. This means that the investment (of US\$ 3.5 million annually) in hydrographic services represents a sound expenditure indeed, with a considerable economic return in terms of vessel operating and passenger time savings.

An analysis has been performed to estimate the level of expenditure in hydrographic services that can be sustained to achieve an IRR of 12 percent for the benefit analysed. An IRR of 12 percent is considered by the international community to represent an acceptable return on this type of investment. The results indicate that hydrographic services expenditure can be increased to approximately US\$ 5.9 million, and still maintain an internationally acceptable IRR (12 percent) for the investment made. This represents an increase of nearly 70 percent over and above the current expenditure level. This means that the benefits to commercial shipping from existing hydrographic services in the Philippines are significant enough to allow expenditure to be increased to nearly US\$ 6 million, and still return an acceptable IRR.

It is also important to note that the analysis is considered to be conservative, and only assumes relatively small incremental impacts in vessel operating and passenger time costs and savings of a matter of minutes over voyages often of many hours. The scope of the study has been restricted by the limited data available. There appears to be potential for much greater savings in specific cases. For example, international shipping entering the Sulu Sea from the Macassar Strait and traveling north towards Luzon is unable to sail directly north by the shortest route partly because of inadequate hydrographic surveys, but instead must sail west to enter the China Sea south of the Palawan Islands, and then north east to Luzon. This extends the voyage by some 150 miles, or up to 10 hours, probably for thousands of ships each year. Currently, voyage data to assist an analysis of these potentially dramatic improvements to maritime traffic does not exist. This is an aspect of regional hydrographic services that is worthy of further study by APEC, with the intention of identifying areas of regional interest that might benefit from regional co-operation in surveying and charting.

In addition, not all of these benefits from improved efficiency of inter-port voyages will flow to the Philippine economy. Many of the ships will be ships in transit, and the benefits will flow to the economies of the ports of departure and destination within the region. It is suggested that APEC

might research ways to collate data on transit voyages on a regional basis so that these potential benefits can be defined.

It is also important to emphasize that vessel navigation-related benefits only represent a fraction of the cumulative benefits to a given APEC economy from hydrographic services. Other significant benefits relate to the commercial fishing sector, environmental protection, sovereign and economic zone maintenance, national defence, coastal resource management, mineral exploration, emergency response, and recreational fishing and boating.

In summary therefore, the analysis indicates the tremendous economic benefits to the Philippine economy from the current expenditure in hydrographic services. It also indicates that, even by considering only the sole navigation-related benefit analysed, which represents only a fraction of total benefits, that additional hydrographic services expenditure can be justified in order to further improve the hydrographic services.

## **5.6 Extrapolation To Other APEC Economies**

### **5.6.1 Introduction**

The previous section presented the economic impacts from vessel-operating and passenger-time voyage savings as a result of varying investment levels in hydrographic services for the selected APEC economy (the Philippines). It reveals that the impacts are considerable; increased or decreased hydrographic services expenditure greatly affects vessel voyage efficiency and corresponding costs. The analysis of this single benefit alone emphasises the considerable economic viability and importance of hydrographic services to the Philippine economy, and highlights the potential for significant, additional benefits through increased expenditure.

The methodology utilized to develop the economic assessment for the Philippine case is both extensive and complex. It requires significant input data, including; (i) detailed voyage data for a range of vessel categories and size classifications; (ii) vessel operating cost data, which varies for each economy; and (iii) variable economic growth rates.

To complete an analysis in similar detail for other APEC economies would involve individual assessment of each economy, as each possesses markedly variable and unique base parameters. This is beyond the scope of this project, but is a clear recommendation of the assessment. Furthermore, once assessment of individual economies has been completed, then the assessment could consider regional effects.

The objective of the final part of this report is to relate the results of the Philippine example to other APEC economies that responded to the hydrographic questionnaire, in order to assess their relative economic sensitivity to the impact of hydrographic services on their economy. The analysis produced the possibility to group APEC economies responding to the questionnaire into three broad classifications;

- (i) Substantial Impact (High sensitivity to increased investment in hydrographic services);
- (ii) Moderate Impact (Moderate sensitivity to increased investment in hydrographic services);
- (iii) Low Impact (Low sensitivity to increased investment in hydrographic services)

### 5.6.2 Methodology

The measure of the impact between the different APEC economies that responded to the questionnaire has been accomplished by identifying two sets of key indicators, which are used to estimate the relative economic sensitivity of the impacts benefit-wise for each of the APEC economies. These two parameter sets are; (i) navigational parameters which relate to physical and infrastructure characteristics for each economy; and (ii) economic parameters, which consider the relative impacts to the national economies. These are further described as follows; Navigation Indicators

As outlined above, the assessment considers the economic impact of reducing or extending the time taken for each voyage due to the quality of hydrographic services. From a navigational sense, this would depend on a number of key factors, but all of which relate to the length of voyage during which hydrographic services influence. For example, for a vessel sailing through open ocean, the impact of hydrographic services would be relatively minimal, whereas for a vessel sailing around the coast, the impact would be greater. Also affecting the voyage and the reliance on hydrographic services is the relative complexity of the seabed, on which the dependency of hydrographic services would increase. From this, therefore, there are a number of key indicators that provide an indication of the length of voyage influenced by hydrographic services, the “navigational complexity”, and therefore the reliance on the hydrographic services.

These are summarized as follows;

- (i) Length of coastline – coastal waters are generally shallow in nature, and contain hazards to navigation which must be surveyed and published in charts. The longer the coastline, then the greater the task facing the hydrographic services;
- (ii) Continental shelf – which is shallow and potentially dangerous to navigation. The greater the width of the continental shelf, the greater the task facing hydrographic services;
- (iii) Archi-pelagic Waters – which are waters within island groups, which represent a special case of wide shallow seas and complex coastlines, which increase the task facing hydrographic services and for which good charts are essential; and
- (iv) Ports – the production of charts for ports requires a higher degree of accuracy, and therefore an increasing number of ports increases the relative complexity of navigation. The restricted navigation of ports and high volume of traffic requires that surveys and charts be developed to much higher specifications and revised at more frequent intervals, which increases the task of the hydrographic services.

The hydrographic audit provides data about the differing geographic circumstances of the APEC economies. The Philippines has a long coastline, extensive areas of shallow water, an archi-pelagic geography and many ports. By contrast, Singapore has a relatively short coastline, a narrow continental shelf, one major port and practically no archi-pelagic waters. The impact on navigation therefore of increasing hydrographic services investment would be greater from a navigational sense in the Philippines than in Singapore.

### Economic Indicators

The economic benefits in this study flow from improved efficiency of shipping, measured in voyage time savings, the number of vessel voyages, vessel cargo values, and passenger movements, represented by the following primary indicators;

- (i) Volume of maritime foreign trade – from which is derived an indication of the number of vessel voyages. When these are aggregated, it provides an indication of the total time saved;
- (ii) Maritime foreign trade as share of GDP – indicating the relative economic importance of international shipping;
- (iii) Per capita GDP – indicating the value of passenger time savings; and
- (iv) Volume of maritime domestic trade – indicating the relative economic importance of domestic shipping.

The economic impact can be again illustrated using the example of Singapore and the Philippines. Singapore has a relatively high dependence on foreign trade and high per capita GDP. In comparison, the Philippines has a lower dependence on foreign trade and lower GDP.

### Scoring System

In order to infer the relative importance of each indicator to the various economies responding to the questionnaire, each economy has been assessed in terms of each of the navigational and economic indicators. A simplified “scoring system” has been utilized, whereby each economy has been assessed for each elementary indicator according to the following three relative levels;

- (i) A score of 3 points is given where there is considered to be a high impact;
- (ii) A score of 2 points is given where there is considered to be a medium impact;
- (iii) A score of 1 point is given where there is considered to be a low impact.

The process of comparison is completed by summing up the value of all the indicators for each economy to provide an overall “impact score”. The results of this are shown on the following table. Where data was lacking, professional judgment was applied.

## ELEMENTARY INDICATORS SCORE STRUCTURE

Economy	Economic Factors					Navigational Factors					Overall Impact Indicator
	Foreign Trade	Foreign Trade/GDP	Domestic Trade/GDP	Per Capita GDP	Total	Ports	Coastline	Continental Shelf	Archi-Pelagic Waters	Total	
AUS	M	S	S	L	7	M	L	L	S	9	16
CAN	L	M	S	L	9	M	L	L	S	9	18
CHL	S	S	S	M	5	M	L	M	S	8	13
HKG	L	L	S	L	10	S	S	S	S	4	14
IND	M	S	L	S	7	M	L	L	L	11	18
JAP	L	S	M	L	9	M	M	M	M	8	17
KOR	L	M	S	M	8	M	M	S	S	6	14
MEX	M	M	M	M	8	M	M	M	S	7	15
NZE	S	S	M	L	7	S	M	M	S	6	13
PER	S	S	S	S	4	S	S	S	S	4	8
PHI	S	M	L	S	7	L	L	L	L	12	19
SIN	L	L	S	L	10	S	S	S	S	4	14
USA	L	S	S	L	8	M	L	L	S	9	17

Legend: L (Large Impact) = 3 points, M (Medium Impact) = 2 points, S (Small Impact) = 1 point.

## Weighting

The overall impact indicators have then been weighted according to the status of hydrographic surveying and charting in each economy, as reported in the hydrographic questionnaire. This weighting represents the size of the outstanding hydrographic task. Thus economies whose surveying and charting is well advanced received a low weighting, and those that have large outstanding areas for surveying and charting receive a high rating. This represents the relative effect of improving hydrographic services, in that economies that still have the bulk of the work to do will benefit more than those whose task is well advanced. The weighting utilized is as follows;

- (i) Where little hydrographic services improvement is considered necessary : 1 point;
- (ii) Where medium hydrographic service improvement is necessary : 2 points;
- (iii) Where large improvements are considered necessary : 3 points.

The following table illustrates the results of the weighting system developed, and the total weighted score for each economy.

### RELATIVE IMPACT OF HYDROGRAPHIC SERVICES AMONG APEC ECONOMIES

Economy	Factor Scores			Weighting System	Final Rating
	Economic	Navigational	Total		
PHI	7	12	19	3	57
IND	7	11	18	3	54
MEX	8	7	15	3	45
CAN	9	9	18	2	36
USA	8	9	17	2	34
AUS	7	9	16	2	32
NZE	7	6	13	2	26
CHL	5	8	13	2	26
JAP	9	8	17	1	17
PER	4	4	8	2	16
HKG	10	4	14	1	14
KOR	8	6	14	1	14
SIN	10	4	14	1	14

## Other Considerations

Two other matters have been considered in coming to a view about the impact of increased investment in hydrographic services in different economies. These are summarized as follows;

- (i) The identification of critical issues and problems in the responses to the questionnaire is to some extent subjective, reflecting the financial realities and service expectations of individual economies. Some well-developed economies have the goal of total hydrographic coverage of the EEZ to the most comprehensive IHO standards, with highly developed navigation

services. Other less well-developed economies have more restricted goals, reflecting the current state of economic development and priorities;

- (ii) This means that a certain status of surveying and charting might be regarded as acceptable in a developing economy, but not acceptable in a developed economy;
- (iii) We have also observed that some economies with relatively large hydrographic budgets regard the size of the budget as a critical issue, whereas other economies with relatively small hydrographic budgets have not reported the value of the budget as an issue.

These issues have been taken into consideration during the evaluation.

### **5.6.3 Results**

As shown on the above table, the results of the analysis have revealed that the APEC economies that responded to the questionnaire can be broadly classified into the following three groups:

- (i) Substantial Impact – This group shows the economies where the benefits associated with increased hydrographic services expenditure are considered to be substantial. Economies: Philippines, Indonesia, and Mexico;
- (ii) Medium Impact – Where the impact of increased hydrographic service expenditure is considered to be medium. Economies: Canada, Australia, USA, New Zealand, Chile, Japan and Peru;
- (iii) Low Impact – Representing economies in which increased expenditure on hydrographic services would seem to offer relatively less benefit. Economies: Hong Kong, Korea and Singapore.

It must be remembered that the extrapolation process has not taken into account the actual investment that economies presently make in hydrography. Therefore the grouping in itself does not suggest that all members of Group 1 and 2 for example should necessarily increase their present investment in hydrographic services. It rather takes account of the responses (where they were received) of the economies' hydrographic authorities, as to whether in their opinion the present rates of funding are sufficient.

Importantly, when interpreting the implications of these responses, it needs to be remembered that such an opinion is highly dependent on the aspirations and social norms of the economy in question. Consequently the response in investment terms will mean very different things between for example the extremes of a developing economy and a developed economy.

Rather these groupings indicate the importance of hydrography for an economy. In other words they indicate the relative potential within an economy for generating economic gain by increased investment in hydrography.

Countries in Group 1 should see increased investment in hydrographic services as potentially providing major value to their economies. For those in Group 2 the potential benefit of increased investment is smaller. Those in Group 3 should see hydrographic services as important but possibly not as critical an issue for economic development, because their present level of investment seems appropriate to their needs.

The analysis of the Philippines case conducted within this report provides a valuable benchmark for economies to gauge their investment requirement. In the case of the Philippines it is clear from the economic analysis that a minimum investment of the order of US\$ 5.9 million per annum is justified based purely on the benefits to shipping efficiency. Additional investment above US\$ 6 million per year is clearly justifiable when benefits to ships in transit and non-transport sector benefits of hydrographic services are taken into account.

Other economies of the Group 1 category can use this benchmark to provide an indicative gauge of their needs by considering the length and difficulty of their coastline and economic status of their economy in relation to that of the Philippines. Because of the evident limitations in this extrapolation of the Philippine results, we repeat our recommendation that a full hydrographic audit and economic assessment should be a priority for economies in the top tier grouping, and an important management tool for other economies.

## **5.7 Conclusions of the Economic Assessment**

Conclusions of the economic assessment are summarized as follows:

- (i) The economic assessment demonstrates that the provision of hydrographic services has a significant and positive economic impact to the efficient and safe performance of the maritime transport sector in the selected APEC case study economy of the Philippines;
- (ii) Based on the economic assessment, the entire national expenditure for hydrographic service provision can be justified from the benefits accruing from only one solitary benefit<sup>3</sup> of hydrographic services. The economic benefits from this single benefit alone when compared with the annual hydrographic services expenditure of US\$ 3.5 million, are sufficient to achieve a Net Present Value (NPV) at a 12 percent discount rate of US\$ 19.2 million and an Internal Rate of Return (IRR) of 23.6 percent;
- (iii) The assessment of this one benefit also indicates that hydrographic service investment can be increased by nearly 70 percent from the current investment level to US\$ 5.9 million and still achieve an internationally acceptable Internal Rate of Return (IRR) of 12 percent;
- (iv) The cumulative benefits of hydrographic services to the Philippine economy are considerably higher than even this estimate, since the numerous other benefits accruing from hydrographic service provision

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<sup>3</sup> Vessel-operating and passenger-time savings / costs accruing from voyage time savings / losses associated with vessel movements.

have not been included in the assessment. These include benefits relating to fisheries, mineral exploration, national defence, delineation and maintenance of sovereign- and economic- zones, search and rescue, environmental protection, sustainable resource management and maritime recreational uses;

- (v) There is sound economic justification that the Philippine economy can benefit significantly from progressive and carefully planned additional investments in hydrographic services;
- (vi) An initial qualitative assessment performed in order to infer relative economic sensitivity to varying hydrographic service investment levels in economies responding to the questionnaire has resulted in a broad classification of three major groupings. These include APEC economies where the benefits from increased investment are considered to be of; (i) substantial value (Philippines, Indonesia and Mexico); (ii) medium value (Canada, Australia, USA, New Zealand, Chile, Japan and Peru, and; (iii) of lower value (Hong Kong, Korea and Singapore).

## **6 KEY ISSUES AND RECOMMENDATIONS**

### **6.1 Issues**

We have identified a number of key issues facing the hydrographic services of the APEC region. They include;

- a. The incomplete status of the surveying and charting of the waters of some of the APEC economies;
- b. The incomplete status of the surveying and charting of some important international trade routes, especially in East Asia;
- c. The availability of appropriate material, human and financial resources in the hydrographic services of some APEC economies;
- d. The availability of easily accessible data on which to base future investment decisions, including data about shipping movements within the EEZ, and data about the current real costs of the hydrographic service;
- e. The need for formal institutional and co-ordination arrangements for hydrography in the APEC economies.

### **6.2 Recommendations**

We propose recommendations for individual economies and for APEC.

It is recommended that economies;

Carry out an audit of their individual hydrographic department, in order to define aspects of the hydrographic programme that need attention, and to identify and establish priorities and time frames for completion of outstanding tasks;

Carry out an economic analysis for their individual hydrographic requirements, using the model proposed in this report, in order to derive an optimum level of investment and budget for the hydrographic service;

Ensure that necessary development of the hydrographic department is included in national or ministerial development plans, including development of human, material and financial resources, and administrative arrangements, appropriate to the national survey and charting plans;

Ensure that national five-year plans for survey and charting are in place;

Review the work practices of the hydrographic department in order to identify the potential for improving cost effectiveness;

Review their individual institutional and co-ordination arrangements for hydrographic activities.

We consider that conducting a hydrographic audit and an economic assessment should be a priority for the economies in Group 1. That process would also be an important management tool for other economies if they wish to take the issue forward.

It is recommended that APEC;

Consider the economic and safety benefits of increasing co-operation in hydrography, especially in the South China Sea, and in the international straits and archipelagic sea-lanes of East Asia.

Consider undertaking research to provide data on the volume and characteristics of international shipping making transit voyages through the international straits and archipelagic sea-lanes of the region.

Consider undertaking research to provide some possible models for navigation levies on ships transiting the archipelagic sea-lanes and international straits.

Consider organising some technical assistance programmes in hydrography for the small island economies of the APEC region.

## **7 POLICY IMPLICATIONS**

The following suggestions are offered for further APEC consideration in order to strengthen existing hydrographic policy;

- Results and conclusions from this assessment should be fully circulated and promoted to relevant policy and sector development entities within APEC and member economies to allow appreciation of the potential economic benefits of current hydrographic services and value of additional investment;
- APEC should further refine the strategies and tools developed in this preliminary assessment and assist interested APEC economies to formulate comprehensive hydrographic evaluation and investment programs, and accurately define optimal investment levels;
- APEC should consider specific evaluation of regional sea-lanes, in order to develop improvement strategies, identify optimal investment levels, and define options for future co-operative hydrographic activity throughout the APEC region.