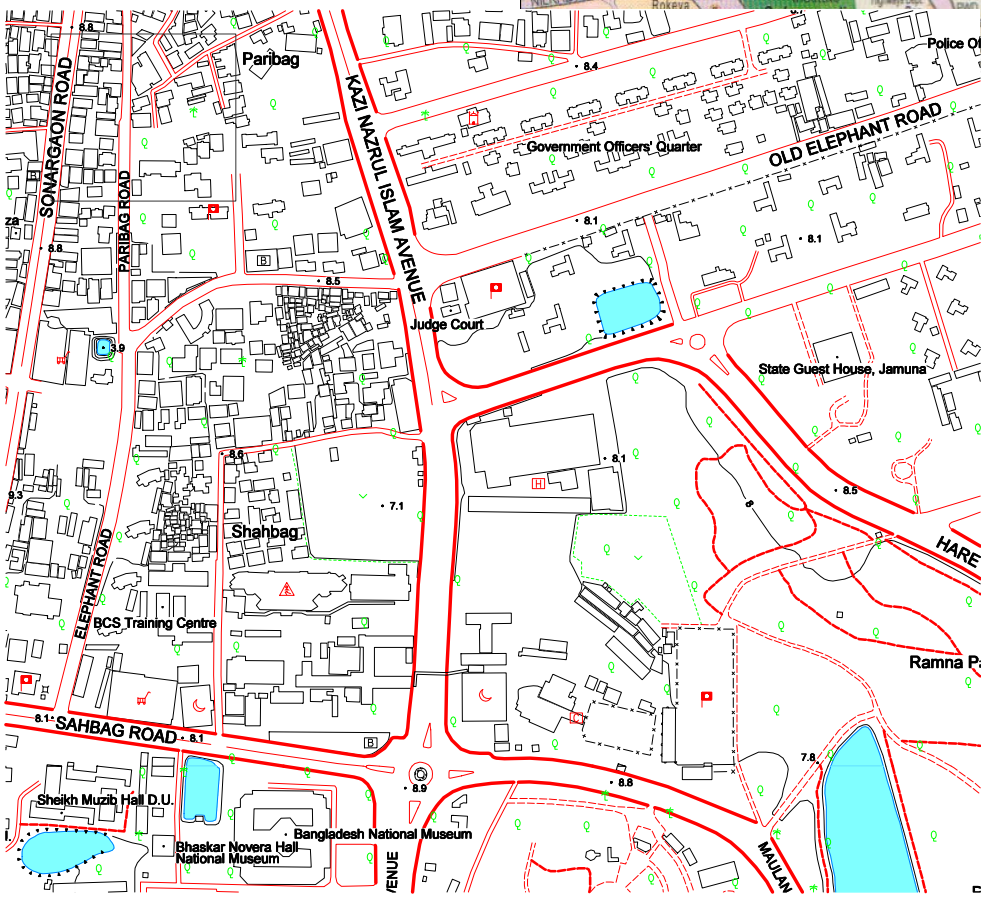
No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
SURVEY OF BANGLADESH (SOB)

Final Report

THE STUDY
ON
URBAN INFORMATION MANAGEMENT
FOR
GREATER DHAKA CITY
IN
THE PEOPLE'S REPUBLIC
OF
BANGLADESH

Summary



August 2004

Asia Air Survey Co ., Ltd.
Aero Asahi Corporation

SD
JR
04-17

Preface

In response to a request from Survey of Bangladesh in the People's Republic of Bangladesh (hereinafter referred to as "SOB"), The Government of Japan decided to conduct "The Study on Urban Information Management for Greater Dhaka City in the People's Republic of Bangladesh" (hereinafter referred to as "the Study") and entrusted the Study to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA selected and dispatched a study team headed by Mr. Toru WATANABE of Asia Air Survey Co., Ltd. to Bangladesh from November 2002 to July 2004 (hereinafter referred to as "the Study team").

The Study team held discussion with the officials concerned of SOB and conducted field survey at the Study area. Upon returning to Japan, the study team conducted further studies and prepared this final report.

I hope that this report will contribute to SOB and also to the promotion of the development projects in the Study area in Bangladesh.

Finally, I wish to express my sincere appreciation of the officials concerned of SOB for their close cooperation extended to the study team.

August 2004

Kazuhisa Matsuoka
Vice President
Japan International Cooperation Agency

Letter of Transmittal

August 2004

Mr. Kazuhisa Matsuoka
Vice President
Japan International Cooperation Agency

Dear Mr. Matsuoka

It is my great pleasure to submit herewith the Final Report for the Study on Urban Information Management for Greater Dhaka City in the People's Republic of Bangladesh.

The Study team consists of Asia Air Survey Co., Ltd. (AAS) and Aero Asahi Corporation (AAC) conducted field survey in Bangladesh during the period from November 2002 to March 2004, and office work such as digital topographic mapping during the period from February 2003 to March 2004 as per the contract with the Japan International Cooperation Agency.

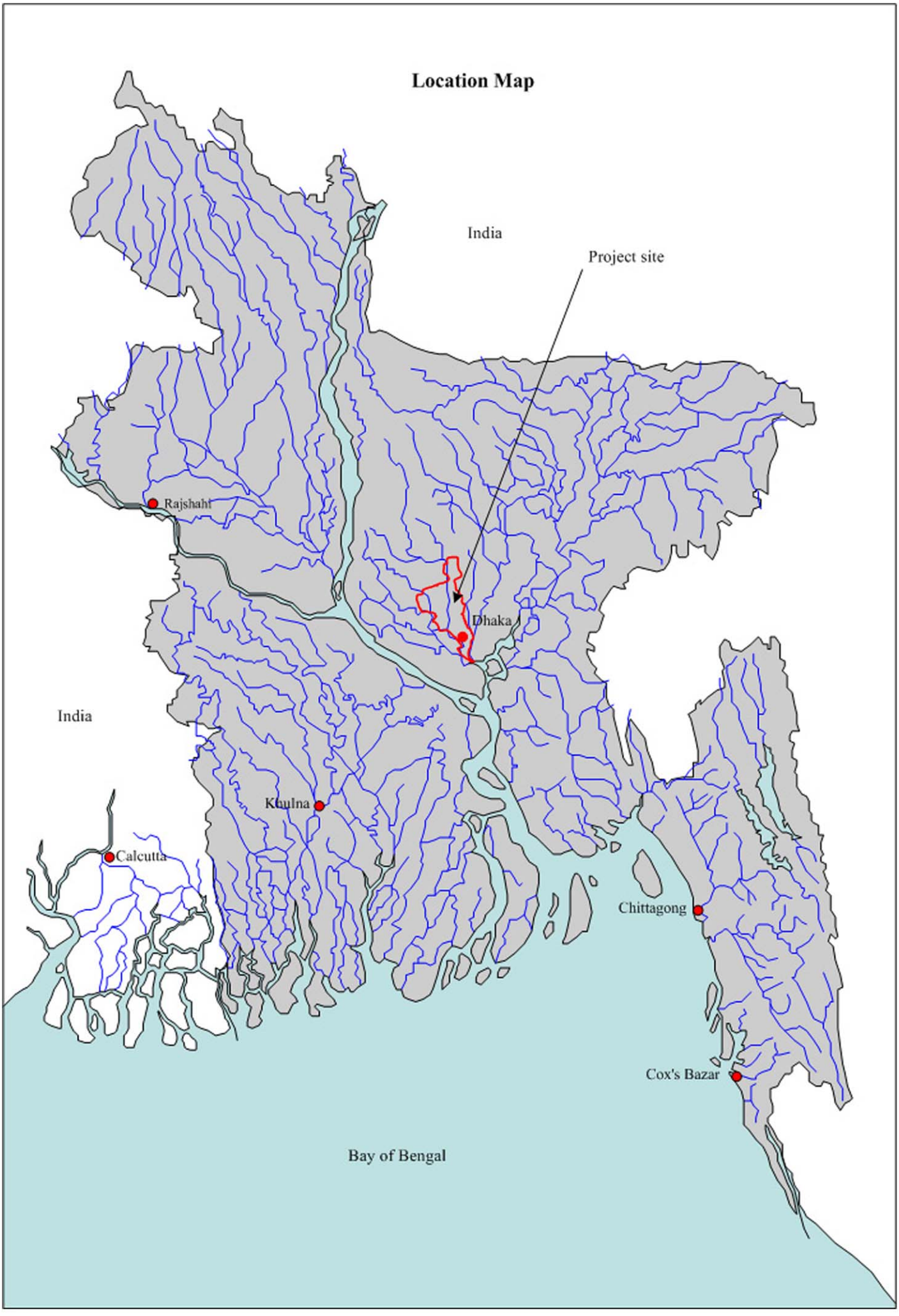
During the field survey in Bangladesh, discussions with the officials of Survey of Bangladesh in the People's Republic of Bangladesh (SOB) were held. Based on the results of the discussions with SOB, digital topographic maps, other final results and final report were prepared.

On behalf of the Study team, I would like to express my heartfelt appreciation to SOB in Bangladesh and other authorities concerned for their diligent cooperation and assistance and for the heartfelt hospitality which they extended to the Study team during our stay in Bangladesh.

I am also greatly indebted to the Japan International Cooperation Agency, the Ministry of Foreign Affairs and the Embassy of Japan in Bangladesh for giving us valuable suggestion and assistance during the preparation of this report.

Yours faithfully,

Toru Watanabe
Team Leader for the Study on Urban Information Management
for Greater Dhaka City in the People's Republic of Bangladesh


Location Map
India
Project site
Rajshahi
Dhaka
India
Khulna
Calcutta
Chittagong
Cox's Bazar
Bay of Bengal

Abbreviation of the Organization Names in Bangladesh

Abbreviation	Name of User of Topographic Data and GIS
AD	Archaeology Department
BDR	Bangladesh Rifles
BARC	Bangladesh Agricultural Research Council
BB	Ban Bhaban (Forest Department)
BBS	Bangladesh Bureau of Statistics
BCL	Bangladesh Consultancy Limited
BEG	Bets Group
GSB	Geological Survey of Bangladesh
BIWTC	Bangladesh Inland Water Transport Corporation
BR	Bangladesh Railway
BRTA	Bangladesh Road Transport Authority
BSI	Bangladesh Survey Institute
BTB	Bangladesh Tea Board
BUET	Bangladesh University of Engineering & Technology
CCC	Chittagong City Corporation
CDA	Chittagong Development Authority
CEC	Concord Engineering & Construction
CEGIS	Center for Environmental & Geographical Information Services
DCC	Dhaka City Corporation
DDC	Development Design Consultant Limited
DESA	Dhaka Electric Supply Authority
DLRLS	Department of Land Records & Settlement Surveys
DMP	Dhaka Metropolitan Police
EAS-D	External Advertising Sub-Division
EGIS	Environment & GIS Support Project
IEB	Institute of Engineers, Bangladesh
FD	Fishery Department
FS&CD	Fire Service & Civil Defense
HBRI	Housing & Building Research Institute
IDE	International Development Enterprises
IGP PHQ	IGP, Police Head Quarter
JICA	JICA Bangladesh Office
JOC	Japan Overseas Consultant Co., Ltd.
JRC	Joint River Commission
KCC	Khulna City Corporation
KEP	Kearn Enargy PLC
KDA	Khulna Development Authority
LGED	Local Government Engineering Department
MAPPA	The MAPPA
MOC	Ministry of Commerce
MOH	Ministry of Home
MWPD-1	Micro Wave Preserver Division-1
PDB	Power Development Board
PHED (DC)	Public Health Engineering Department (Drainage Circle)
PWD	Public Works Department
RAJUK	Rajdhani Unnayan Kartripakkha
RCC	Rajshahi City Corporation
R&H	Road & Highway Department
RIC	Resource Integration Center
RRI	River Research Institute
SOB	Survey of Bangladesh
SPARRSO	Space Research & Remote sensing Organization

SRDI	Soil Resource Development Institute
SRI	Soil Resource Institute
SSL	Sthapati Sangshad Limited
SUC	Survey Corporation Pvt. Limited
SUMISHO	Sumitomo Corporation
SWMC	Surface Water Modeling Centre
T&T	Bangladesh Telegraph & Telephone Board
WARPO	Water Resources Planning Organization
WASA	Water Supply and Sewerage Authority

Summary of the Study

Item of Work		Volume of Work
1. Aerial photography		
Photo scale		1:20,000
Aerial photography area		960km^2
Positive film making		1 set, 330 sheets
Contact film making		1 set, 330 sheets
Scanning of positive film		1 set, 330 sheets
2. Interview survey		
Interview survey		1 set
3. Ground control point survey		
Monumentation		23 points
Establishment of photo signals		14 points
GPS observation		Existing: 6 points, New: 24 points
Leveling		160 km
Pricking		46 points
Field identification	581km^2	1 set
4. Aerial triangulation		
Aerial triangulation	30 runs、330 sheets	307 models
5. Digital topographic mapping		
Map scale		1:5,000
Mapping area		581 km^2
Number of sheet		122 sheets
Contour interval	Intermediate contour	2 m
6. GIS basic data creation		
Scale		1:5,000
Area		581 km^2
7. Production of CD-ROM, etc.		
Digital topographic map data		2 sets
GIS basic data		100 sets
Printing film		1 set
PS-plate		1 set
8. Printing of topographic maps		
1:5,000 scale printing map	Printed by SOB	500 sets

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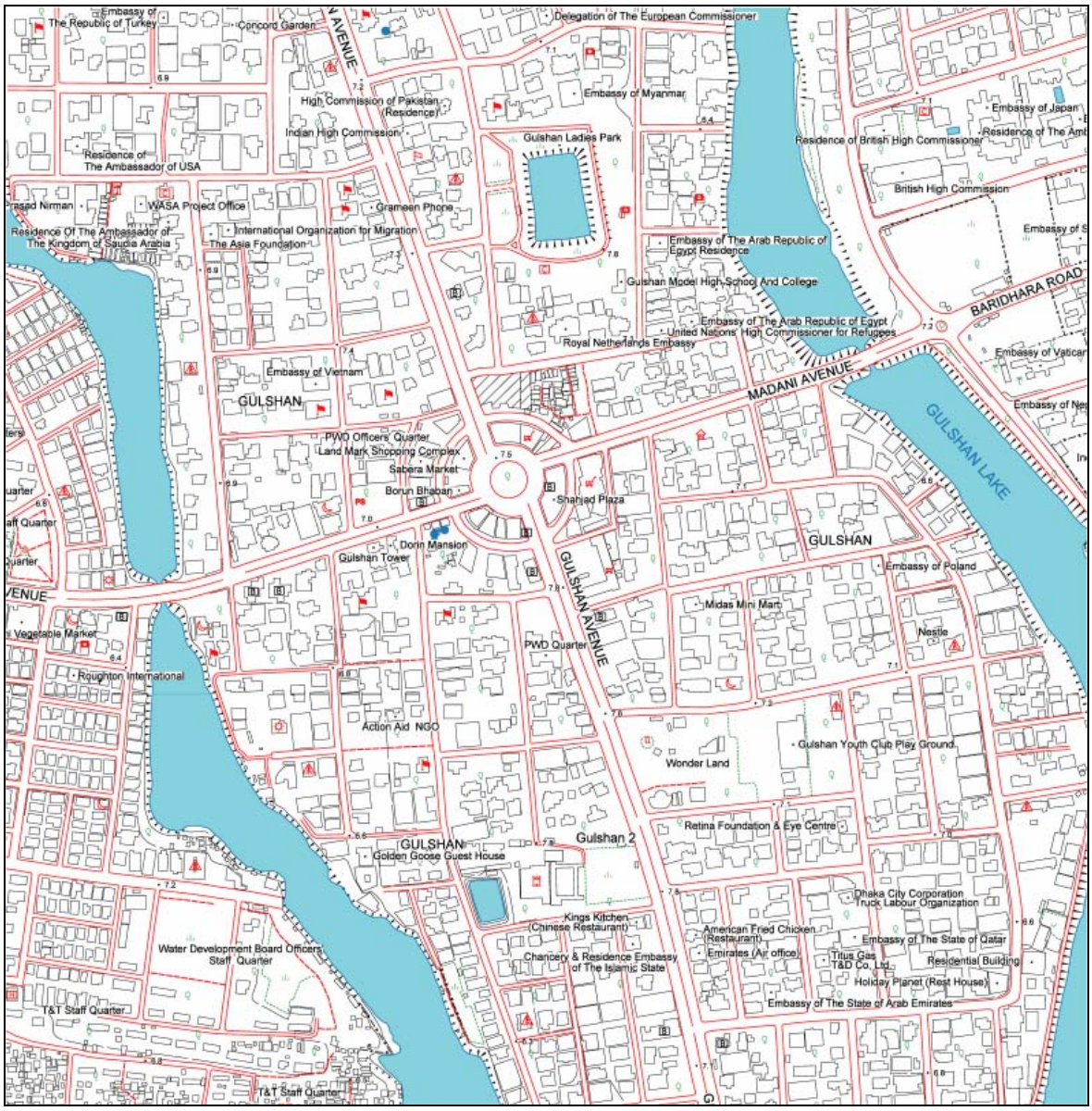
Chapter 1 Outline of the Study



Sample of 1:5,000 digital topographic map

Location: Gulshan Circle 2

Chapter 1 Outline of the Study

1.1 Background of the Study

In response to the request made by the Government of the People's Republic of Bangladesh (hereinafter referred to as "GOB"), the Government of Japan has decided to conduct "The Study on Urban Information Management for Greater Dhaka City in the People's Republic of Bangladesh (hereinafter referred to as "the Study")", in accordance with the relevant laws and regulation in force in Japan.

The Japan International Cooperation Agency (hereinafter referred to as "JICA"), an official agency responsible for the implementation of the international technical cooperation programs of the Government of Japan, sent a Japanese Study Team (hereinafter referred to as "the Study team") and the Study team carried out the Study in close cooperation with Survey of Bangladesh (hereinafter referred to as "SOB") and other Bangladesh authorities concerned.

The Study areas including the Dhaka Metropolitan Area are as follows:

1) 1:20,000 scale aerial photography area 960 km^2
2) 1:5,000 scale digital mapping area 581 km^2
3) 1:5,000 scale GIS basic data creation area 581 km^2

The Study area is shown in Figure 1.1.1 "1:5,000 Scale Digital Topographic Mapping Area".

1.2 Objectives of the Study

The objectives of the Study is to produce 1:5,000 scale digital topographic maps and GIS basic data in the Dhaka Metropolitan Area immediately to assist the planning and implementation for solving the urban problems to be tackled in this area. Furthermore, technology of large to medium scale digital topographic mapping and production of GIS basic data will be transferred to the counterparts of SOB through the implementation of the Study.

1.3 The Period and Items of the Study

The Study was started from the middle of November 2002 and to be completed by the end of July 2004. The Study items and the period of the Study of each year were as follows:

1.3.1 The 1st year's Study

The outline of the 1st year's Study was as follows:

1) Preparation work in Japan

Work period: From the middle of November 2002 to the end of November 2002

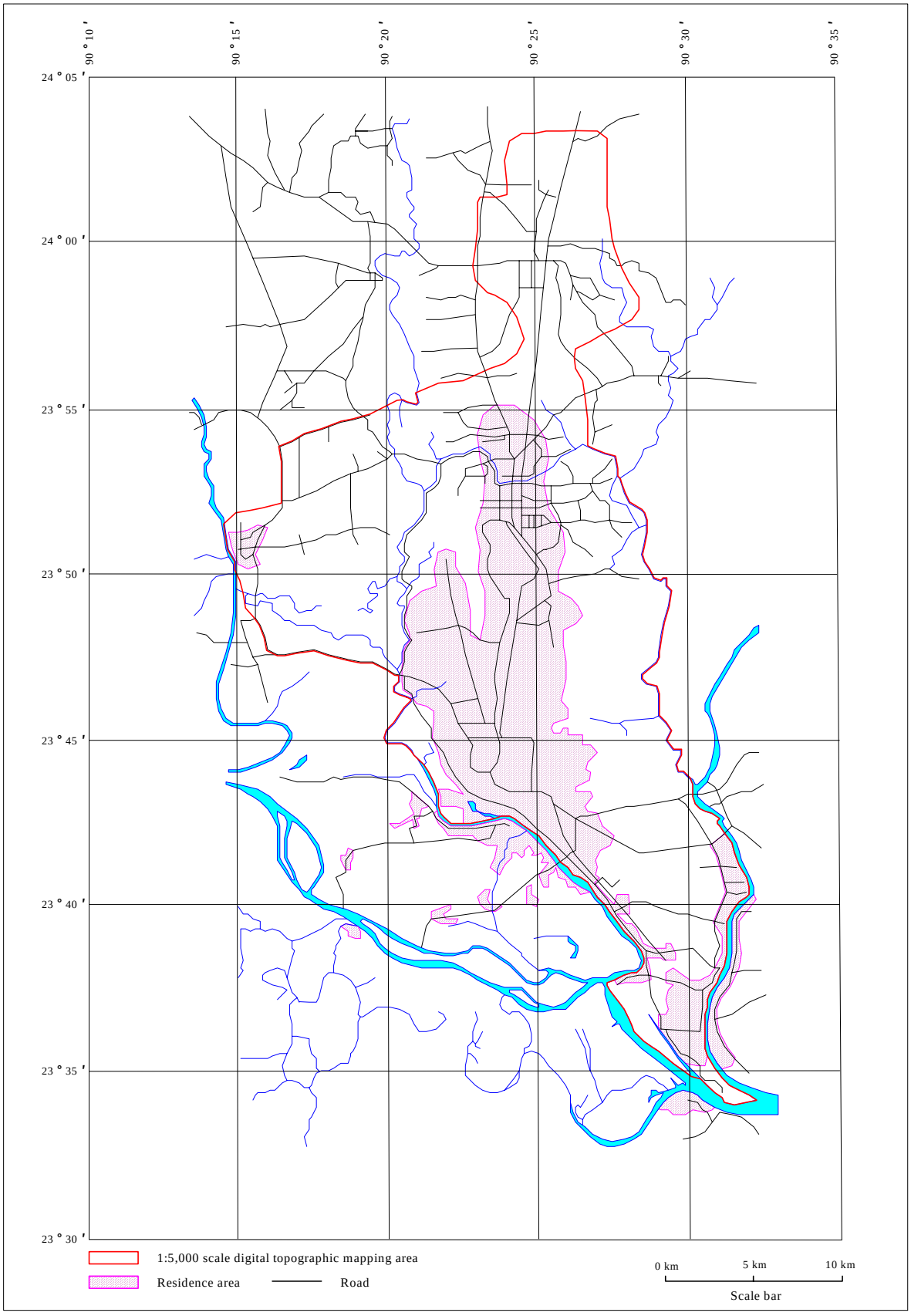


Figure 1.1.1 "1:5,000 Scale Digital Topographic Mapping Area"

Work item: 1) Collection of the existing data and information
2) Preparation of inception report

2) The 1st fieldwork in Bangladesh

Work period: From the end of November 2002 to the middle of March 2003
Work item: 1) Inception report meeting
2) Aerial photography
3) Discussion of map style and map symbols (1)
4) Ground control point survey
5) Field identification (1)
6) Interview survey
7) Production of 1:5,000 digital orthophotos

3) Office work in Japan

Work period: From the middle of March 2003 to the end of March 2003
Work item: 1) Scanning of positive films
2) 1:5,000 scale digital topographic map sheet planning

1.3.2 The 2nd year's Study

The outline of the 2nd year's Study was as follows:

1) The 1st office work in Japan

Work period: From the beginning of May 2003 to the end of May 2003
Work item: 1) Preparation of Progress report
2) Aerial triangulation
3) Preparation of a sample of 1:5,000 scale digital topographic maps

2) The 2nd fieldwork in Bangladesh

Work period: From the middle of May 2003 to the end of June 2003
Work item: 1) Progress report meeting
2) Discussion of map style and map symbols (2)
3) Discussion of GIS basic data
4) Field identification (2)

3) The 2nd office work in Japan

Work period: From the middle of May 2003 to the end of September 2003
Work item: 1) Digital mapping
2) Digital compilation (1)
3) Preparation of work manual
4) Preparation of interim report

4) The 3rd fieldwork in Bangladesh

Work period: From the middle of August 2003 to the end of August 2003

Work item: 1) Procurement of necessary equipment for technology transfer

5) The 4th fieldwork in Bangladesh

Work period: From the beginning of October 2003 to the beginning of March 2004

Work item: 1) Interim report meeting

2) Field identification (3)

3) Technology transfer
- Digital mapping
- Digital compilation and symbolization
- GIS basic data production
- Quality control and schedule management

4) Procurement of printing materials

5) Returning of positive films to SOB

6) The 3rd office work in Japan

Work period: From the beginning of October 2003 to the end of March 2004

Work item: 1) Digital compilation (2) and symbolization

2) Structuralization (GIS basic data production)

3) Printing film, PS-plate and CD-ROM making

4) Preparation of draft final report

1.3.3 The 3rd year's Study

The outline of the 3rd year's Study was as follows:

1) The 5th fieldwork in Bangladesh

Work period: From the end of June 2004 to the end of July 2004

Work item: 1) Seminar

2) Follow-up of the technology transfer

3) Draft final report meeting

2) The 4th office work in Japan

Work period: From the beginning of August 2004 to the end of August 2004

Work item: 1) Preparation of final report

1.4 Flow of the Study

The workflow of the Study and actual assignment schedule of the members of the Study team are shown in Figure 1.4.1 "Workflow and Actual Assignment Period of the Study Team".

1.5 Organization of the Study Team

The members and their assignment period of each year's Study were as follows:

The 1st year's Study team

Assignment	Name	Assignment Period	Days
Team leader	Toru Watanabe	07/12/2002～05/01/2003	30 days
		01/03/2003～15/03/2003	15 days
Supervisor of aerial photography	Hidehito Hosoda	28/11/2002～26/01/2003	60 days
Leveling and GPS	Kentaro Usuda	26/12/2002～01/03/2003	66 days
Field identification	Takashi Harada	14/02/2003～15/03/2003	30 days
Technical specifications	Kozo Toyoda	02/01/2003～31/01/2003	30 days
Administration support (1)	Ichiro Nonaka	28/11/2003～27/12/2002	30 days
		29/01/2003～12/02/2003	16 days
Administration support (2)	Michi Hayashi	22/12/2002～26/01/2003	36 days

The 2nd year's Study team

Assignment	Name	Assignment Period	Days
Team leader	Toru Watanabe	10/05/2003～24/05/2003	15 days
		15/06/2003～04/07/2003	20 days
		16/08/2003～30/08/2003	15 days
		04/10/2003～18/10/2003	15 days
		12/11/2003～11/12/2003	30 days
		20/02/2004～05/03/2004	15 days
Field identification	Takashi Harada	10/05/2003～08/06/2003	30 days
		04/10/2003～17/11/2003	45 days
Digital mapping	Nobuhiro Sata	04/10/2003～16/01/2004	105 days
Digital compilation	Yoshiaki Hirota	10/05/2003～08/06/2003	30 days
		01/11/2003～29/01/2004	90 days
GIS	Kazumi Suwabe	01/06/2003～30/06/2003	30 days
		07/12/2003～05/03/2004	90 days
Administration support (2)	Michi Hayashi	10/05/2003～08/06/2003	30days
		13/10/2003～07/11/2003	26 days
		10/03/2004～24/03/2004	15 days

The 3rd year's Study team

Assignment	Name	Assignment Period	Days
Team leader	Toru Watanabe	26/06/2004～31/07/2004	36 days
GIS	Kazumi Suwabe	26/06/2004～31/07/2004	36 days
Digital mapping	Nobuhiro Sata	26/06/2004～31/07/2004	36 days

Digital compilation	Yoshiaki Hirota	26/06/2004～31/07/2004	36 days
GIS (Solid waste)	Shigeru Ono	26/06/2004～31/07/2004	36 days
Administration support (2)	Michi Hayashi	26/06/2004～31/07/2004	36 days

At the beginning of 2004, JICA requested the Study team to produce GIS data to support the Solid Waste Management Study at Dhaka Metropolitan Area started from the end of 2003 by the technical cooperation program of the Government of Japan as an additional work to the GIS basic data production in the Study.

To meet the requirement, following additional members were sent to Bangladesh for the fieldwork in Dhaka Metropolitan Area to collect the necessary data and information for the creation of GIS data.

Assignment	**Name**	**Assignment Period**	**Days**
Team leader	Toru Watanabe	28/01/2004～11/02/2004	15 days
Field survey (1)	Kozo Toyoda	28/01/2004～27/03/2004	60 days
Field survey (2)	Takayuki Iritani	28/01/2004～27/03/2004	60 days
GIS	Shigeru Ono	28/01/2004～07/03/2004	40 days
Administration support	Michi Hayashi	03/02/2004～22/02/2004	20 days

The objectives of this additional work is to produce the following GIS data to support the Solid Waste Management Study using the results of the Study such as 1:5,000 digital topographic data and GIS basic data. Furthermore, the GIS data to be produced will be utilized not only for Solid Waste Management Study, but also for other development projects in Dhaka Metropolitan Area.

1) Land use maps
2) Land conditions maps
3) Social economic conditions maps
4) Flood areas maps and flood simulation
5) Road type and road width maps
6) Administrative boundary maps
7) Types and numbers of houses, and estimation of population
8) Collecting points and collecting routes of solid waste
9) Other necessary GIS data for solid waste management

This final report does not include the contents of GIS data production for solid waste management. The outline and results of GIS data production for solid waste management are described in “Report on GIS Data Production for Solid Waste Management”.

1.6 Key Points for the Implementation of the Study

Followings are the important key points for the implementation of the Study of which the Study team has

explained to SOB at the beginning of the Study.

1) Through the implementation of the Study, technology transfer to the counterparts of SOB will be executed. The final target of the technology transfer is to make the counterparts capable to produce 1:5,000 scale digital topographic maps on the remaining unmapped area (approximately 371 km^2) in the aerial photography area (approximately 960 km^2) by SOB themselves.

2) In case of large to medium scale topographic mapping, cooperation of relevant organizations in Bangladesh will be truly needed. Furthermore, it is also important that the final results of the Study should be used effectively by the relevant organizations.

3) The SOB counterparts will mainly implement the Study and the Japanese members of the Study team will assist and cooperate the activities of the counterparts of SOB.

4) The existing equipment of SOB should be used effectively wherever possible for the implementation of the Study, and the minimum of necessary equipment will be prepared by the Study Team.

5) SOB has no experience of 1:5,000 scale digital topographic map production. Therefore, it is necessary to create the map style, map symbols, manual for 1:5,000 scale digital topographic mapping and so on from ABC through the Study. The Study team will prepare the visible samples of above-mentioned items to help the understanding of the counterparts of SOB as much as possible.

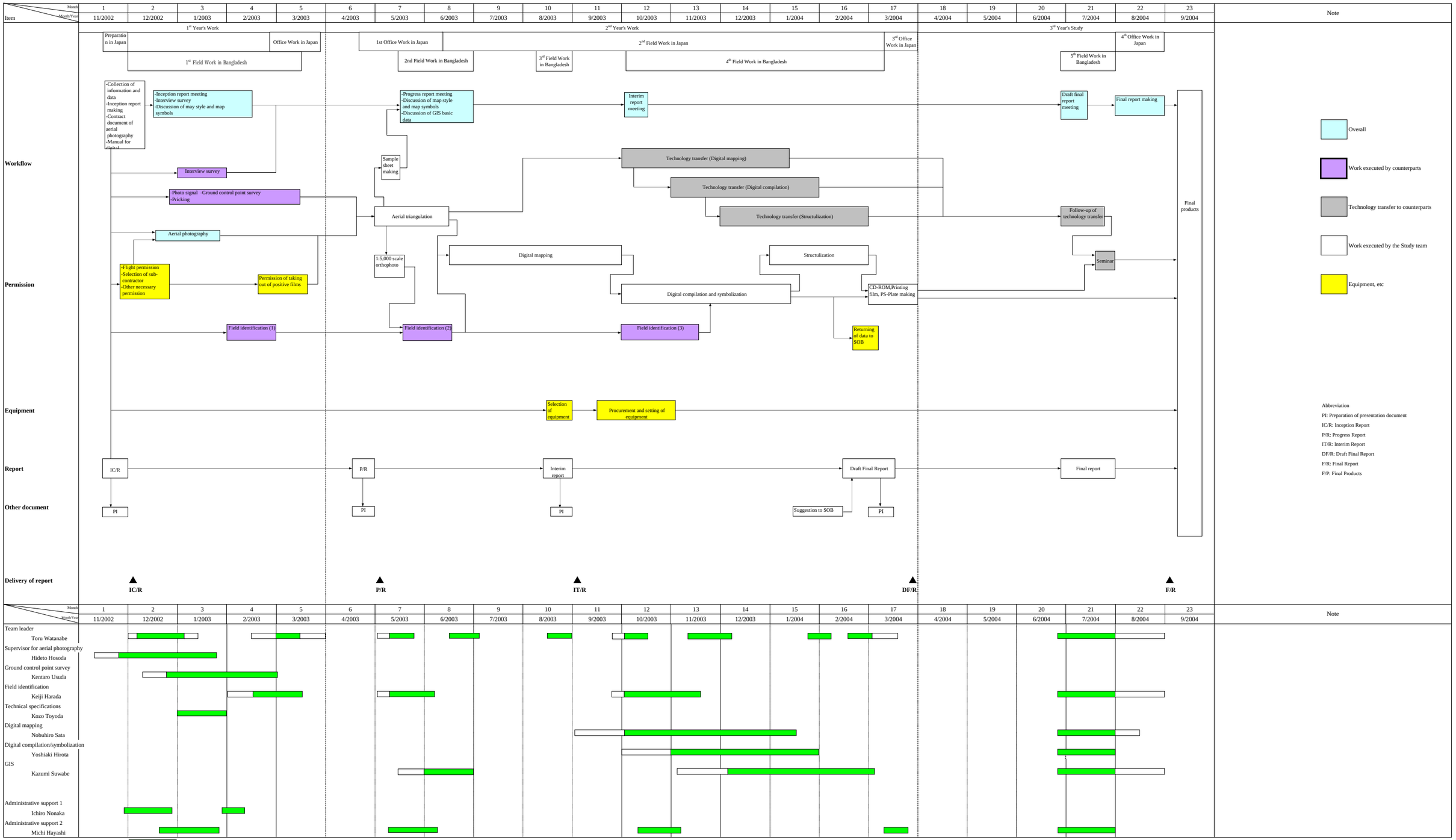
6) The main items of technology transfer through the Study are “Digital mapping”, “Digital compilation and symbolization”, “Structuralization” and “Field identification”.

7) The necessary data and materials for the implementation of the Study in Japan will be brought out from Bangladesh to Japan according to the regulation of the Government of Bangladesh. At the end of the Study, the data and materials brought out to Japan will be surely returned to SOB.

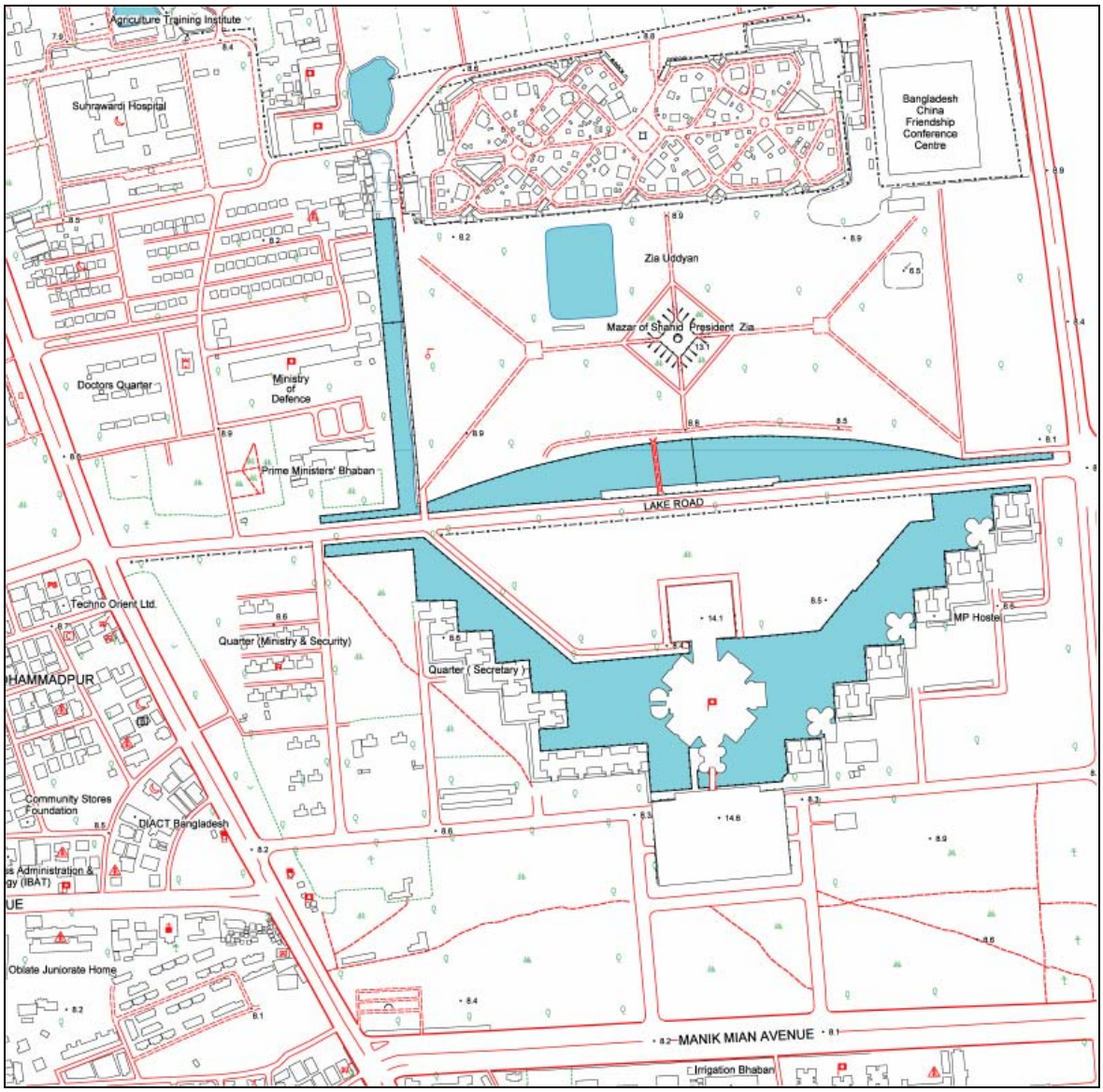
1.7 Project Office

The SOB supplied an office room to the Study team. It is on the 4th floor of the new building located behind the main building of SOB. The room was previously used for the stock room of topographic maps in SOB. This office room has 3 air conditioners, and a telephone line has been already installed into the room.

Figure 1.4.1 "Workflow and Actual Assignment Period of the Study Team"



Chapter 2 Survey of Bangladesh (SOB)



Sample of 1:5,000 scale digital topographic map

Location: Assembly Hall

Chapter 2 Survey of Bangladesh (SOB)

2.1 History of SOB

The Survey of India started the survey in Bengal Region (Bangladesh, India, Pakistan and Myanmar) under the British rule. The Survey of India was established in 1767 and established triangulation and leveling networks covering the Indian sub-continent and its surrounding areas by 1880. The geodetic datum origin of the geodetic network was located at Kalianpur in north India, and they also established 9 tidal observation stations.

In 1947, India Region became independent from British. At this time, due to the reason of religion, India region was separated as India and Pakistan, and Survey of Pakistan succeeded the survey works in Pakistan region from Survey of India.

Survey of Pakistan executed the triangulation and leveling survey to establish the geodetic networks for the areas not executed by Survey of India, and also produced 1:50,000 scale topographic maps (total 42 sheets) by compiling the existing topographic maps and aerial photos. These works were executed by a regional office of Survey of Pakistan for East Pakistan located in Dhaka City.

After the independence of Bangladesh from Pakistan, a regional office of Survey of Pakistan for East Pakistan was reorganized as Survey of Bangladesh (SOB). Under these circumstances, SOB started its work with serious problems as described below.

1) There was no geodetic datum point in Bangladesh,
2) Geodetic control points were distributed homogeneous,
3) Leveling network was divided into two parts due to the Padma River,
4) The data and information concerning survey and mapping were stored in India and there were no enough data and information in regional office in Dhaka at the time of the independence and
5) The staffs and equipment succeeded from Survey of India were not sufficient.

2.2 Technical Assistance by the Foreign Countries to SOB

In 1970's, after independence from Pakistan, 1:30,000 scale aerial photography project was carried out by the cooperation of Canada. However, real technical cooperation programs in the fields of surveying and topographic mapping by foreign countries were started from 1990's, after the Government of Bangladesh became stable.

2.2.1 Technical assistance by the government of Japan

The Government of Japan has executed many technical cooperation programs in the fields of surveying and mapping in Bangladesh. It is supposed that the first surveying and mapping work in Bangladesh by the technical cooperation by the Government of Japan was the survey and mapping work for Jamuna Bridge

construction plan in 1970's. After this project, the following technical cooperation programs by the government of Japan were executed.

1) The study on the geodetic survey in the Peoples Republic of Bangladesh (1992～1995)

To establish new geodetic control points network covering 2/3 of whole territory of Bangladesh except southern part, the following works were executed from 1992 to 1995.

1) Establishment of a geodetic control points (GPS points) network,
2) Establishment of a leveling network,
3) Establishment of a tidal observation station,
4) Build up of geodetic datum origin points,
5) Determination of mean sea level and
6) Technology transfer of the above-mentioned work to the staff of SOB.

As a result of this Study, geodetic control points network and leveling network covering approximately 2/3 of whole Bangladesh territory except southern part of Bangladesh were established and a basis of survey and mapping in Bangladesh was brought to realization.

2) The project for supply of cartographic equipment in the People's Republic of Bangladesh (1998～2000)

Due to the reason of old fashioned or broken down of printing machines for topographic map production in SOB, the Government of Japan decided to supply the latest type of printing machines and other necessary equipment for topographic map printing and also to establish the geodetic control point network and leveling network at the remaining area (southern part of Bangladesh).

After the completion of this equipment supply to SOB, the problems such as shortage of topographic maps, poor quality of topographic map printing were solved and also printing skill in SOB was improved. Furthermore, using the supplied survey equipment, geodetic control point network and leveling point network at southern part of Bangladesh was established by SOB.

3) Long-term expert (1999～present)

To utilize the results of above mentioned projects effectively, and also to strengthen the capability of SOB and for the smooth supply of the data and information of topographic maps and survey data to the users, SOB requested long-term experts to the Government of Japan. Based on the request from SOB, the Government of Japan dispatched long-term experts from July 1999 up to present to make technical and administrative support to SOB.

2.2.2 Technical assistance by the other foreign government

From 1997 to 2001, IGN International (France) executed the technical cooperation program to SOB for the

purpose of the following items:

1) Digital topographic map compilation,
2) Analysis of satellite image,
3) Introducing digital photogrammetric mapping system to SOB,
4) Digitalization of the existing topographic maps,
5) Correction of digital topographic maps and
6) Technical training to the staff of SOB.

As the results of this project, 1:50,000 scale satellite image maps covering Dhaka City was produced on a trial basis. Also, 1:20,000 scale Dhaka City Guide Map was produced and published. The experts dispatched from IGN International executed the technology transfer of the above-items during their stay in Bangladesh. This project was completed on February 2000 and the equipment from IGN international was donated to SOB and presently placed under the control of SOB.

However, concerning the digital mapping, the working procedure transferred from IGN International to the staff of SOB was the map-digitizing method (2 dimensional digital data acquisition). The 3 dimensional digital data acquisition using digital photogrammetric method and GIS data creation technique using the digital topographic data were not transferred to the staff of SOB.

2.3 Present Situation of SOB

Necessary information concerning SOB and its surrounding situation was collected to provide the recommendation and suggestion to SOB in the field of survey and mapping. Following is the outline of SOB and its surrounding situation.

2.3.1 Organization

According to the organization chart, total numbers of SOB staffs are 893 persons. However, it is estimated that the total numbers of SOB staffs are 557 persons as of January 2003. It is presumed that the reduction of staffs is caused by the financial condition of SOB.

The Digital Mapping Center that was established by the cooperation of IGN International and is now under the direct control of Surveyor General of SOB. The staffs of digital Mapping Center belong to No.1 Cartography Office of Defense Survey.

2.3.2 Staff

The key persons of SOB are officers of the Ministry of Defense and the major key persons are as follows:

1)	Surveyor General	1 person (Brig general)
2)	Director	2 persons (Major or Lieutenant Colonel)

3) Survey Superintendent 3 persons
4) Assistant Survey Superintendent 4 persons

2.3.3 Budget

The budgets of SOB in last 5 years are shown in Table 2.3.1 "Budgets of SOB in Last 5 Years". Approximately 85 % of the budget is the personnel expense and allowance.

Table 2.3.1 "Budgets of SOB at Last 5 Years"

Item	1998～1999	1999～2000	2000～2001	2001～2002	2002～2003
Personnel expense	48,946,000	52,700,000	53,250,000	55,251,000	56,156,000
Project cost	7,804,000	7,150,000	6,800,000	6,499,000	7,094,000
Maintenance cost	250,000	250,000	250,000	250,000	250,000
Total budget	57,000,000	60,100,000	60,300,000	62,000,000	63,500,000
% of personnel expense	85.87%	87.68%	88.30%	89.11%	88.43%
% of project cost	13.69%	11.89%	11.27%	10.48%	11.17%
% of maintenance cost	0.43%	0.41%	0.41%	0.40%	0.39%

Unit: Taka（1Taka=Approx. 2 Yen）

The percentage of personnel expense is increasing year by year. However, percentage of project cost and maintenance cost is decreasing. Especially, even though the total budget of SOB is increasing year by year, the amount of maintenance cost does not increase. It is presumed that the small amount of maintenance cost is one of the main reasons of imperfect condition of the equipment in SOB.

2.3.4 Training

SOB has sent many technical staffs for the overseas training in foreign countries as follow:

1) IGN International (France)

Photogrammetry	5 persons
Tracing and printing	6 persons
Image processing	3 persons
Total	14 persons

2) Other countries

India (mainly tracing course)	16 persons
ITC (Netherlands)	20 persons
JICA (Japan)	10 persons
Germany (University)	5 persons
Total	51 persons

The duration of overseas training was approximately 28 weeks. Furthermore, several key persons of SOB had overseas training for key personnel in IGN International.

2.3.5 Works of SOB

SOB is executing the geodetic control point survey, leveling survey, topographic mapping and map printing according to the regulation of the Ministry of Defense of Bangladesh. The use of these results is defined on this regulation. Especially, the use of aerial photographs is strictly controlled in Bangladesh.

The works of SOB is summarized as follows:

1) Establishment of geodetic control point network,
2) Execution of ground survey,
3) Production and revision of each scale topographic maps,
4) Determination of national boundary,
5) Production of administrative map and atlas and
6) Execution of aerial photography, and control and custody of aerial film.

2.3.6 Topographic maps published by SOB

The topographic maps published by SOB at 2003 are as shown in Table 2.3.2 “Topographic Maps Published by SOB at 2003”.

Table 2.3.2 “Topographic Maps Published by SOB at 2003”

Kind of map		Area	Sheet	Note
Topographic map	1:25,000	Cittagong	116	Base map, English, The use is Restricted
	1:50,000	Whole territory	267	Base map, English, The use is Restricted.
	1:250,000		27	Base map, English, The use is Restricted.
	1:500,000		6	Base map, English, The use is Restricted.
	1:1,000,000		1	Base map, English, The use is Restricted.
Thematic map	1 inch 16 miles		1	Guide map, English, Open to use
	1 inch 16 miles		1	Guide map, English, Open to use
	1:1,000,000		1	Guide map, English, Open to use
Miscellaneous	1:1,000,000		1	English, Open to use
	1 inch 16 miles		1	English or Bengal, Open to use
	1 inch 32 miles		1	English or Bengal, Open to use
City guide map	1:15,000	Comila, Sylhet, Mymensing, Bogra	4	English or Bengal, Open to use, Other city is under planning
	1:20,000	Dhaka, Cittagong, Rajshahi	3	English, Open to use, Other city is under planning

2.3.7 Aerial photos possessed by SOB

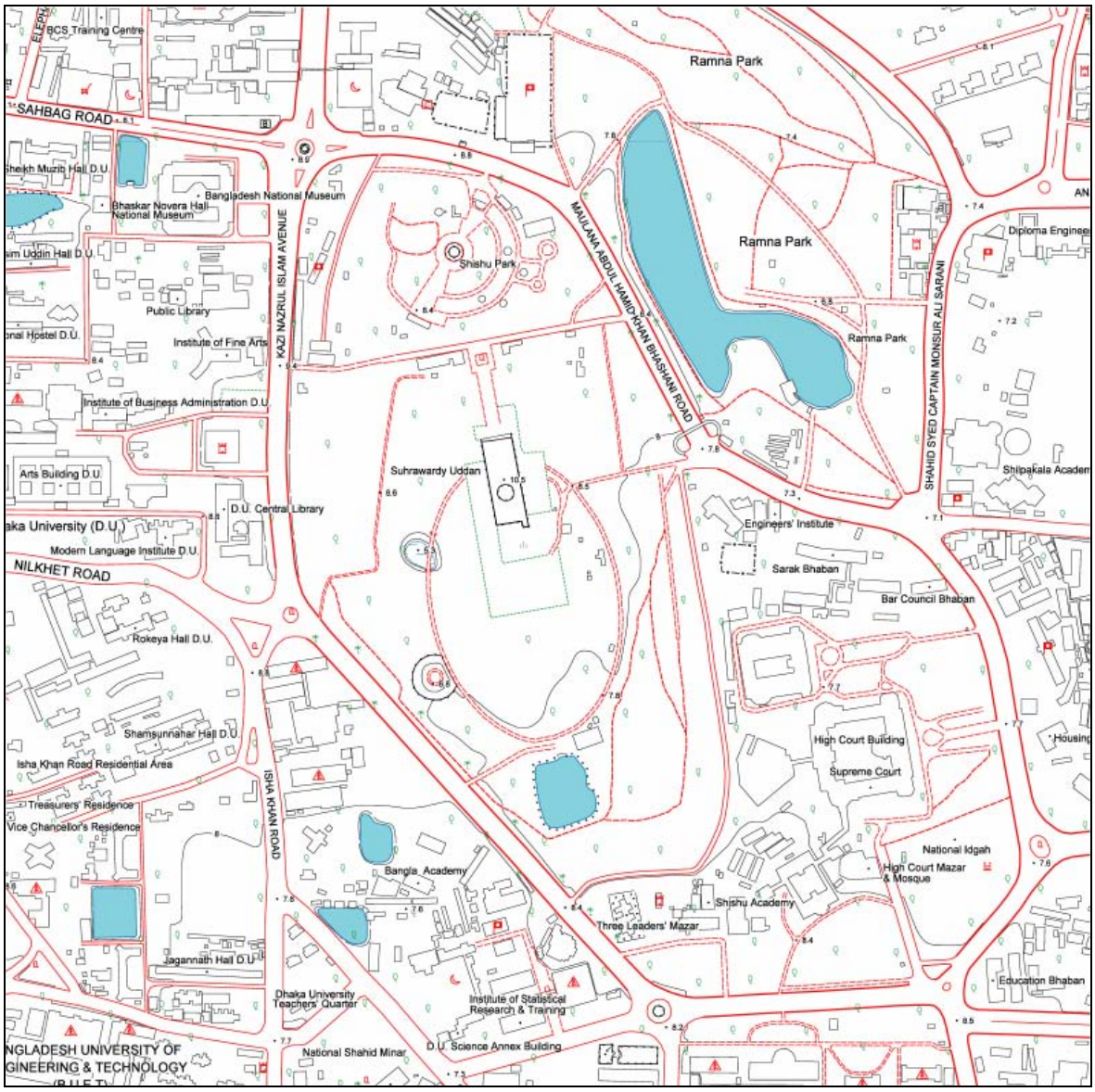
The aerial photographs possessed and kept by SOB at present are shown in Table 2.3.3 “Aerial Photos

Possessed by SOB".

Table 2.3.3 "Aerial Photos Possessed by SOB"

Date	Scale	Material	Area	Purpose
1983～1984	1:50,000	Negative film	Whole territory	Correction of topographic maps
1990	1:30,000	Negative film	Coastal area and along Jamuna River	Flood control
1998～2001	1:25,000	Print	Hole territory	Population census
2003	1:20,000	Negative film	Dhaka metropolitan Area	Topographic mapping

Chapter 3 Discussion with SOB and Other Relevant Organizations



Sample of 1:5,000 scale digital topographic map

Location: Ramna Park

Chapter 3 Discussion with SOB and Other Relevant Organizations

3.1 Inception Report Meeting

3.1.1 Main items explained by the Study team

Several meetings for the explanation and discussion of Draft Inception Report were held between SOB and the Study team. The Study team explained the scope of work, methodology, work schedule and so on to SOB using Draft Inception Report that was prepared in Japan. The key points for the execution of the Study explained by the Study team were as follows:

1) The Study will be implemented mainly by the counterparts of SOB and the members of the Study team will assist the activities of the counterparts of SOB and give the advice to them, if necessary.

2) The most important work of the 1st fieldwork is aerial photography. The aerial photography work always depends on the weather condition and the succeeding work cannot be implemented without the results of the aerial photography. Therefore, the aerial photography has the first priority in the 1st fieldwork.

3) SOB has no experience of 1:5,000 scale digital topographic map production and SOB has not map style and map symbols for 1:5,000 scale digital topographic map. Therefore, it is necessary to create the map style and map symbols for 1:5,000 scale digital topographic maps before starting the actual digital topographic map production.

   The Study team will discuss the map style and map symbols that will be applied to the Study with SOB during the 1st fieldwork in Bangladesh. However, it is difficult to grasp the final image of 1:5,000 scale digital topographic maps without the sample of 1:5,000 scale digital topographic maps.

   Therefore, the Study team will prepare the sample of 1:5,000 scale digital topographic maps using the results of 1st year's Study by the beginning of the 2nd year's Study. Map style and map symbols to be applied for the Study will be discussed and decided between SOB and the Study team based on the sample.

4) The existing data will be used as much as possible for the production of 1:5,000 scale digital topographic maps. Therefore, the necessary data and information of governmental and public buildings and facilities that will be shown on the 1:5,000 scale digital topographic maps will be collected from the authorities concerned and the governmental and public buildings and facilities list will be prepared based on the collected data and information.

   If the governmental and public buildings and facilities are clearly identified on the aerial photographs (orthophoto) using the existing collected data and information, the field check of

these public facilities will not be executed. The actual procedures of field identifications and field completion will be as follows:

- The main purpose of "Field identification (1)" of the 1st fieldwork in Bangladesh is to collect the existing data that can be used for the 1:5,000 scale digital topographic mapping. Also, the necessary information of governmental and public buildings and facilities from the authorities concerned will be collected and the governmental and public buildings and facilities list will be made based on the collected information.

- In "Field identification (2)" of the 2nd fieldwork in Bangladesh, the locations of governmental and public buildings and facilities will be plotted on the four times enlarged photographs (1:5,000 scale orthophoto) based on the collected data and information. The data plotted on 1:5,000 scale orthophoto will be used at the time of digital data acquisition using digital plotter and plotted out topographic maps (manuscript) will be used at the time of field identification (3) of the 4th fieldwork in Bangladesh.

- In "Field identification (3)" of the 4th fieldwork in Bangladesh, using the plotted out 1:5,000 scale topographic maps (manuscript), the field check of the remaining public facilities and ambiguous points encountered through the execution of digital plotting and digital compilation will be executed. Based on the results of field check, final governmental and public buildings and facilities list will be prepared and digital topographic data will be corrected.

5) The 1:20,000 scale aerial photography area and 1:5,000 scale digital topographic mapping area are not clear on the map attached to the Scope of Work. Therefore, The Study team requested SOB to make clear the boundary of 1:20,000 scale aerial photography area and 1:5,000 scale digital topographic mapping area as soon as possible on the 1:50,000 scale topographic maps.

6) The Study team requested SOB to make arrangement for implementation of masking of Key Point Installation on positive films, and to obtain permission of bringing the positive films from Bangladesh to Japan for the production of 1:5,000 scale digital topographic maps in Japan.

3.1.2 Question and request from SOB

On the Inception Report meeting, the questions, requests and explanation concerning the Inception Report form SOB were as follows:

Item 1

The area of 1:20,000 scale aerial photography and 1:5,000 scale topographic mapping will be plotted and informed to the Study team as soon as possible.

Item 2

Concerning the equipment that will be used for technology transfer to the counterparts of SOB in Bangladesh, SOB requests the Study team the smooth procurement of equipment, and also to consider the maintenance of equipment in Bangladesh.

Item 3

SOB requests the Study team to execute the technology transfer in Japan for the items not including in the technology transfer program (ex. aerial triangulation and so on) in Bangladesh. SOB requests 3 persons for technology transfer program in Japan, if possible.

Item 4

SOB wants to establish concrete monuments for new GPS points.

Item 5

SOB requests the Study team to supply the necessary materials, chemicals and papers for 1:5,000 scale topographic map printing in Bangladesh that will be executed on the 3rd year's Study.

Item 6

The Key Point Installation (restricted area for topographic mapping) will be eliminated from the area of field identification and field completion. Also, masking on the positive films for the Key Point Installation will be executed immediately after the completion of aerial photography.

Therefore, there will be no obstruction for the production of 1:5,000 scale digital topographic mapping as well as the public use of the final products of the Study. The estimated period necessary for the masking on the positive films will be approximately 3 - 4 days.

Surveyor General of SOB has the power to issue the permission of bring out the positive films from Bangladesh to Japan.

Item 7

The direction of flight that is shown on the Inception Report is east - west. However, the direction of main roads in Dhaka City is mostly north - south. In case the direction of flight of aerial photography is east - west, the tall buildings on the photographs may hide some part of main roads. Therefore, SOB requests the Study team to change the direction of flight from the east - west to the north - south.

Item 8

Concerning the size of air photo signals, SOB requests the Study team to follow the standard of ITC manual.

Item 9

Concerning the quality of negative film, SOB requests the Study team to follow the standard of ITC manual.

3.1.3 Explanation and answer by the Study team

The explanation and answer to the questions and requests from SOB by the Study team were as follows:

Item 1

Considering the weather condition, the Study team wants to start aerial photography as soon as possible. Therefore, the Study team requests SOB to decide the boundary of aerial photography area and 1:5,000 scale digital topographic mapping area as soon as possible. Without these information final flight plan for aerial photography cannot be decided.

Item 2

The Study team is not in a position to make a comment to Item 2. The Study team will convey the request of SOB to the Head Office of JICA in Tokyo.

Item 3

The Study team is not in a position to make a comment to Item 3. The Study team will convey the request of SOB to the Head Office of JICA in Tokyo.

Item 4

If SOB wants to establish the concrete monuments on the GPS points, the Study team will supply the necessary materials for concrete monuments. Unfortunately, the Study team has not enough members and time for the establishment of concrete monuments. Therefore, the Study team requests SOB to execute establishment of concrete monuments by SOB members.

Item 5

The Study team is not in a position to make a comment to Item 5. The Study team will convey the request of SOB to the Head Office of JICA in Tokyo.

Item 6

The Study team requests SOB to execute the masking on the positive films immediately after the completion of aerial photography.

Item 7

The photo scale is 1:20,000. Therefore, the flight altitude is 3,000 m. Considering the heights of the buildings in Dhaka City, the buildings except some tall buildings may not hide the roads. Generally, the flight directions of aerial photography will be set up on east - west except special cases such as the aerial photography along the transmission line, pipe line, highway and so on.

Also, in case aerial photographs of north - south direction were used for digital topographic mapping, an operator of digital mapping may feel some difficulties for photo interpretation at the time of data acquisition due to the reason of the direction of the shadow.

However, in case of larger-scale aerial photography, it is necessary to consider the percentage of over-lapping or direction of flight.

Item 8

There is no problem concerning Item 8. The Study team request SOB to show the size of air photo signals.

Item 9

It is considered that the quality of negative films development specified in the ITC manual can be applied in the case of the best weather condition for aerial photography. However, considering the present weather condition such as the dust in the daytime and the fog in the morning at Dhaka City, the weather condition for aerial photography is far from the best condition.

The quality of aerial photographs mostly depends on the weather condition at the time of the execution of aerial photography. The Study team will try to do the best efforts to get the high quality aerial photos as much as possible. However, it is impossible to commit to fulfill the specifications for quality of aerial photographs specified in the manual of ITC. The key point for judgment of the quality of aerial photographs is whether aerial photographs can be used for digital photogrammetric mapping or not.

The weather is fine. However, due to the dust, the visibility over Dhaka City is very limited and weather condition is not suitable for aerial photography.

Photo 3.1.1 “Weather Condition at Dhaka City”

3.1.4 Minute of meeting for inception report meeting

Before signing the Minutes of Meeting for Inception Report, the Study team explained the contents of Inception Report to the Secretary of the Ministry of Defense. After several discussion of Inception Report meeting, Minute of Meeting for Inception Report was prepared, and signed by the representatives of Economic Relation Division of the Ministry of Finance, Survey of Bangladesh and the Study team.

3.2 Progress Report Meeting

Meeting for the explanation and discussion of Progress Report were held between SOB and the Study team on 20 May 2003. The Study team explained the outline of the results of the 1st year's Study, and also the plan of the 2nd year's Study including technology transfer.

3.2.1 Discussion of progress report

The main items discussed between SOB and the Study team was as follows:

Item 1

The Study team requested SOB to prepare the adequate space with electricity and air conditioner for the equipment that will be procured by JICA. SOB explained that SOB was already considering the room space and related facilities such as air conditioner, power supply system and so on for the equipment.

Item 2

SOB expressed that the printing of 122 sheets of the 1:5,000 scale topographic maps of the Study will take long time because SOB has routine printing work and printing works for other projects of SOB. Therefore, it is considered that the printing of the 122 sheets topographic maps will not be completed by July 2004 as the printing of large number of sheets like this usually takes 6 to 8 months in normal working schedule. The Study team promised to convey SOB's anxiety to the JICA Head Office in Tokyo.

Item 3

The Study team requested SOB to collect the necessary data of administrative boundaries and to draw the administrative boundaries on the manuscript of 1:5,000 scale topographic plotted out maps at the 4th field work in Bangladesh and SOB agreed it.

Item 4

SOB requested JICA to supply cartographic and photogrammetric equipment or software compatible to the existing equipment presently used by SOB. The Study team agreed to convey the request of SOB to the JICA Head Office in Tokyo.

3.2.2 Minute of meting for progress report meeting

Minute of Meeting on Progress Report was prepared and signed between SOB and the Study team on 21 May 2003.

3.3 Interim Report Meeting

Meeting for the explanation and discussion of Interim Report was held between SOB and the Study team on 7 October 2003.

3.3.1 Discussion of interim report

The main items discussed between SOB and the Study team were as follows:

Item 1

SOB requested the Study team to deliver the proof prints of 1:5,000 scale topographic maps for checking by SOB before preparing PS plate and SOB explained that it would take about one month for checking by SOB.

The Study team explained SOB that it would be difficult to execute this checking by SOB from the viewpoint of the Study schedule agreed by SOB and JICA on Scope of Work. Therefore, the Study team requested SOB that checking by SOB would be executed using the plotted out manuscript prepared by the Study team for field identification (3) and SOB agreed to it.

Item 2

SOB suggested that equipment to be procured by JICA should be purchased from the local companies in Bangladesh from the viewpoint of maintenance and supply of spare parts.

The Study team explained that Digital Plotting System (SocetSet) would be directly procured from U.S.A. due to the termination of sales agreement between maker of SocetSet and the sales agent. Therefore, it is impossible to procure through a local company in Bangladesh. However, other equipment will be procured through local companies in Bangladesh. SOB accepted the explanation by the Study team.

Item 3

SOB explained that it would take a long time for printing of 1:5,000 scale topographic maps by SOB due to the reason of volume of printing work of the Study and also the SOB routine work and SOB would not be able to complete the printing by the end of the Study.

The Study team understood the situation of SOB concerning the printing by SOB. However, the Study team requested SOB to execute printing work as fast as possible.

Item 4

Concerning the coordinates to be shown on the 1:5,000 scale topographic maps requested by SOB, SOB and the Study team agreed to put the Longitude and Latitude on the 1:5,000 scale digital topographic maps instead of metric coordinates from the viewpoint of public use of the final products of the Study (refer to Item 3.8).

Item 5

Concerning the copyright of 1:5,000 scale digital topographic maps requested by SOB, the Study team explained the official comments of the JICA Head Office in Tokyo to SOB.

SOB explained that SOB is not in a position to decide the some comment of the JICA Head Office in Tokyo. Therefore, SOB also explained that this matter will be discussed with the Government of Bangladesh and the official answer will be informed to the Study team after discussion with the Government (refer to Item 3.9).

3.3.2 Minute of meeting for interim report meeting

Minute of Meeting on Interim Report was prepared and signed between SOB and the Study team on 8 October 2003.

3.4 Draft Final Report Meeting

3.4.1 Comments on draft final report

Draft final report was submitted to SOB from the Study team at the beginning of the fieldwork of 3rd year's Study. The Study team requested to SOB to give the comments on Draft Final Report to the Study team by the end of the fieldwork of 3rd year's Study. Finally, SOB gave their comments on Draft Final Report to the Study team on 28 July 2004.

3.4.2 Minutes of meeting on draft final report

Minutes of meeting on Draft Final Report was prepared and signed between SOB and the Study team on 29 July 2004.

3.5 Discussion of 1:5,000 Scale Topographic Map Sheet Plan

1:50,000 scale orthophoto images with BTM coordinates were produced from the scanned aerial photo images and coordinates of principal points of aerial photographs that were obtained by GPS aerial photography. The 1:5,000 scale digital topographic mapping area shown on the 1:50,000 scale topographic maps by SOB was transferred to 1:50,000 scale orthophoto image. The 1:5,000 scale digital topographic map sheet plan was made using this 1:50,000 scale orthophoto images with BTM coordinates under the following conditions.

1) The size of map sheet for 1:5,000 scale digital topographic maps shall be A-1.
2) The map sheet shall be used as lengthwise.
3) Inner size shall be 50 cm × 60 cm.
4) The coordinates system shall be BTM
5) The numbering system of topographic maps will be 1,2,3…. from left top to right down temporarily.
6) Map information shall be at the left down and map symbols shall be at the center and right down of map sheet.

The total number of 1:5,000 scale digital topographic maps is 122 sheets. The sheet index plan shown in

Figure 3.5.1 "1:5,000 Scale Digital Topographic Map Sheet Index (for work)" was agreed between SOB and the Study team.

For the implementation of the actual work such as field identification, digital topographic mapping and so on, it is necessary to put the number to each sheet. Therefore, SOB and the Study team agreed that the numbering system of topographic maps was 1,2,3… from left top to right down temporarily. Final numbering of digital topographic maps was decided between SOB and the Study team as shown in Figure 3.5.2 "Final 1:5,000 Scale Digital Topographic Map Sheet Plan and Sheet Number" considering the remaining area of 1:5,000 scale digital topographic mapping.

3.6 Discussion of Map Style and Map Symbols

Up to present, SOB has no experience of 1:5,000 scale digital topographic mapping. Therefore, it is necessary to prepare map style and map symbols to be used for 1:5,000 scale digital topographic maps through the discussion with SOB before starting the actual work of 1:5,000 scale digital topographic maps production.

As already explained in the Inception Report meeting, it is difficult to define the map style and map symbols perfectly at the 1st fieldwork in Bangladesh. It is also difficult to grasp the final image of 1:5,000 scale digital topographic maps without any sample.

Furthermore, new findings concerning topographic features may arise through the execution of actual work such as field identification and digital topographic mapping. Therefore, the Study team explained to SOB the procedures to decide the map style and map symbols as follows:

1) On the 1st fieldwork in Bangladesh (from the end of November 2002 to the middle of March 2003), "Map Style and Map Symbols for 1:5,000 Scale Digital Topographic Maps (Version 1.0)" will be prepared through the discussion between SOB and the Study team based on the existing 1:50,000 scale topographic maps and 1:20,000 scale Dhaka Guide Maps presently SOB publishing.

2) On the 1st office work in Japan (from the beginning of May 2003 to the end of May 2003), sample sheets of 1:5,000 scale digital topographic maps will be prepared based on "Map Style and Map Symbols for 1:5,000 Scale Digital Topographic Maps (Version 1.0)". Sample sheets of 1:5,000 scale digital topographic map will be prepared both in center and suburb areas of Dhaka City because the features of the 1:5,000 scale digital topographic maps may be completely different.

3) "Map Style and Map Symbols for 1:5,000 Scale Digital Topographic Maps (Version 1.0)" will be modified and revised based on the new findings through the preparation of sample sheets of the 1:5,000 scale digital topographic maps.

4) On the 2nd field work in Bangladesh (form the middle of May 2003 to the end of June 2003), “Map

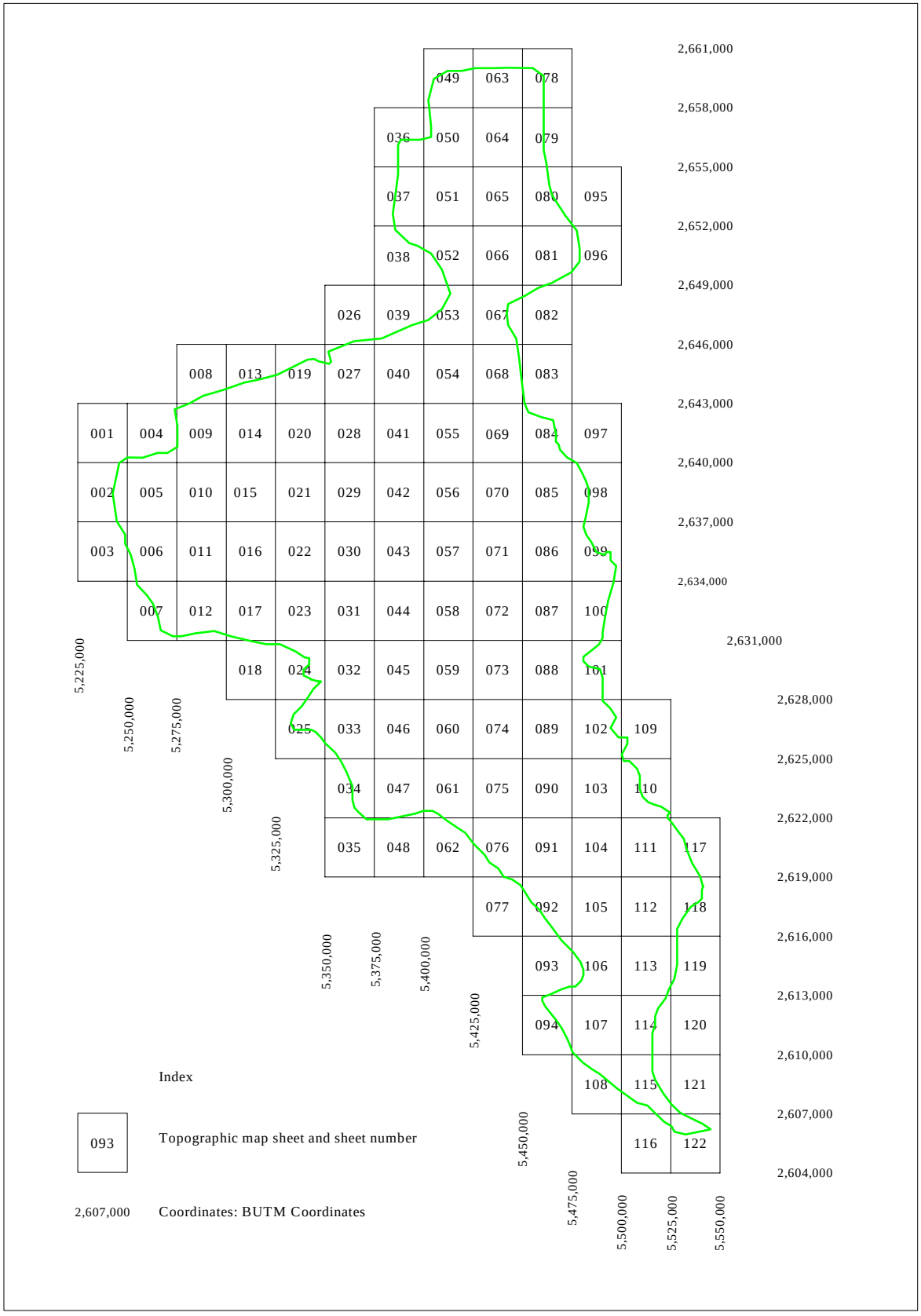


Figure 3.5.1 "1:5,000 Scale Topographic Map Sheet Index (for Working)"

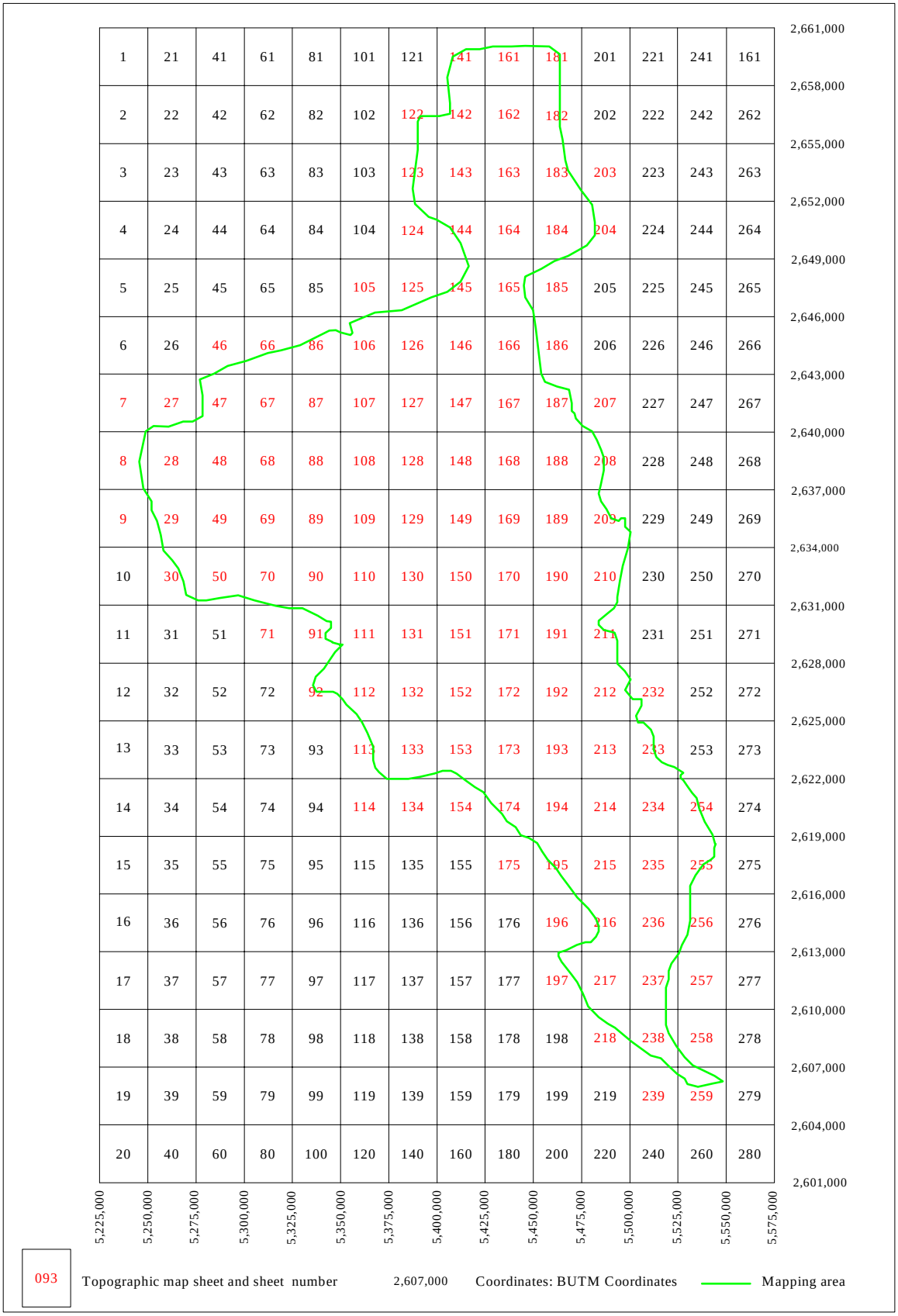


Figure 3.5.2 "Final 1:5,000 Scale Topographic Map Sheet Index and Sheet Number"

Style and Map Symbols for 1:5,000 Scale Digital Topographic Maps (Version 2.0)" will be made through the discussion between SOB and the Study team based on the new findings at the time of sample sheet making.

5) The 1:5,000 scale digital topographic mapping covering 581 km^2 will be executed based on this map style and map symbols (Version 2.0). In case some modification of Version 2.0 is necessary, discussion between SOB and the Study team will be held on the 4th fieldwork in Bangladesh (from the beginning of October 2003 to the beginning of March 2004), and "Map Style and Map Symbols for 1:5,000 Scale Digital Topographic Maps (Version 3.0)" will be prepared.

6) Finally, the 1:5,000 scale digital topographic maps will be produced based on "Map Style and Map Symbols for 1:5,000 Scale Digital Topographic Maps (Version 3.0)".

The key points of discussion concerning the map style and map symbols for 1:5,000 scale digital topographic maps between SOB and the Study team were as follows:

1) SOB has no experience of production of large to medium scale digital topographic maps. Therefore, the staff of SOB could not grasp the actual image of 1:5,000 scale topographic maps to be produced by the Study.

2) Especially, the staffs of SOB did not understand the characteristics of topographic maps by the scales. For example, small-scale topographic maps are the compiled maps. However, topographic features of large to medium scale topographic maps are shown at the true positions with truly scaled sizes as much as possible.

3) At first, SOB requested the Study team to apply the map style and map symbols of 1:50,000 scale topographic maps and 1:20,000 scale Dhaka City Guide Map directly for 1:5,000 scale digital topographic maps to be produced by the Study.

4) Concerning the colors in 1:5,000 scale digital topographic maps in the Study, at first, SOB requested the Study team as follows:

   - Yellow color (fill) for vegetation
   - Red color (fill) for main roads
   - Red color (line) for buildings and houses
   - Blue color (fill) for water areas such as rivers, lakes and ponds

   However, the Study team explained that the color fill technique usually does not apply to the medium to large-scale topographic map. Instead of color fill technique, the differences of topographic features will be expressed by the color of line, line width and kind of line in the

medium to large-scale topographic maps.

Furthermore, due to the reason of the scale of topographic maps to be produced by the Study, the covering area by one topographic map sheet is small comparing with small scale topographic map such as 1:50,000 scale topographic map. Therefore, the color image of 1:5,000 scale topographic maps to be produced by the Study will become as follows:

- In the countryside, yellow color (fill) of vegetation will be outstanding.
- In the city area, the read color of road (fill) and building and house (line) will be outstanding.

Finally, SOB and the Study team agreed that blue color (fill) would be applied for water areas such as rivers, lakes and ponds considering the most important topographic features in the Study area.

5) SOB also requested that red color would apply to not only for road line but also for the line of building and house. However, due to the same reason of above item 4), SOB and the Study team finally agreed that red color will apply to the road line and black color will apply to the building and house line.

The discussion between SOB and the Study team were held by showing the visible samples, which enable them to grasp the final image of 1:5,000 scale topographic maps to be produced by the Study team as much as possible.

3.7 Discussion of GIS Basic Data

Discussion of the GIS basic data was held between SOB and the Study team to define the contents of the GIS basic data.

3.7.1 What is GIS basic data?

The GIS basic data is data that compose spatial data infrastructure produced by the data acquired in the digital topographic mapping. Quality and contents of GIS data depend on the purpose of the use and user's demand for GIS, and its attribute is different among users.

There are various kinds of user's needs for the GIS basic data. It is impossible to correspond to the needs of all users by the data acquired at the stage of digital topographic mapping. Therefore, the GIS basic data will be limited to the common items and be supposed to be spatial data infrastructure.

GIS users have to construct their own GIS for their own purpose by using the GIS basic data that will be supplied from SOB. So the GIS users have to collect the necessary data and information for their own purpose by themselves when they construct the GIS. The relation between SOB and the GIS users is shown in Figure 3.7.1 "Relation between SOB and GIS Users".

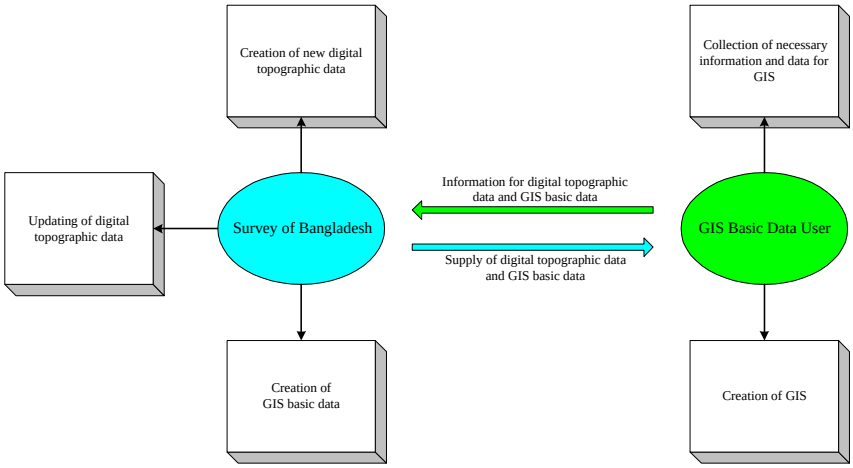


Figure 3.7.1 "Relation between SOB and GIS Users"

3.7.2 Contents of the GIS basic data in the Study

The data and information necessary for the production of digital topographic mapping and construction of the GIS are not same. In general, the data classification of topographic mapping in Japan is defined as shown in Table 3.6.1 "Standard Category of Topographic Data in Japan".

Table 3.7.1 "Standard Category of Topographic Data in Japan"

No.	Category	Sub-category	Contents
1	Boundary	Boundary	National boundary, Administrative boundary
		Other boundary	
2	Traffic facility	Road	
		Road facility	Tunnel for road, Overhead walkway, Traffic strip, etc.
		Railway	
		Railway facilities	Tunnel for railway, Platform, etc.
3	Building, etc.	Building	
		Building appurtenant	Gate, Gateway, etc.
		Symbol of building	Public facilities such as government office, school and etc.
4	Small objects	Landmark	Monument, Isolated tree, Tower, Pipe line, Electric transmission line, etc.
5	Water and water Area	Water area	Shore line, River, Wadi, etc.
		Water facility	Jetty, Break water, Dam, Waterfall, Watergate, etc.
6	Fence, etc.	Fence, etc	Artificial slope, Embankment, Fence, etc.
7	Open area	Open area	Territory boundary, parking, Garden, Grave, etc.
8	Vegetation	Vegetation	
9	Topography, and control points	Contour line	
		Distorted surface Area	Bare rock, Coral reef, etc.
		Control point	Triangulation point, Benchmark, GPS point, etc.

However, the data category of GIS will totally depend on the purpose of GIS when the users want to construct the GIS.

As already mentioned above, the GIS basic data will be produced using the data and information collected from the digital topographic mapping. The data limited to common items among the users will be structuralized as the GIS basic data.

However, GIS users in Bangladesh collected the data and information by themselves without any relationship with other organizations and also defined the contents of data individually. Therefore, presently it is difficult to share the data and information among the GIS users in Bangladesh.

Considering the above-mentioned matters, the Study team decided the data category of the GIS basic data and proposed to SOB it as shown in Figure 3.7.2 "Category of GIS Basic Data in the Study "

Table 3.7.2 "Category of GIS Basic Data in the Study"

No.	Category	Sub-category	Contents
1	Boundary	Administrative boundary	District, Upazilla, Wards
2	Road	Main double line road	
		Bridge of main double line road	Except masked bridge
3	Railway	Railway	
		Bridge on railway	Except masked ridge
		Station	
4	Public facility	Public building	Building with symbol or text
		Open space for public use	Park, Cemetery, etc.
		Open space for traffic, etc	Bus terminal, Airport, etc.
5	Water area	Double line river	
		Single line river	
		Lake, pond, dam	
		Canal	

3.7.3 Systematizing and definition of geographic features in the GIS basic data

To utilize the acquired data in the digital topographic mapping to GIS basic data production, it is necessary to define the quality and the contents of geographic features, and linkage between digital topographic data and the GIS basic data have to be established.

The relation between the digital topographic data defined by "Map Style and Map Symbols for 1:5,000 Scale Topographic Mapping (version 2.0)" and "Category of GIS Data" shown in Table 3.7.2 above are summarized as shown in Figure 3.7.2 "Relation between the Digital Topographic Data and the GIS Basic Data in the Study".

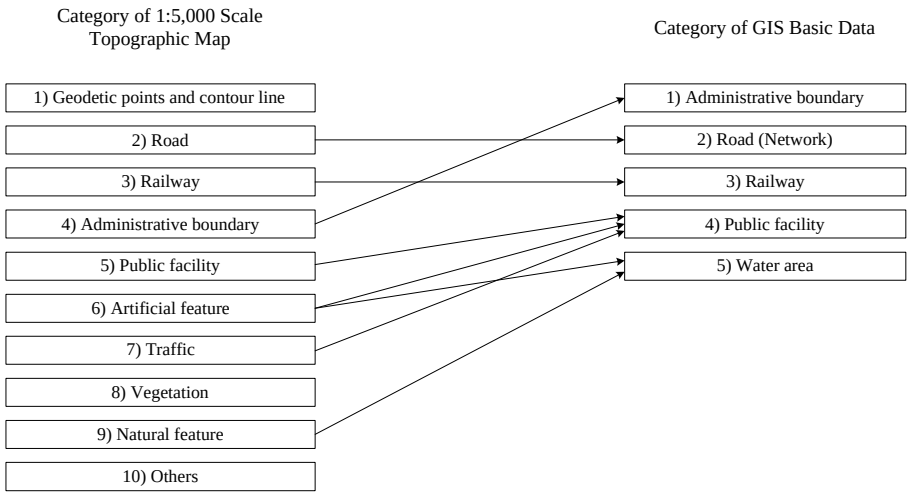


Figure 3.7.2 “Relation between the Digital Topographic Data and GIS Basic Data in the Study”

The category of GIS basic data and data types to be produced by the Study is shown in Table 3.7.3 “Data Types of the GIS Basic Data in the Study”.

Table 3.7.3 “Data Types of GIS Basic Data in the Study”

Contents of GIS Basic Data	Location of Data Acquisition	Data Type
1. Administrative boundary (Upazilla and Wards)	Administrative area	Polygon
2. Road		
Main 2 lines road	Road network*	Line
Bridge for main 2 lines road except masked bridge	Center of facility**	Point
3. Railway		
Railway line	Railway network*	Line
Bridge	Center of facility**	Point
Station	Center of facility**	Point
4. Public facility		
Building of public facility	Center of facility**	Point
Area for public use	Center of facility**	Point
Traffic site, water management facility, etc.	Center of facility**	Point
5. Water and water area		
2 lines river	Water area of 2 lines river	Polygon
1 line river	Line of river	Line
Lake, pond, dam	Area of lake, pond, dam	Polygon
Irrigation/drainage canal	Line of canal	Line

Note: *and **: means the additional data acquisition by the digital topographic mapping.

*: Network is defined as a line data of the centerline in the road with double line; Railway is defined as same definition.

**: The point is representing the center of the facility.

3.8 Coordinates on the Border of 1:5,000 Scale Digital Topographic Maps

At the time of the discussion of map style and map symbols in the 2nd fieldwork in Bangladesh (from the middle of May 2003 to the end of June 2003), SOB made the following comments concerning the coordinates values to be shown on the border of the 1:5,000 scale digital topographic maps.

1) According to the regulation in Bangladesh, it is impossible to open the topographic maps with grids and coordinates in metric system for public use. Therefore, SOB requests the Study team to show the Longitude and Latitude values on 1:5,000 scale topographic maps instead of metric coordinates of BUTM.

The Study team explained to SOB that this matter cannot be decided by the Study team only. Therefore, the study team decided to discuss this matter with the JICA Head Office in Tokyo and official comment concerning this matter will be decided by the beginning of the 4th fieldwork in Bangladesh (from the beginning of October 2003 to the beginning of march 2004).
The most important thing for the Study is the final products such as printed 1:5,000 scale topographic maps, digital topographic map data and GIS basic data can be used effectively by the many Bangladesh organizations as much as possible. Due to the reason of the regulation in Bangladesh, metric coordinates and grids are obstacles to opening the data for public use, therefore, JICA will agree to show the Latitude and Longitude values on the 1:5,000 scale topographic maps instead of metric coordinates of BTM.

The Study team explained the JICA's official comment for this matter to SOB in the Interim Report meeting held at the beginning to the 4th fieldwork and both parties agreed that the Longitude and Latitude values will be shown on the 1:5,000 scale topographic maps to be produced by the Study.

3.9 Copyright Sentence on the Marginal Information of 1:5,000 Scale Digital Topographic Maps and Agreement of Copyright

3.9.1 Copyright sentence on the marginal information of 1:5,000 scale digital topographic maps

At the time of discussion of map style and map symbols for 1:5,000 scale topographic maps in the 2nd fieldwork (from the middle of may 2003 to the end of June 2003), SOB expressed the following comment concerning the copyright of the 1:5,000 scale digital topographic maps to be produced by the Study.

1) SOB wants to put the sentence concerning the copyright to forbid any unauthorized copying to the 1:5,000 scale digital topographic maps to be produced by the Study.

2) The sentence concerning the copyright will be as follows:

GOVERNMENT OF BANGLADESH
COPYRIGHT RESERVED
It is an offence under the Copyright Act to make and issue any copy or copies of this map or any part of this map, with or without alteration and addition, unless the prior written permission of the Surveyor General of Bangladesh has been obtained.

The Study team explained that the Study team is not in a position to comment this matter. Therefore, the Study team promised that the request of SOB will be conveyed to the JICA Head Office in Tokyo and the official answer of JICA Head Office in Tokyo will be brought to SOB by the beginning of 4th fieldwork in Bangladesh (from the beginning of October 2003 to the beginning of March 2004).

The Study team explained the official answer of the JICA Head Office in Tokyo concerning this matter to SOB at the time of Interim report meeting.

1) Both SOB and JICA keep the copyright of the final results of the Study.

2) JICA agreed copyright sentence would be put to the footnote of 1:5,000 scale digital topographic maps.

3) In case JICA wants to use the final products of the Study for Japanese ODA (Official Development Assistance) programs, SOB will agree that the JICA and/or JICA Study team can use the final products with prior notice to SOB from JICA for the execution of the program without any charge.

4) In case SOB wants to revise the contents of the final products of the Study, SOB can revise without a notice to JICA.

5) An agreement concerning copyright will be made between SOB and JICA before completion of the Study.

SOB explained that SOB is not in a position to decide this matter by himself. SOB also explained that this matter will be discussed with the Government of Bangladesh and the official answer will be informed to JICA study team after discussion with the Government.

On 1 November 2003, an official answer from the Ministry of Defense was delivered to the Study team from SOB by letter.

3.9.2 Agreement on copyright

Based on the discussion between SOB and the Study team as mentioned above, agreement on copyright was prepared and signed between SOB and the Study team on 29 July 2004.

3.10 Alteration of 1:5,000 Scale Digital Topographic Mapping Area and Aerial Photography Area

The Study Team started the preparation work for aerial photography based on the information shown in the Scope of Work. On 28 December 2002, SOB made the request of alteration for aerial photography area and 1:5,000 scale digital topographic mapping area to the Study team. The reasons of this alteration of aerial photography area and digital topographic mapping area by SOB were as follows:

1) The opposite side of Dhaka City (right bank area of Urhi Ganga River) is flat and swampy area, and less developed area comparing with the left bank area. Therefore, the necessity of 1:5,000 scale digital topographic maps is low at present.

2) The northern part of the originally defined 1:5,000 scale topographic mapping area is rapidly developing area in recent years. Therefore, the necessity of 1:5,000 scale digital topographic maps is very high.

3) Revision of the 1:5,000 scale digital topographic mapping area was decided through the discussion with the authorities concerned.

According to the request from the SOB, the Study team prepared the new flight plan for 1:20,000 scale aerial photography, and found that the total number of aerial photos and aerial photography area were not changed from the original plan. Therefore, the Study team agreed to change 1:20,000 scale aerial photography area and 1:5,000 scale digital topographic mapping area.

The above-mentioned situation occurred from 28 December 2002 to 2nd January 2003. The year-end and New Year holiday season had already started in Japan and JICA Bangladesh office was also closed. Therefore, the alteration of 1:20,000 scale aerial photography area and 1:5,000 scale digital topographic mapping area requested from SOB was agreed by the judgment of the team leader of the Study team. The approval of JICA concerning this alteration was obtained after New Year holiday.

3.11 Meeting with Relevant Organizations Concerning Administrative Boundaries

The small-scale topographic map is a compiled map and the topographic features are not shown at the real positions. However, in case of medium to large-scale topographic map, the topographic features are shown at the real positions by really scaled sizes as much as possible. Therefore, special attention will be necessary to show the information of administrative boundaries on the medium to large-scale topographic maps.

Basically, the information concerning the administrative boundaries, administrative names, road names will not be collected in the site. This information shall be collected from the relevant organizations and the information will be shown on the topographic maps. Especially, in case the administrative names and/or area names are in local language and these names are transliterated into English and shown on the

topographic maps, the English spelling of administrative names and/or area names shall be same as the name decided by the authorities in charge.

In case of medium to large-scale topographic maps the accurate administrative boundary is necessary, because the topographic features are shown in really scaled sizes and at real positions as much as possible. Therefore, inaccurate administrative boundary may cause the troubles between the organizations and/or residents. To draw the administrative boundary on the medium to large-scale topographic maps, the close cooperation between the relevant organizations is really needed and joint fieldwork by the relevant organizations is also necessary.

The meeting with relevant organizations to discuss the administrative boundary was held at SOB. The purpose, attendants and items discussed and so on are shown Clause 3.10.1 “Meeting with relevant organizations”.

3.11.1 Meeting with relevant organizations

The outline of the meeting with the relevant organizations concerning the administrative boundaries was as follows:

1) Date: 8 December 2003, from 11:15 AM to 13:00 PM
2) Location: Conference Room of SOB

3) Attendant:

Maj. Khandaker Aftab Hossain	Director, SOB
Md. Nurul Islam	Assistant Supdt. of Survey, SOB
Mr. Nazmul Ahasan Choudhury	DPCO, Survey of Bangladesh
Mr. Md. Asaduzzaman	Research Officer, DCC
Mr. Md. Abdul Quaser	A.D.S. DLRS
Mr. Munir Siddiquee	Assistant Engineer, GIS, LGED
Mr. Gazi Md. Mozammel Hoque	Sr. Assistant Police Commissioner (Estate) D.M.P Dhaka
Mr. A.S.M. Quamruzzaman	Cartographer (S.O), BBS
Mr. Md. Abul Kalam	PSO, SPARRSO
Mr. Md. Atiar Rahman	PSO, SPARRSO
Mr. Toru Watanabe	Team Leader, JICA Study Team
Mr. Nobuhiro Sata	JICA Study Team
Mr. Yoshiaki Hirota	JICA Study Team
Mr. Shinji Takazawa	JICA Expert

4) Items of discussion
   - What kind of administrative boundary data will be necessary for the governmental organization in Bangladesh.

■Does the organizations have the data and information to be able to show the administrative boundaries on the 1:5,000 scale digital topographic maps or not?

■In case of no data and information to be able to show the administrative boundaries on the 1:5.000 scale digital topographic maps exist, what methodology will be suitable for this purpose?

5) Conclusion

■Unfortunately, there are no accurate data and information to be able to show the administrative boundaries on the 1:5,000 scale digital topographic maps.

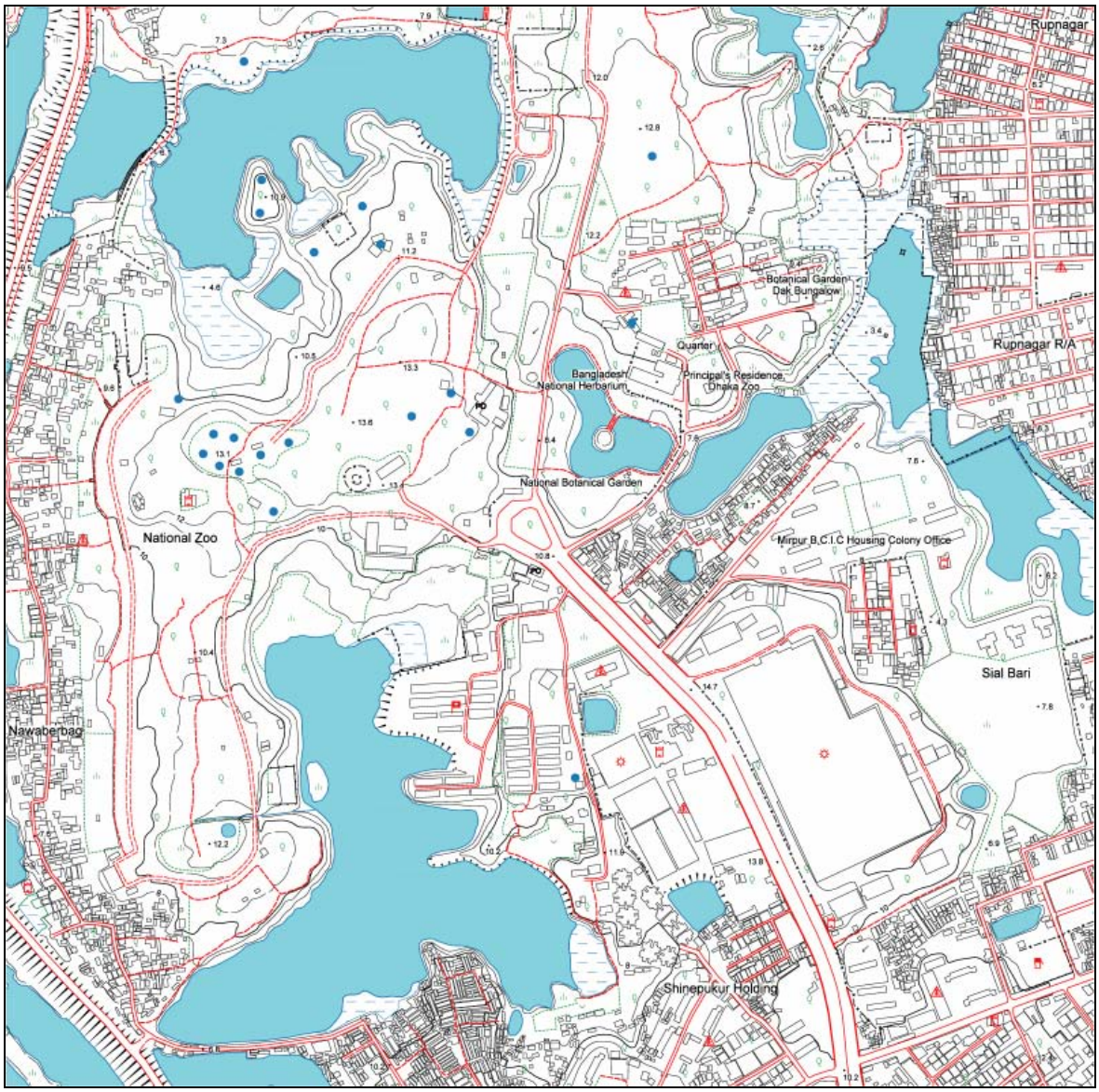
■DCC is now preparing ward maps and as of at this present (December 2003), 33 ward maps (approximately 1/3 of total number of wards) are completed. DCC considers that this ward map can be used to show the administrative boundaries on the 1:5,000 scale digital topographic maps.

■It is considered that inaccurate administrative boundaries may cause troubles. Therefore, the administrative boundary will not be shown on the 1:5,000 scale digital topographic maps in the Study.

■However, the administrative boundary is an essential data and information for any governmental organization. Therefore, further discussion concerning the methodology of this work will be held among the governmental organizations including SOB.

■As the first step, the administrative boundaries will be plotted on 1:5,000 scale digital topographic map using ward maps. Then, suitability of this methodology will be judged and further discussion between relevant organizations will be held based on this results.

Chapter 4 Interview Survey



Sample of 1:5,000 scale digital topographic map

Location: National Zoo

Chapter 4 Interview Survey

4.1 Purpose of Interview Survey

The purpose of the interview survey is to grasp the present situation of the organizations in Bangladesh from the viewpoint of utilization of digital topographic data and GIS, and also to collect the future plan of authorities concerning utilization of digital topographic data and GIS.

4.2 Results of SOB's Inquiry Survey

SOB has executed inquiry survey to the authorities in Bangladesh concerning the utilization of digital topographic data and GIS in February and August 2000. Many organizations were not responded to SOB's inquiry survey. The main reason of no response to SOB's inquiry survey can be the lack of interest due to the reason of insufficient equipment such as computer, GIS software and also GIS engineers in the organization. However, the organizations responded to the SOB's inquiry survey are actively utilizing digital topographic data and GIS system and the level of GIS technique is higher than the non-response organizations.

4.3 Interview Survey on Users of Digital Topographic Data and GIS Basic Data

To grasp the present situation of the organization using digital topographic data and GIS, interview survey has been executed by the Study team with the cooperation of counterparts of SOB. Following information was collected through the interview survey.

1) Problems the organizations encountered
2) Utilization of digital topographic data and GIS
3) Future plan of utilization of digital topographic data and GIS
4) Necessary information of digital topographic data and GIS
5) Expectation to the Study

4.4 Analysis of SOB's Inquiry Survey and Interview Survey by the Study Team

4.4.1 Analysis of survey results

The results of SOB's inquiry survey and the interview survey by the Study team were analyzed and under-mentioned specific features were found in the field of using of topographic map, digital topographic data and GIS.

1) Specific feature 1

Many organizations have no interest in the inquiry survey of SOB. Only 20 organizations among 74 organizations answered this survey. The organizations not responding to this inquiry survey have not enough equipment, persons and experience to use the digital topographic data and GIS.

2) Specific feature 2

The users that answered the inquiry survey of SOB and the organizations planning to use the digital topographic data actively have acute interests in the products of the Study, because they are planning to establish GIS data base for their own purpose.

3) Specific feature 3

SOB is now using GeoConcept as GIS software. However, other authorities in Bangladesh are using ArcInfo/Arcview as GIS software. Total 6 authorities among 20 organizations that answered the inquiry survey of SOB are using ArcInfo/Arcview as GIS Software.

4) Specific feature 4

The 1:20,000 scale Dhaka City Guide Map has no horizontal coordinates due to the reason of national security. However, the users of topographic maps need the horizontal coordinates, because many users are now using GPS for positioning, and also prices of GPS equipment is become lower than before.

5) Specific feature 5

The users of topographic maps have a strong desire for the color topographic maps (color lines) for large to medium scale topographic maps. The main reason to request for color line topographic maps can be considered their lack of experience to use large to medium scale topographic maps. However, it is necessary to consider whether color line topographic maps is suitable for large to medium scale topographic maps or not.

6) Specific feature 6

According to the interview survey, many users of topographic maps are requesting 1.0 m interval contour lines or more accurate contour lines. Considering the topographic features around Dhaka Metropolitan Area, the request of these users can be understood. However, considering the accuracy of photogrammetric mapping and also time schedule of the Study, it is very difficult to meet their request in the Study.

4.4.2 Implementation policy for specific items

Based on the analysis of Inquiry survey of SOB and interview survey by the Study team, the Study team made a decision to execute the Study by the under-mentioned implementation policy.

1) For specific feature 1

For the users lacking the experience of digital topographic data and GIS, the effective using method of digital topographic data and GIS will be presented in the seminar that will be held on the 3rd year's Study. Also, printed topographic maps will be supplied to the organizations not having the necessary equipment and software for using of digital topographic data.

Furthermore, it is necessary to promote the effective use of the digital topographic data produced by the Study to the organizations presently using the digital topographic data and GIS actively through the implementation of the Study such as inviting them to the seminar and supplying the sample data of digital topographic map.

2) For specific feature 2

It is impossible to provide all the necessary information and data to the organizations actively using GIS, because the information and data needed to these organizations are different.

Furthermore, the organizations actively using GIS are capable to collect the necessary information and data by themselves and also capable to construct GIS for their own purpose. Therefore, the purpose of GIS basic data production by the Study is to provide the common information and data that can be used by many organizations.

Table 4.4.1 "Summary of SOB's Inquiry Survey and Interview Survey by the Study Team" shows the necessary information and data to each organization known by the inquiry survey of SOB and interview survey by the Study team. On this Table, the users can be divided into two groups as follows:

1) Organizations who simply use the topographic maps and digital topographic data.
2) Organizations who use the digital topographic data as basic information to produce GIS data by adding necessary information and data.

Some of the organizations such as Dhaka City Corporation and University and so on intend to use the digital topographic data as a basic data for own GIS construction. The differences in the usage of data may be caused by the differences in the contents of work of each organization and also the necessary data for them. Therefore, it is necessary to consider what data will be structuralized for GIS basic data in the Study. Finally, the Study team decided that the contents of GIS basic data would be produced as follows:

1) Structuralization will be applied to double line road, but not applied to footpath.

2) Structuralization will be applied to railway.

3) Structuralization will be applied to the bridge along double line road, but not applied for masked bridge.

4) Structuralization will be applied to the administrative boundaries of Upazilla and Wards if accurate administrative boundary information is available.

5) Structuralization will be applied to the buildings with symbols, but not applied for building

and houses without symbols.

6) Structuralization will not be applied to the vegetation boundary.

7) Structuralization will be applied to water area such as river, lake and pond, and irrigation/drainage canal.

3) For specific feature 3

Many organizations in Bangladesh use ArcInfor/Arcview as GIS software except SOB. Therefore, The GIS basic data to be produced by the Study will be the ArcInfo/Arcview based data. Furthermore, ArcInfo/Arcview will be selected as GIS software to be used for technology transfer to the counterparts of SOB in the Study.

4) For specific feature 4

The data collection using GPS has already become common methodology. Therefore, horizontal coordinates are essential information for many users of topographic maps and digital topographic data.

In Bangladesh, many organizations are producing GIS data individually and the digital topographic data that is the basic information for GIS also produced by organization by organization. Therefore, the scale and accuracy of digital topographic data used by many organizations are not unified and accuracy of digital topographic data is not enough. Therefore, the GIS data produced by one organization cannot be used by other organization effectively and this is a vital issue of GIS utilization in Bangladesh.

Therefore, through the implementation of the Study and seminar, importance of unification of basic data (accuracy, projection, spheroid, scale and so on of digital topographic data) will be explained and make not only the counterparts of SOB, but also persons in the other organizations understood.

5) For specific feature 5

In general, medium to large-scale topographic maps is produced by Black and White, and color lines are not used. However, many organizations in Bangladesh including SOB expressed the necessity of color line topographic maps. This may be caused by lack of experience in using medium to large-scale topographic maps by the organizations in Bangladesh.

It is necessary to explain the difference between small-scale topographic maps and medium to large-scale topographic maps to SOB and also to other organizations in Bangladesh through the implementation of the Study.

6) For specific feature 6

Considering the topographic features (flat and low elevation) in Dhaka Metropolitan Area, it can be understood that many organizations want 1.0 m interval or 0.5 m interval contour lines. However, considering the accuracy of elevations observed by photogrammetric mapping method, it is difficult to draw the accurate 1.0 m or 0.5 m interval contour lines by the photogrammetric mapping method only.

To draw the accurate 1.0 m or 0.5 m interval contours, it is necessary to observe the leveling points (elevation points decided by leveling work) as much as possible and the contour lines drawn by the photogrammetric method should be corrected and adjusted by the leveling points. However, for this method, especially, leveling work in the site, it will take long time and huge manpower. If other organizations need more accurate contour lines such as 1.0 m or 0.5 m interval contour lines, it is recommended that they execute such work by themselves and correct the contour lines using the results of the Study.

Chapter 5 Aerial Photography and Photo Processing

Sample of 1:5,000 scale digital topographic map

Location: Countryside of Dhaka City

Chapter 5 Aerial Photography and Photo Processing

5.1 Contract of Aerial Photography Work

Due to the reason of the weather condition and based on the instruction from the JICA Head Office in Tokyo, necessary procedures for contracting of aerial photography work has been started before Inception Report meeting. Finally, Fugro Spatial Solution Pty. Ltd. has been selected as the sub-contractor for the execution of aerial photography work.

5.2 Organization and Equipment Used for Aerial Photography

1:20,000 scale aerial photography was executed by the sub-contract from the Study team to Fugro Spatial Solution Pty. Ltd. Fugro Spatial Solution Pty. Ltd. sent the staff to Dhaka City for the execution of aerial photography and photo processing.

The equipment used for aerial photography and photo processing by Fugro Spatial Solution Pty. Ltd. was as follows:

Table 5.2.1 "Aircraft"

No.	Volume	Equipment
1	1	Aircraft, Cessna 441 Conquest II S/N 441-0081 Australian Registration VH-LEM Modified as a photographic survey aircraft

Table 5.2.2 "GPS and Attachment"

No.	Volume	Equipment
1	3	Novatel Euro 4 GPS Receivers
2	1	Novatel GPS 600 Antenna
3	1	Acer 225X Laptop and accessories
4	1	Compaq Contura 400 Notebook computer including power adapters
5	2	Steering indicators and cables
6	2	Camera interface boxes and cables
7	2	Zip Drivers
8	2	4 Amp Battery chargers
9	2	Tripod
10	1	Compaq Contura 386

Table 5.2.3 "Photo Processing Equipment"

No.	Volume	Equipment
1	1	Lekta Laboratories printing box including transformer
2	1	Zeiss Aerotopo rewind film processor FE 120
3	1	Zeiss Aerophoto aerial film dryer TG 24
4	1	Rowi printer dryer model 1534 and calbes
5	2	Patterson developing trays 30 cm×30 cm
6	1	Kodak GRALAB timer type 300
7	2	Darkroom safe lights
8	1	Graphtec model MP5000 plotter

Photo 5.2.1 "Cessna 441 and GPS Base Station"

5.3 Progress of Aerial Photography

The progress of aerial photography was as follows:

From 26th December 2002 to 28th December 2002
Mobilization of aircraft and equipment to Dhaka City
From 29 December 2002 to 2nd January 2003
Custom clearance, preparation and discussion of flight plan
3rd January 2003
Flight operation of aerial photography
4th January 2003
Renovation of dark room in SOB
From 5th January 2003 to 15th January 2003
Photo processing
From 16th January 2003 to 17th January 2003
Demobilization of aircraft and equipment from Dhaka
19th January 2003
Delivery of final results from Fugro Spatial Solution Pty. Ltd. to the Study team

The flight operation for 1:20,000 scale aerial photography was completed in 3rd January 2003. The renovation of dark room in SOB was started immediately after completion of flight operation. The necessary photo processing was started after completion of renovation of the dark room in SOB. On 15 January 2003, the final products were submitted from Fugro Spatial Solution Pty. Ltd. to the Study team and the staff of SOB executed the masking on the positive films immediately.

5.4 Development and Check of Aerial Photographs

The list of 1:20,000 scale aerial photos is shown in Table 5.4.1 "List of Aerial Photograph" and flight index map is shown in Figure 5.4.1 "Aerial Photo Index Map".

Table 5.4.1 "List of Aerial Photograph"

Film No.	Run No.	Photo No.	Number of Photo.	Date of Photography
1	1	1 ～ 10	10 sheets	3rd January 2003
1	2	1 ～ 10	10 sheets	3rd January 2003
1	3	1 ～ 17	17 sheets	3rd January 2003
1	4	1 ～ 17	17 sheets	3rd January 2003
1	5	1 ～ 17	17 sheets	3rd January 2003
1	6	1 ～ 17	17 sheets	3rd January 2003
1	7	1 ～ 17	17 sheets	3rd January 2003
1	8	1 ～ 17	17 sheets	3rd January 2003
1	9	1 ～ 17	17 sheets	3rd January 2003
1	10	1 ～ 17	17 sheets	3rd January 2003
1	11	1 ～ 17	17 sheets	3rd January 2003
1	12	1 ～ 15	15 sheets	3rd January 2003

1	13	1 ～ 15	15 sheets	3rd January 2003
1	14	1 ～ 15	15 sheets	3rd January 2003
1	15	1 ～ 10	10 sheets	3rd January 2003
2	16	1 ～ 10	10 sheets	3rd January 2003
2	17	1 ～ 10	10 sheets	3rd January 2003
2	18	1 ～ 10	10 sheets	3rd January 2003
2	19	1 ～ 8	8 sheets	3rd January 2003
2	20	1 ～ 11	11 sheets	3rd January 2003
2	21	1 ～ 15	15 sheets	3rd January 2003
2	22	1 ～ 17	17 sheets	3rd January 2003
2	23	1 ～ 21	21 sheets	3rd January 2003
Total	23 runs		330 sheets	

Immediately after the renovation of the dark room of SOB, development of negative films was executed. SOB has no automatic developing device for negative film. Therefore, development of negative films was executed by using handy manual development device.

After completion of development of negative films, contact prints were prepared. Using these contact prints, quality check by the photo processing engineer of Fugro Spatial Solution Pty. Ltd., staff of SOB and the member of the Study team was executed (refer to Photo 5.4.1 “Development Procedure” and Photo 5.4.2 “Check of Aerial Photos”).

Photo 5.4.1 “Development Procedure”

Photo 5.4.2 “Check of Aerial Photos”

5.5 Masking on the Positive Films and Permission for Use of the Positive Films Outside Bangladesh

Masking on the positive films is to delete the Key Point Installation (restrict areas, buildings and facilities for mapping) on the aerial photographs. This masking on the positive films is the condition to bring out the positive films from Bangladesh to Japan for necessary processing of digital topographic mapping in Japan (refer to photo 5.5.1 “Masking of the Positive Films”).

The masking on the positive films was executed to scrape the surface of the positive films and paint there with black ink one by one. It took about two weeks to mask all the positive films.

Photo 5.5.1 "Masking of the Positive Films"

5.6 Scanning of the Positive Film

The positive films were scanned (1 pixel = 20 micron) in Japan and digital photo image data was stored in CD-ROM. This digital data were used for aerial triangulation and acquisition of digital topographic data.

5.7 1:50,000 Scale Orthophoto Making for Map Sheet Plan

Using the digital image of aerial photographs and the coordinates of principal points of aerial photographs obtained by GPS aerial photography, 1:50,000 scale orthophoto images were prepared in the 1st year's Study.

1:5,000 scale digital topographic mapping area was transferred on this 1:50,000 scale orthophoto image from the 1:50,000 scale topographic maps and 1:5,000 scale digital topographic map sheet plan was made using this 1:50,000 scale orthophoto image.

5.8 1:5,000 Scale Orthophoto Making

Using the digital images of aerial photographs and the results of aerial triangulation, 1:5,000 scale orthophoto images were produced sheet by sheet. 1:5,000 scale orthophoto was used for determination of the exact boundary of 1:5,000 scale digital topographic mapping area and also for the field identification.

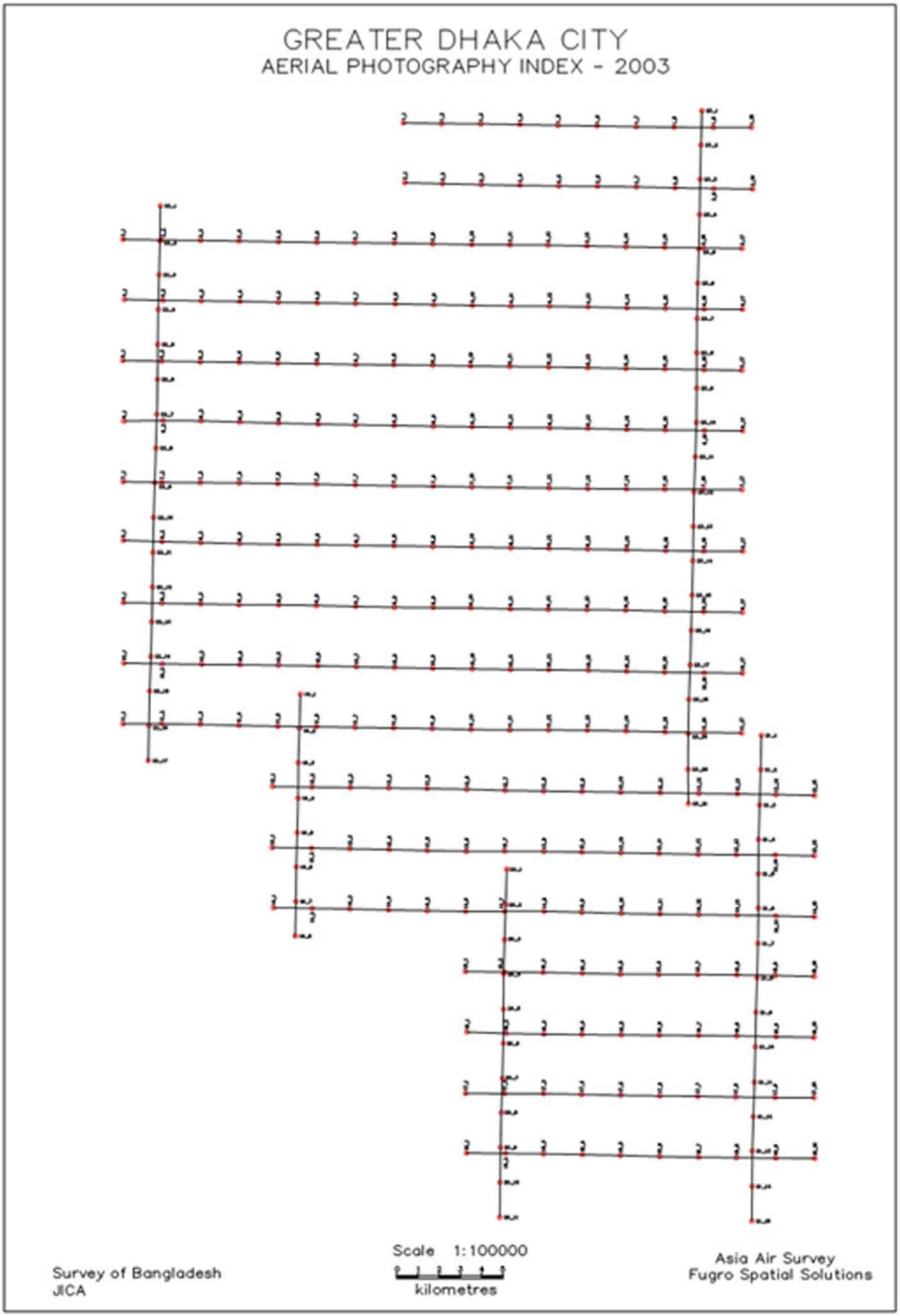
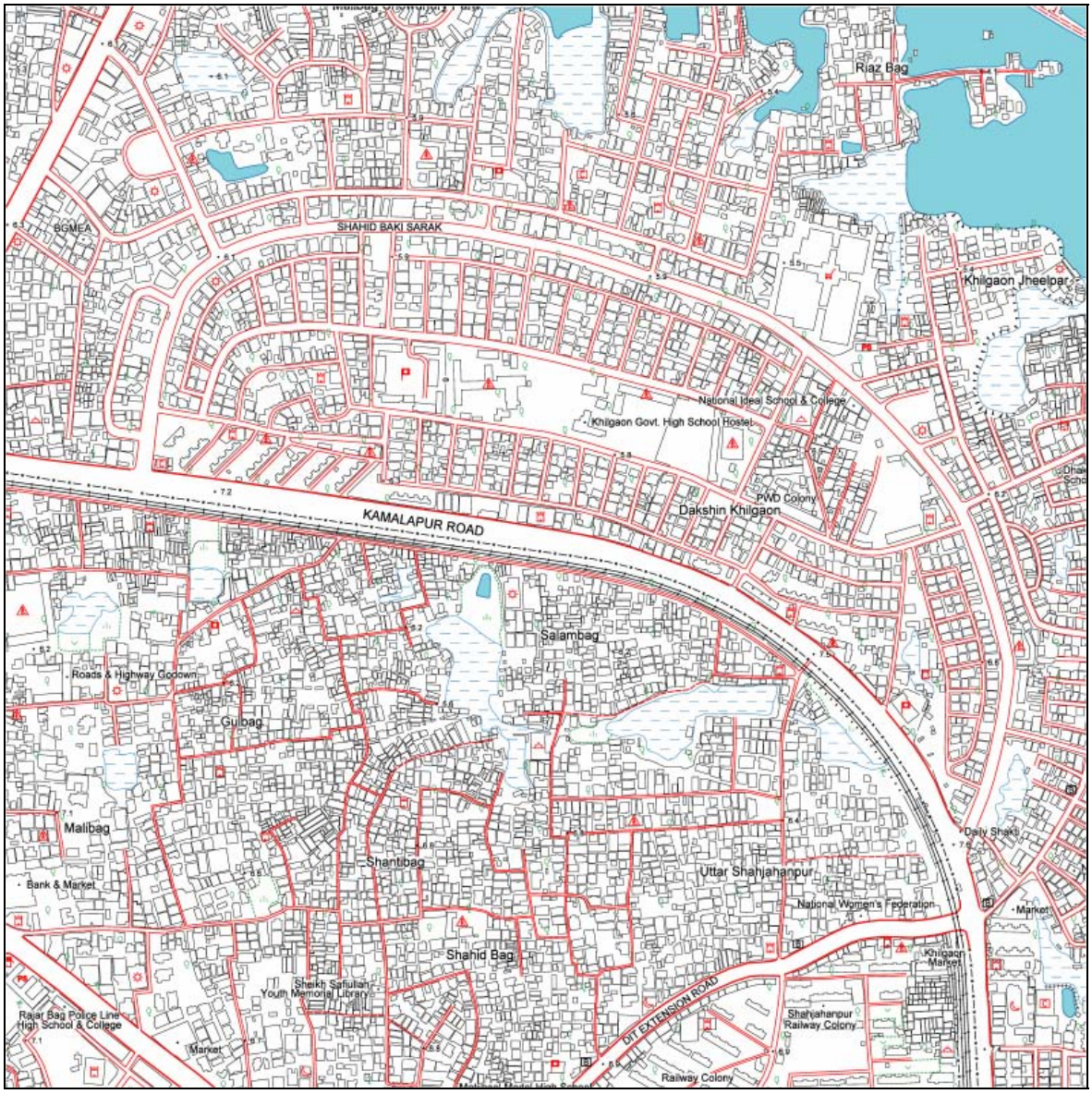


Figure 5.4.1 "Aerial Photo Index Map"

Chapter 6 Ground Control Point Survey



Sample of 1:5,000 scale digital topographic map

Location: Khilgaon Area in Dhaka City

Chapter 6 Ground Control Point Survey

6.1 Standard of Survey and Mapping

The standard of survey and mapping applied for the Study is as follows:

1) Spheroid: Everest 1830
2) Horizontal datum: Datum point at Gulshan
3) Elevation datum: Mean sea level at Bay of Bengal
4) Projection: BTM（Bangladesh Transverse Mercator Projection）

Photo 6.1.1 “Horizontal Datum Point”

Photo 6.1.2 “Vertical Datum Point”

6.2 Field Location of Control Points and Checking of the Existing Points

Prior to the establishment of photo signal, field location of GPS points and checking of the existing GPS points and benchmarks were executed jointly by the counterparts of SOB and the members of the Study team.

Finally, following numbers of new GPS points, existing GPS points and existing benchmarks were located and checked in the site.

1) Field location of the new GPS point: 24 points
2) Checking of the existing GPS point: 6 points
3) Checking of the existing benchmark: 20 points

6.3 Establishment of Photo Signals

As already explained on the Inception Report meeting, aerial photography is the first priority work in the 1st fieldwork in Bangladesh. Therefore, considering the time schedule of aerial photography, photo signals on GPS points were decided to establish as much as possible before the starting of aerial photography and pricking method was applied for the remaining GPS points.

Photo signals were established preferentially on the points of every corners of aerial photography area. These points are the most important points to keep the horizontal accuracy of aerial triangulation. Finally,

photo signals of 13 points at the corners of aerial photography area and 1 point on the roof of SOB building were established before starting aerial photography (refer to Figure 6.3.1 “Location of Photo Signals and Pricking Points”).

The size and type of photo signal were as follows:

1) Type of photo signal: 4 blades
2) Size of photo signal: 0.5 m × 2.0 m (one blade)

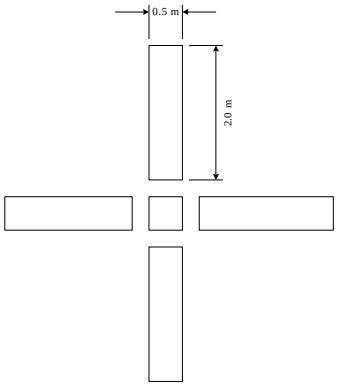


Figure 6.3.2 “Size of Photo Signal”

Photo 6.3.1 “Establishment of Photo Signal”

6.4 Pricking

New 13 GPS points and the existing 2 GPS points were pricked on the aerial photographs directly or indirectly (eccentric observation). Eccentric observation was executed by using plane table and alidade to measure the eccentric angle and distance for the calculation of horizontal coordinates. Descriptions of pricking points with stereo aerial photographs were prepared after observation.

Photo 6.4.1 “Pricking”

Photo 6.4.2 “Pricking
(Right side: Mr. Saito of JICA Expert)”

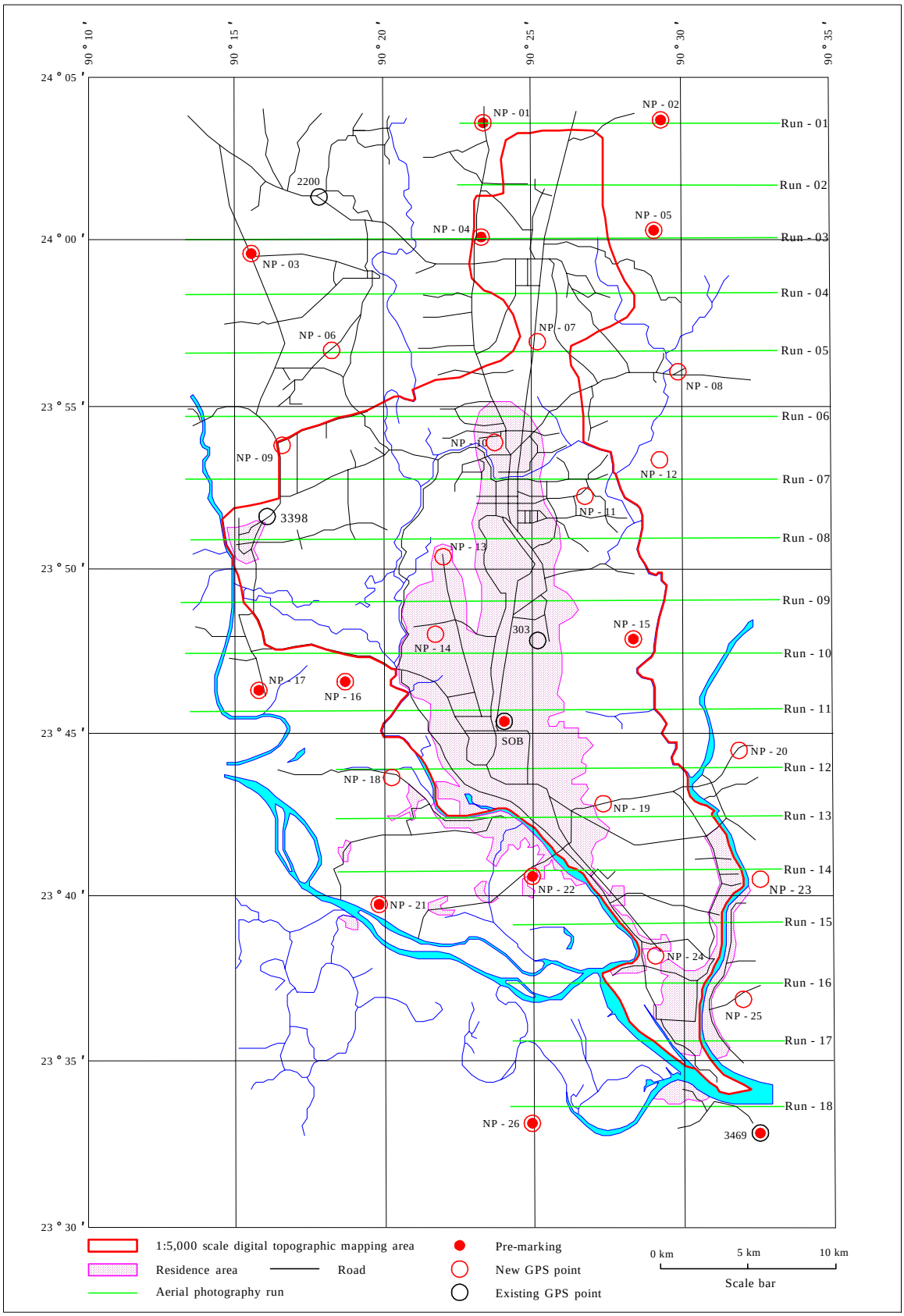


Figure 6.3.1 "Location of Photo Signals and Pricking Points"

6.5 Monumentation

On the Inception Report meeting, the Study team agreed to supply the necessary materials for establishment of concrete monuments on the new GPS points to SOB. However, due to the shortage of manpower of SOB, establishment of concrete monuments on the new GPS points was not executed before starting the execution of aerial photography and GPS observation in the 1st field work.

Finally, the monumentaiton on the new GPS points has been executed in the 2nd fieldwork in Bangladesh and total number of monumentation was 22 points.

6.6 GPS Observation

According to the alteration of 1:20,000 scale aerial photography area requested by SOB, it was necessary to amend the locations of ground control points necessary for aerial triangulation. Furthermore, SOB informed to the Study team that three large Key Point Installations (restrict area or building for mapping, two of the three are air ports) exist in the 1:20,000 scale aerial photography area. The stereo models in these areas would become imperfect models for the aerial triangulation by the masking of Key Point Installation. Therefore, locations of new GPS points were decided considering above-mentioned situation and final GPS point distribution plan is shown in Figure 6.6.1 "GPS Observation Network". The outline of GPS observation is as follows:

1)	Existing GPS point:	6 points	
2)	New GPS point:	24 points	
3)	Number of GPS survey party:	5 parties	
4)	Equipment used:	Trimble 4000 SSE	2 sets
		Trimble 4000 SSI	3 sets
5)	Observation time:	1 session (70 minutes)	

The results of GPS observation are shown in Table 6.6.1 "Coordinates of Control Points" and the accuracy of GPS observation is shown in Table 6.6.2 "Accuracy of GPS Observation (Standard Deviation)".

Photo 6.6.1 "GPS Observation"

Photo 6.6.2 "GPS Observation"

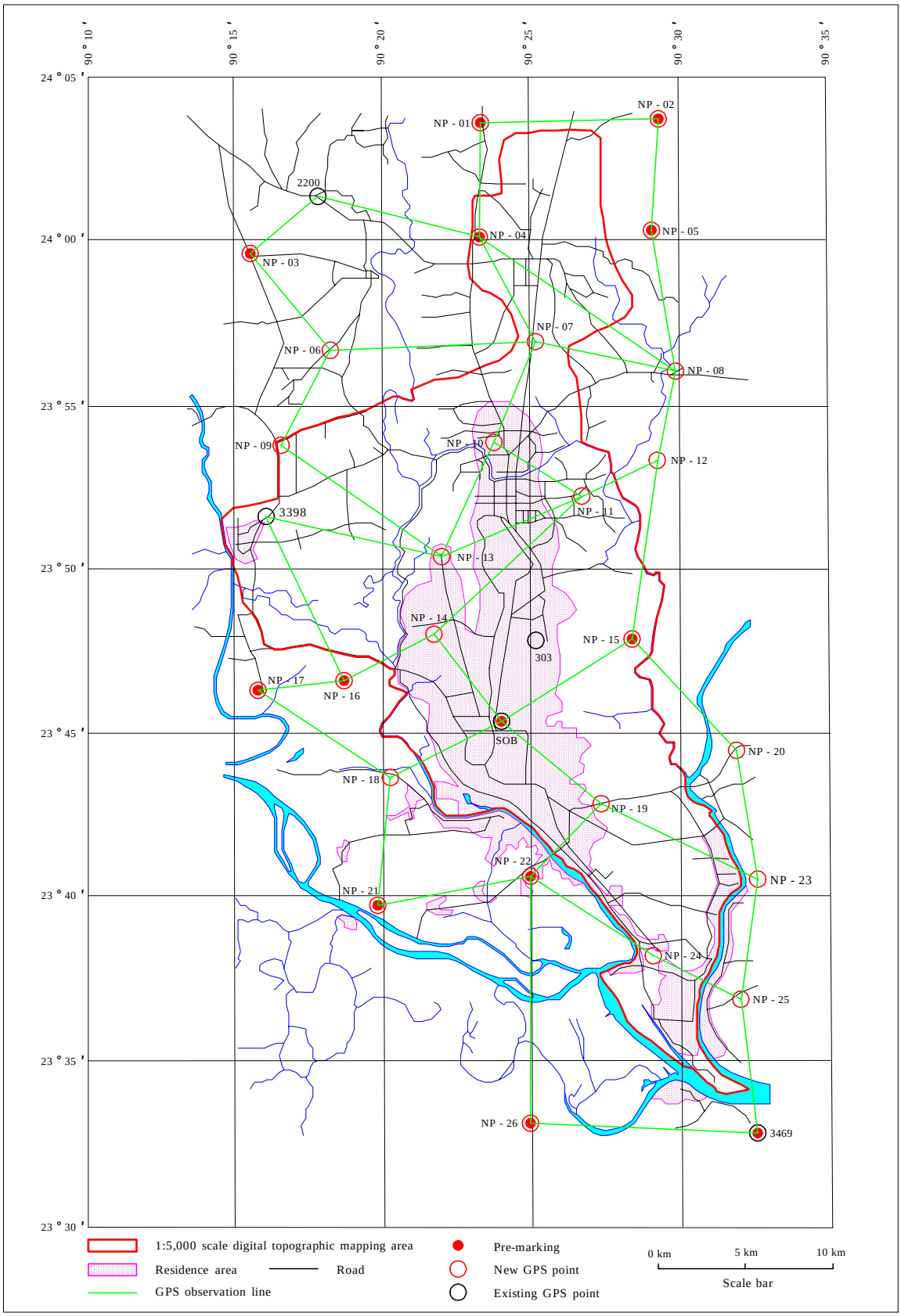


Figure 6.6.1 "GPS Observation Network"

Table 6.6.1 "Coordinates of Control Points"

WGS 84				B.T.M						
Station	B	L	Ellip. H	B	L	Ellip. H	N	E	γ	s/S
2200	24.01257589	90.17380627	-41.220	24.012329293	90.174823775	11.9007	2,656,599.856	530,171.482	-0_07_14.8887	0.999611
3398	23.51389455	90.15515199	-44.130	23.513643235	90.160166877	9.0730	2,638,547.261	527,195.658	-0_06_29.0023	0.999609
SOB	23.45236967	90.23514039	-34.360	23.452114342	90.240160499	19.5978	2,627,038.817	540,800.772	-0_09_40.7448	0.999621
3469	23.32507990	90.32181132	-48.540	23.324817378	90.322836165	6.3606	2,603,932.035	555,231.160	-0_12_58.3834	0.999638
3469EEC	23.32511390	90.32147946	-50.142	23.324851387	90.322504265	4.7540	2,603,942.138	555,137.033	-0_12_57.0603	0.999638
NP 01	24.03386325	90.23093935	-40.600	24.033617150	90.231961325	12.8946	2,660,708.889	539,519.694	-0_09_30.6210	0.999619
NP 02	24.03449128	90.29087059	-47.510	24.034244572	90.291897096	6.4425	2,660,933.510	549,666.051	-0_11_57.1850	0.999630
NP 03	23.59404411	90.15204533	-45.020	23.593796884	90.153060868	7.9644	2,653,353.338	526,290.190	-0_06_18.4240	0.999609
NP 04	24.00114065	90.23035852	-43.850	24.000892830	90.231379965	9.7135	2,654,335.370	539,373.077	-0_09_26.9717	0.999619
NP 05	24.00222720	90.28527235	-50.350	24.001978823	90.290298212	3.6568	2,654,699.843	549,236.034	-0_11_49.1015	0.999630
NP 06	23.56447235	90.18025982	-44.660	23.564223350	90.181277022	8.5958	2,647,958.402	530,882.998	-0_07_23.5158	0.999612
NP 07	23.57001037	90.24569424	-47.870	23.565760737	90.250716692	5.9095	2,648,461.127	542,593.065	-0_10_11.8114	0.999622
NP 08	23.56060941	90.29416869	-49.190	23.560358799	90.295194602	4.9751	2,646,826.072	550,647.005	-0_12_06.9886	0.999632
NP 09	23.53490077	90.16208647	-38.240	23.534650493	90.163102005	14.9517	2,642,548.685	528,017.928	-0_06_41.4467	0.999610
NP 10	23.53553942	90.23313075	-47.650	23.535288405	90.234151715	6.0888	2,642,773.683	540,188.422	-0_09_35.8785	0.999620
NP 11	23.52178472	90.26312584	-50.080	23.521532549	90.264148859	3.9261	2,639,788.745	545,285.981	-0_10_48.0974	0.999625
NP 12	23.53235758	90.29032151	-44.890	23.532105686	90.291346583	9.2865	2,641,824.215	549,576.617	-0_11_50.1135	0.999630
NP 13	23.50275477	90.21477855	-48.460	23.502502203	90.215797769	5.2244	2,636,373.855	537,277.705	-0_08_52.7175	0.999617
NP 14	23.48061110	90.21318177	-26.050	23.480357382	90.214200470	27.6674	2,632,023.059	536,837.010	-0_08_45.4444	0.999617
NP 15	23.47543964	90.28089615	-47.680	23.475185092	90.281919822	6.5511	2,631,695.563	548,075.971	-0_11_25.6550	0.999629
NP 16	23.46359238	90.18283526	-48.970	23.463338250	90.183851467	4.5471	2,629,237.337	531,651.641	-0_07_30.9452	0.999612
NP 17	23.46214622	90.15360474	-48.560	23.461892276	90.154618749	4.7429	2,628,782.855	526,775.937	-0_06_21.4075	0.999609
NP 18	23.43411685	90.20011702	-50.690	23.433861086	90.201134015	3.0121	2,623,869.019	534,291.141	-0_08_07.4304	0.999615
NP 19	23.42505289	90.27085046	-51.330	23.424795926	90.271872712	2.9393	2,622,345.087	546,394.926	-0_10_59.0432	0.999627
NP 20	23.44327047	90.31398086	-50.530	23.443013853	90.315006743	4.0494	2,625,513.765	554,065.424	-0_12_49.0386	0.999636
NP 21	23.39494160	90.19353181	-49.710	23.394683952	90.194547981	4.0478	2,616,740.298	533,575.531	-0_07_55.8045	0.999614
NP 22	23.40388220	90.24430341	-49.900	23.403624402	90.245323551	4.2330	2,618,282.217	542,287.563	-0_09_59.6562	0.999622
NP 23	23.40324638	90.32235001	-49.880	23.402987688	90.323375922	4.8481	2,618,130.186	555,330.307	-0_13_04.5471	0.999638
NP 24	23.38094305	90.28496662	-50.580	23.380683559	90.285989538	3.9277	2,613,709.830	549,288.483	-0_11_37.5596	0.999630
NP 25	23.36547138	90.31444095	-50.980	23.365210942	90.315465894	3.7820	2,611,429.551	554,247.899	-0_12_46.9936	0.999636
NP 26	23.33112514	90.24406611	-51.230	23.330863626	90.245085262	3.0733	2,604,518.055	542,259.932	-0_09_55.7349	0.999622

Table 2.6.2 "Accracy of GPS Oservation (Standard Deviation)"

Station No.	Geodetic Position		Ellipsoidal Height	
	Standard Deviation (m)	Tolerance (m)	Standard Deviation (m)	Tolerance (m)
NP - 01	0.035	0.15	0.129	0.30
NP - 02	0.042	0.15	0.161	0.30
NP - 03	0.043	0.15	0.086	0.30
NP - 04	0.026	0.15	0.097	0.30
NP - 05	0.046	0.15	0.160	0.30
NP - 06	0.036	0.15	0.071	0.30
NP - 07	0.029	0.15	0.113	0.30
NP - 08	0.028	0.15	0.177	0.30
NP - 09	0.035	0.15	0.099	0.30
NP - 10	0.029	0.15	0.086	0.30
NP - 11	0.027	0.15	0.121	0.30
NP - 12	0.028	0.15	0.028	0.30
NP - 13	0.030	0.15	0.030	0.30
NP - 14	0.031	0.15	0.075	0.30
NP - 15	0.019	0.15	0.091	0.30
NP - 16	0.036	0.15	0.106	0.30
NP - 17	0.041	0.15	0.137	0.30
NP - 18	0.043	0.15	0.104	0.30
NP - 19	0.063	0.15	0.158	0.30
NP - 20	0.021	0.15	0.125	0.30
NP - 21	0.058	0.15	0.191	0.30
NP - 22	0.056	0.15	0.145	0.30
NP - 23	0.063	0.15	0.175	0.30
NP - 24	0.056	0.15	0.134	0.30
NP - 25	0.054	0.15	0.130	0.30
NP - 26	0.026	0.15	0.129	0.30

Accuracy of observatior 3 ppm × Observation distance

Divergence of baseline : less than 30 mm

6.7 Leveling

SOB has own leveling network. In and around Dhaka City, leveling routes are spreading in a radial manner from the center of Dhaka City. There are 20 benchmarks (first order and second order benchmarks) in the 1:20,000 scale aerial photography area and these benchmarks are available for the Study.

Accordingly, leveling survey route plan was changed from the original plan to use the existing benchmarks as much as possible. Finally, leveling route plan as shown in Figure 6.7.1 "Leveling Route Plan" was decided considering the distribution of vertical control points to keep the vertical accuracy of aerial triangulation. Outline of leveling was as follows:

1)	Total distance of leveling route:	Approximately 160 km	
2)	Observation method:	Double runs observation	
3)	Points established by the leveling:	GPS point:	12 points
		Leveling point:	34 points
4)	Accuracy:	50mm $\sqrt{S}$: S = leveling distance in km	
5)	Number of leveling party:	3 parties	
6)	Equipment:	Wild NA 3003	3 sets

The elevations of GPS points, leveling points and pricking points of the existing benchmarks decided by leveling are shown in Table 6.7.1 "Elevation of Control Points", Table 6.7.2 "Elevation of Benchmark and Leveling Point". The accuracy of leveling is shown in Table 6.7.3 "Accuracy of Leveling".

Photo 6.7.1 "Leveling"

Photo 6.7.2 "Leveling"

6.8 Geoid Undulation Map

The geoid undulation map was prepared using the results of direct leveling and GPS observation (18 new GPS points and 4 existing GPS points) to estimate the elevations from mean sea level of GPS points that could not be decided by direct leveling (refer to Figure 6.8.1 "Geoid Undulation Map").

Considering the accuracy of elevation decided by direct leveling and geoid undulation map, the elevations of GPS points were shown as following order.

1) Elevation decided by direct leveling 0.01 m order
2) Elevation estimated by the geoid undulation map 0.1 m order

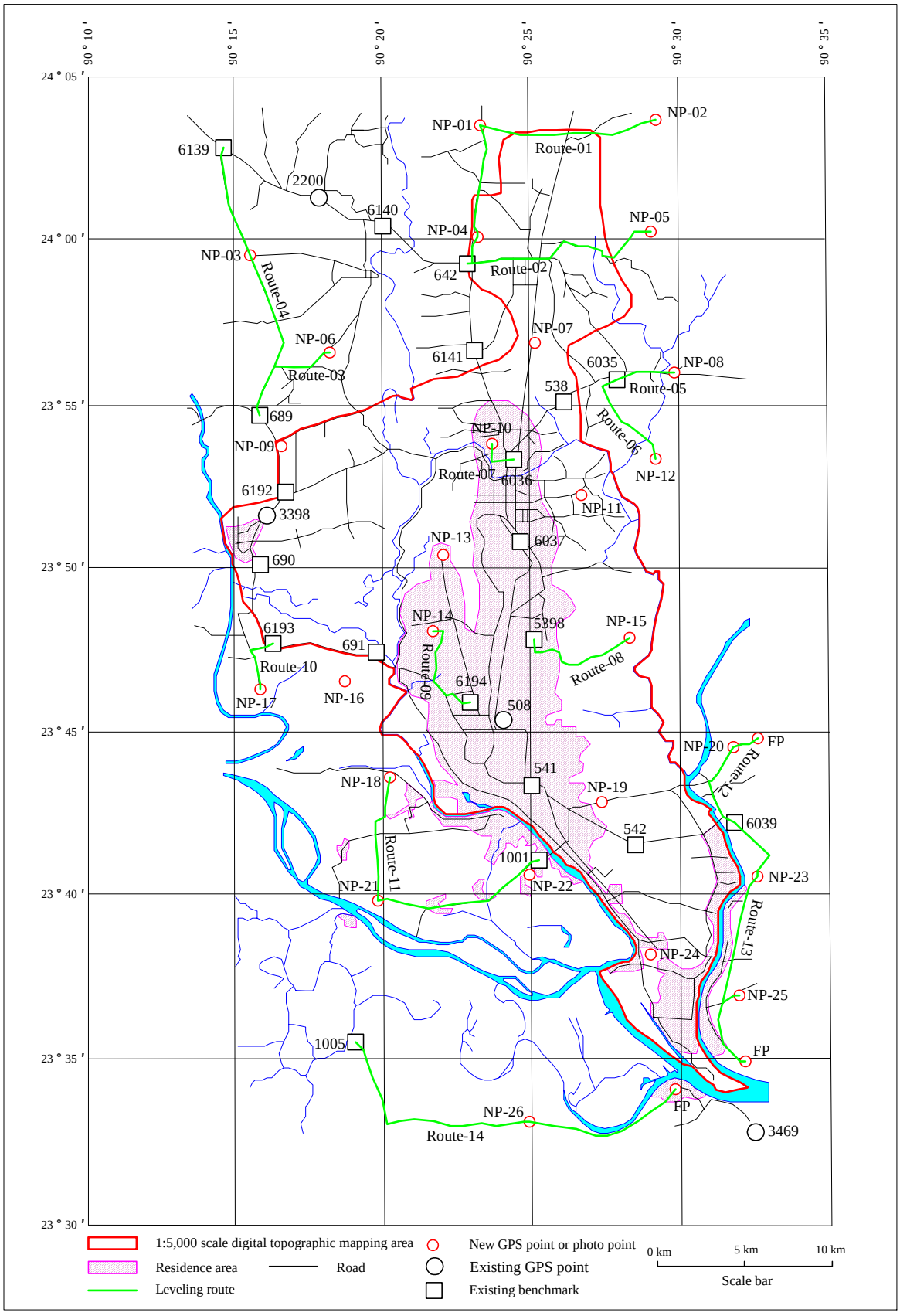


Figure 6.7.1 "Leveling Route Plan"

Table 6.7.1 "Elevation of Control Point"

Station No.	Main Point (m)	Eccentric Point (m)	Method of Survey
NP - 01	13.09		Direct leveling
NP - 02	5.94		Direct leveling
NP - 03	9.14		Direct leveling
NP - 04	9.91		Direct leveling
NP - 05	3.11		Direct leveling
NP - 06	9.43		Direct leveling
NP - 07	5.9	5.2	Interporation from geoid map
NP - 08	4.22		Direct leveling
NP - 09	15.9		Interporation from geoid map
NP - 10	6.22	3.29	Direct leveling
NP - 11	3.7		Interporation from geoid map
NP - 12	8.66		Direct leveling
NP - 13	5.6	5.6	Interporation from geoid map
NP - 14	28.03		Direct leveling
NP - 15	6.02		Direct leveling
NP - 16	5.4		Interporation from geoid map
NP - 17	6.03		Direct leveling
NP - 18	3.56		Direct leveling
NP - 19	2.6		Interporation from geoid map
NP - 20	-----	----	--------
NP - 21	4.79		Direct leveling
NP - 22	4.27		Direct leveling
NP -23	3.83		Direct leveling
NP -24	3.5		Interporation from geoid map
NP - 25	2.90		Direct leveling
NP - 26	3.05		Direct leveling

Table 6.7.2 "Elevation of Benchmark and Leveling Point"

Point No.	Main Elevation (m)	Pricked Elevation (m)	Point No.	Main Elevation (m)	Pricked Elevation (m)
6139	11.531		P01		9.626
6192	8.370	8.648	P02		9.049
6193	6.338	6.009	P03		9.125
6140	7.905	7.323	P04		9.277
6141	8.760		P05		9.644
6035	6.801	6.541	P06		8.060
6036	7.371	6.586	P07		7.882
6037	7.559	7.104	P08		9.392
642	11.737	11.173	P08-1		7.058
689	11.827	11.489	P08-2		7.700
690	7.735	7.994	P09		7.819
538	7.240	6.769	P10		9.815
691	6.621	7.999	P11		10.053
6194	7.101	6.41	P12		6.298
539B	6.566		P13		7.529
541	6.923	6.323	P14		5.102
542	5.528		P15		6.007
6039	6.009	4.794	P16		6.607
1001	6.776		P17		6.622
1005	6.602		P18		5.870
			P19		6.393
			P20		6.317
			P21		6.234
			P22		6.700
			P23		7.210
			P24		6.907
			P25		4.505
			P26		5.856
			P27		5.419
			P28		5.995
			P29		6.242
			P30		5.468
			P31		5.730
			P32		6.411

Table 6.7.3 "Accuracy of Leveling"

Route No.	Distance (km)	Station to Station	Misclosure (mm)	Allowable Misclosure (mm)
1	21.0	from BM642 to NP-02	152	229
2	12.0	from BM642 to NP-05	17	173
3	6.0	from BM689 to NP-06	14	122
4	17.0	from BM6139 to F4	16	206
5	3.0	BM6035 to NP08	9	86
6	7.0	BM6035 to NP12	2	132
7	4.0	BM6036 to NP-10	2	100
8	8.5	BM539B to NP-15	6	145
9	6.0	BM6194 to NP-14	25	122
10	4.0	BM6193 to NP-17	3	100
11	22.5	BM1001 to NP-18	6	237
12	7.0	BM6039 to F10	4	132
13	17.0	BM6039 to F95	42	206
14	25.0	BM1005 to F4	21	250
Total	160.0 km			

Allowable misc 50 mm $\sqrt{S}$, S = Distance in km

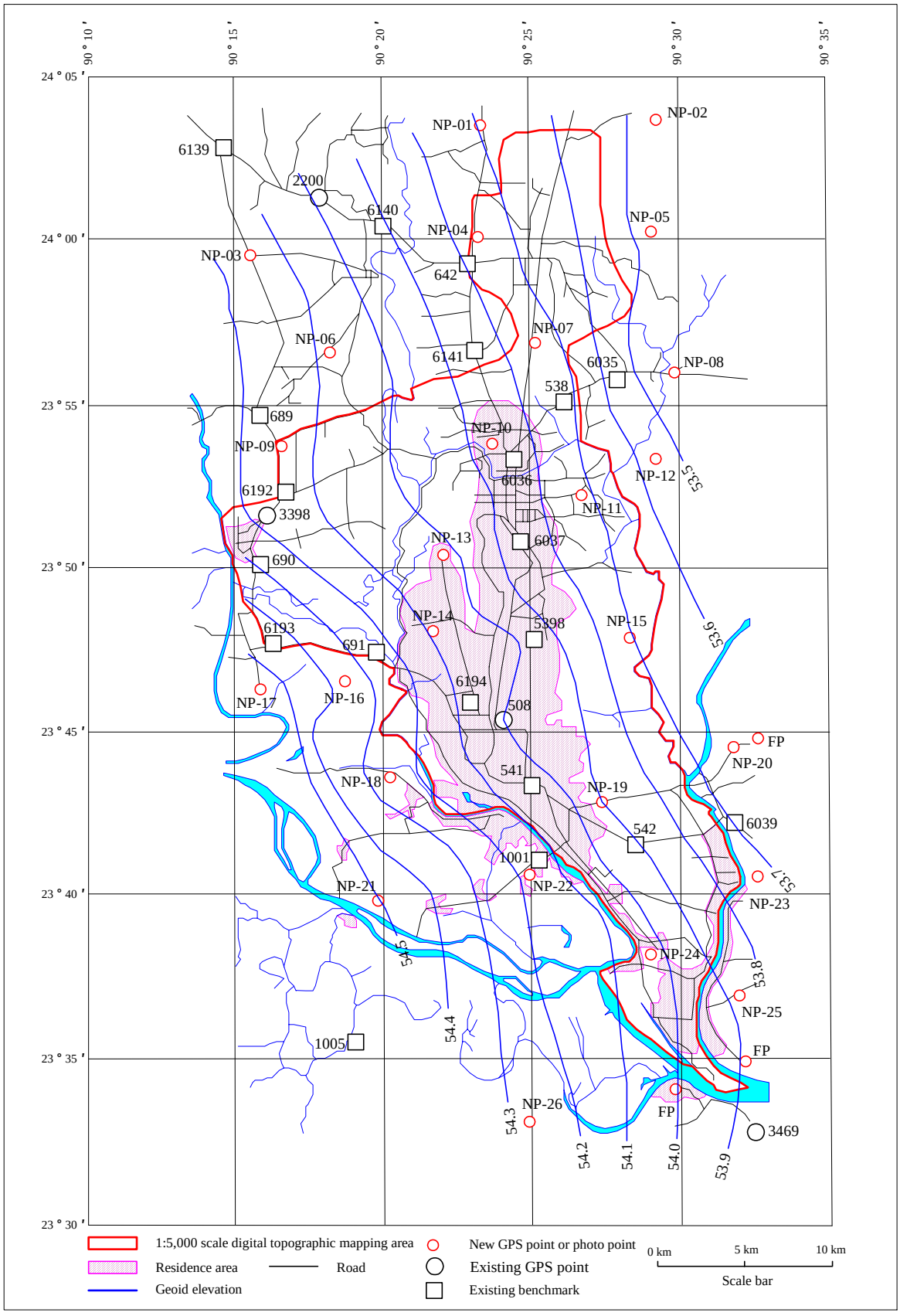


Figure 6.8.1 "Geoid Undulation Map"

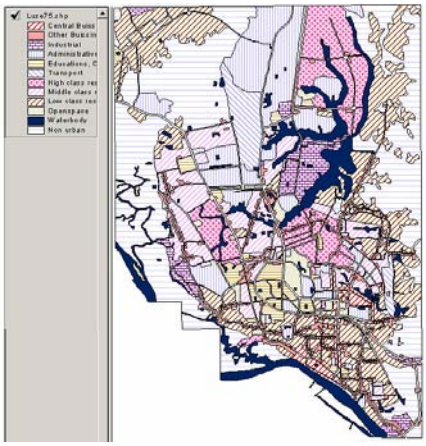
Chapter 7 Field Identification

Production of Land Use Map using Topographic Map

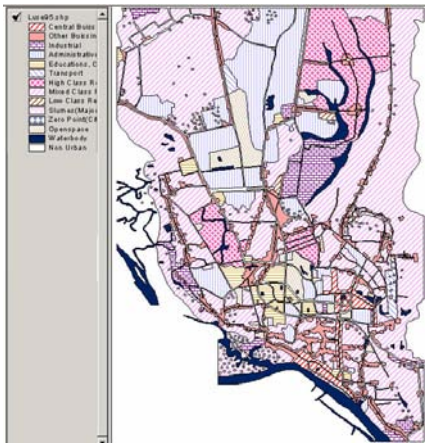
Land use map is a very important thematic map for the decision of the urban planning and it can cope with it at the same time about the monitoring of the present condition of the land development, grasping of the developable site and for the development. The land use map is produced by photo interpretation based on the orthophoto and topographic map data in the digital mapping and reference of existing land use map.

In Dhaka city, the city has been formed at the natural embankment but, according to the population concentration about 10 million and the development without order, residential area for lower income residence people become the slum to the surrounding of the city and the phenomenon of sprawlization of the urban area city progresses, so it is needed to install the proper land use management for urban planning.

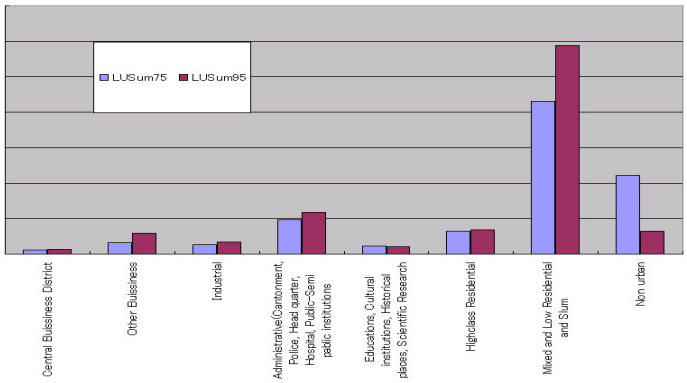
The follows is a result of compilation to thematic map from existing land uses map in 1975 and in 1995 in the Dhaka city and shows time series of change for land use development.



Land Use Map of Dhaka City – 1975



Land Use Map in 1995



Time Series of Land Use about Trend of Development

Chapter 7 Field Identification

7.1 Technology Transfer of Field Identification

Up to present, SOB has no experience to produce medium to large-scale topographic maps. Therefore, SOB has no experience and knowledge of field identification for medium to large-scale topographic mapping. The field identification executed for 1:20,000 scale Dhaka Guide Map in 2001 is only the same kind of work to the field identification work for medium to large-scale topographic mapping.

SOB emphasized that the field identification of 1:20,000 scale Dhaka Guide Map was a difficult and time consumed work. Therefore, it was decided that the field identification for medium to large scale topographic mapping was one of the items of technology transfer in the Study, and practical and effective method of field identification for medium to large scale topographic mapping had to be transferred to the counterparts of SOB.

7.2 Method of Field Identification

7.2.1 Field identification (1)

Field identification (1) was executed in the 1st year's Study and the existing data in SOB and also from the relevant organizations were collected, and the public facility list was prepared.

Based on the collected data and information, the public facility lists were prepared separately for each map sheet of the 1:5,000 scale topographic by Excel format.

7.2.2 Field Identification (2)

Field identification (2) was executed in the first half of the 2nd year's Study and the collected data and information were plotted on the 1:5,000 scale orthophoto. In case the locations of public facilities were clearly identified on the 1:5,000 scale orthophoto, the location of public facilities were pointed out (?) directly on the 1:5,000 scale orthophoto. However, in case the locations of public facilities were not clearly identified on 1:5,000 scale orhtophoto, the approximate locations were shown on the 1:5,000 scale orthophoto with circle mark.

The information of public facilities shown on the 1:5,000 scale orthophoto were transferred into digital data at the stage of digital plotting and digital compilation using the results of field identification (1). The plot-out 1:5,000 scale topographic maps (map manuscripts) were prepared for field identification (3). Also, the ambiguous features found in the stage of digital plotting were verified and a public facility list was prepared for field check in field identification (3).

7.2.3 Field Identification (3)

Field identification (3) was executed in the latter half of the 2nd year's Work. Also, the public facility list was corrected based on the results of field check. Before execution of field check, features necessary to be

checked in the field were sorted out under the cooperation of counterparts of SOB based on the 1:5,000 scale topographic maps (plot-out map manuscripts). The features to be checked in the site were selected by the following criteria:

1) The ambiguous features found in the digital plotting.
2) The large buildings without symbols of public facilities.
3) The public facilities shown on the results of field identification (2) are checked again if necessary. The opinions of counterparts concerning the public facilities, especially around the area near counterparts' residences should be respected.

The public facilities were checked in the site and the results were shown directly on the 1:5,000 scale topographic maps (plotted-out map manuscripts). The public facility list for each 1:5,000 scale topographic map sheet were corrected based on the results of field check.

Generally, the administrative names, administrative boundaries, names of roads and so on are already defined by the government organizations. Therefore, the Study team requested SOB to collect the necessary data concerning these items officially from the relevant organizations and put these information on the 1:5,000 scale topographic maps (plotted-out map manuscripts).

In parallel with the field check, the counterparts of SOB and the Study Team discussed the specifications and check on the contents of the 1:5,000 scale topographic maps (plotted-out map manuscripts).

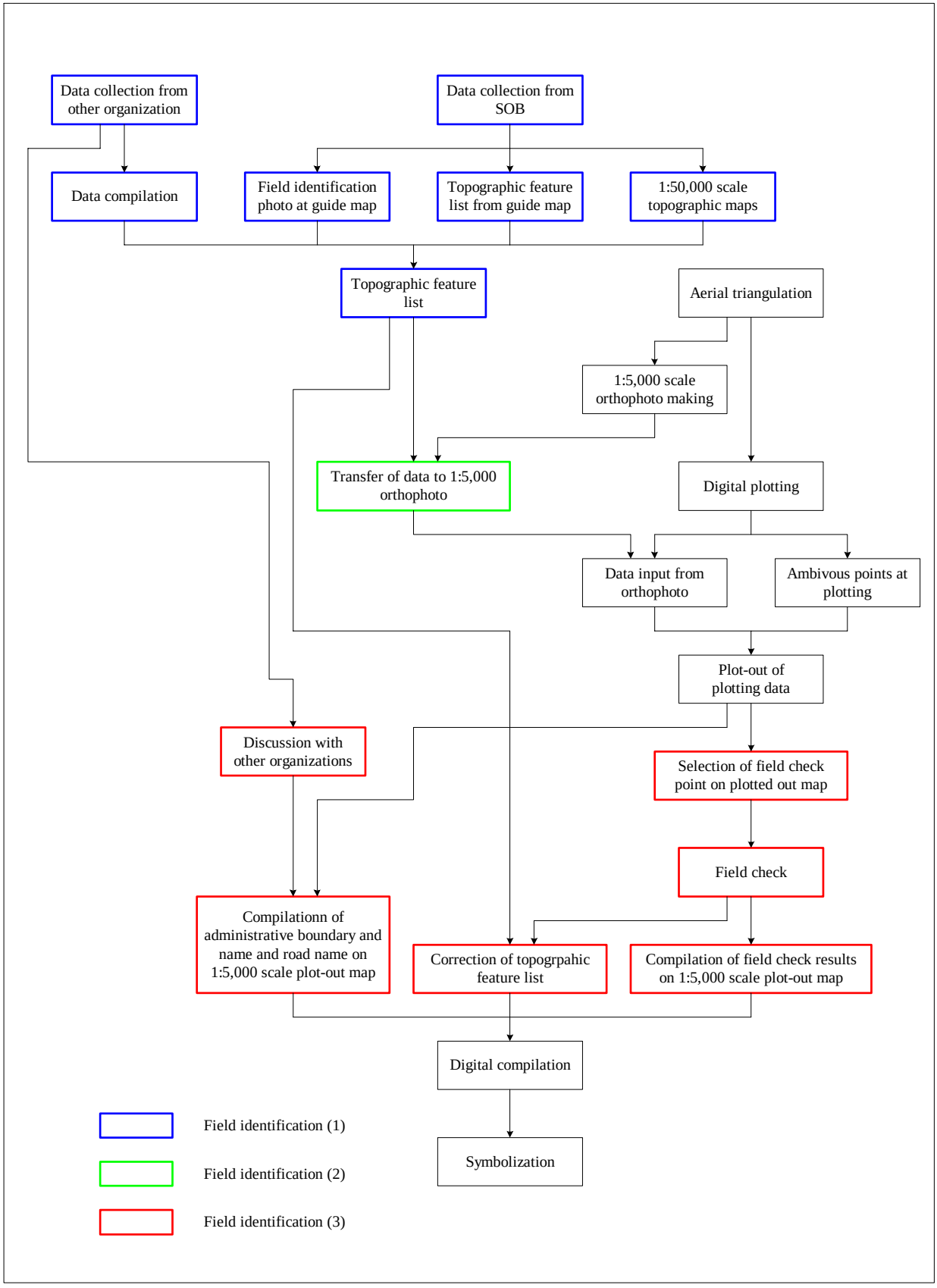


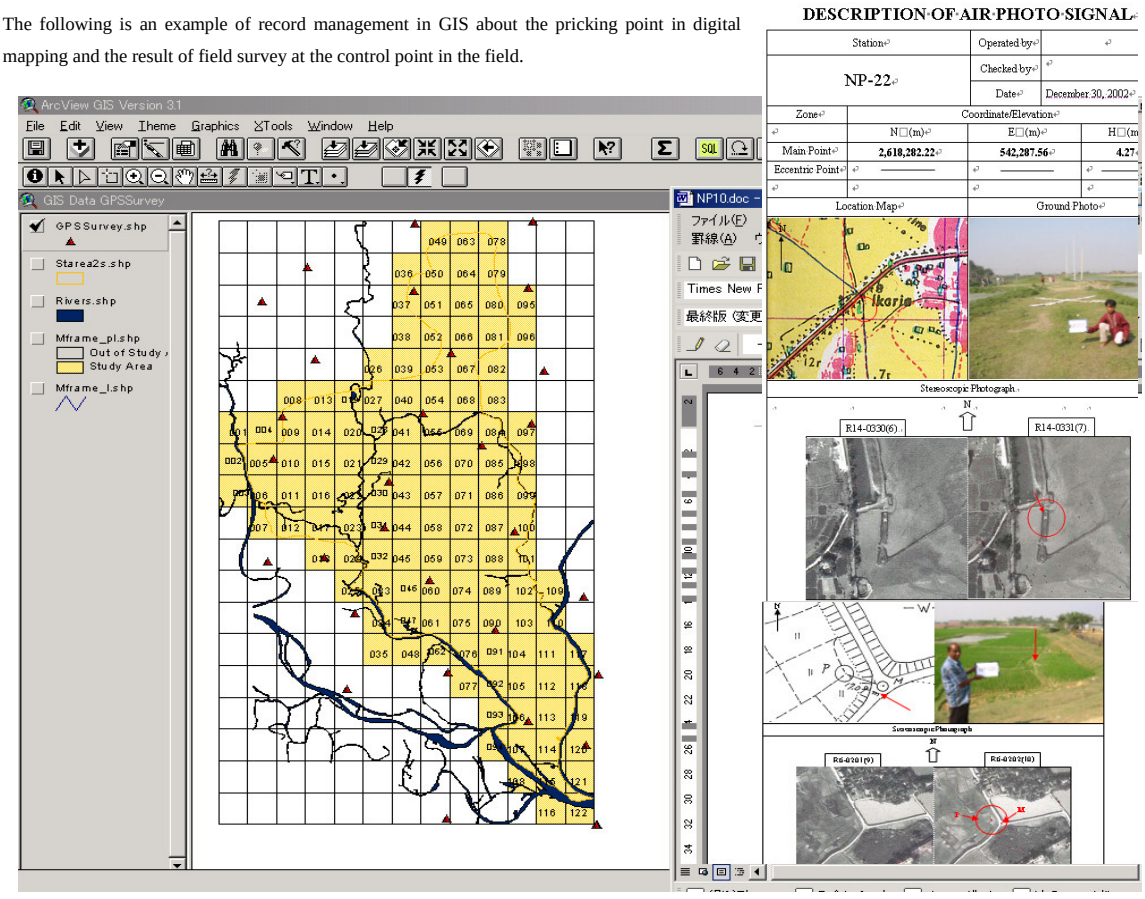
Figure 7.1.1 "Workflow of Field Indetification"

Chapter 8 Aerial Triangulation

Record Management in SOB

In the point of view as the Information Infrastructure in SOB the, there are issues that it is necessary to make it promote a switchover to the digital management from the analog one at the present. Especially about digital data relating to jobs in geodesy, in digital mapping and in the concerning works, each division has already possessed about digital data resources. So it is expected that those data make an contribution for Information Infrastructure in the department by the consolidation management of figure data and tabular data as a GIS data.

The following is an example of record management in GIS about the pricking point in digital mapping and the result of field survey at the control point in the field.



Internal Record Management for Information Infrastructure in SOB

Chapter 8 Aerial Triangulation

8.1 Workflow of Aerial Triangulation

Aerial triangulation was executed based on the results of ground control point survey and digital photo image obtained by scanning of the positive film that are the results of 1st year's Study. The workflow of aerial triangulation is shown in Figure 8.1.1 "Flow of Aerial Triangulation".

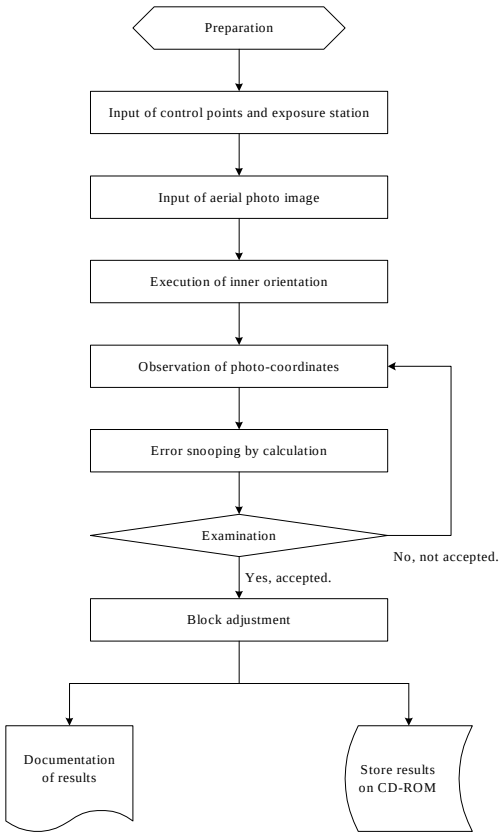


Figure 8.1.1 "Work Flow of Aerial Triangulation"

8.2 Outline and Accuracy of Aerial Triangulation

The outline and accuracy of aerial triangulation was as follows:

1) Number of flight runs: 23 runs
2) Number of stereo models: 307 stereo models
3) Method of adjustment: Bundle method
4) Equipment used: SocetSet
5) Number of control points used for aerial triangulation:
   - Horizontal control point: 33 points

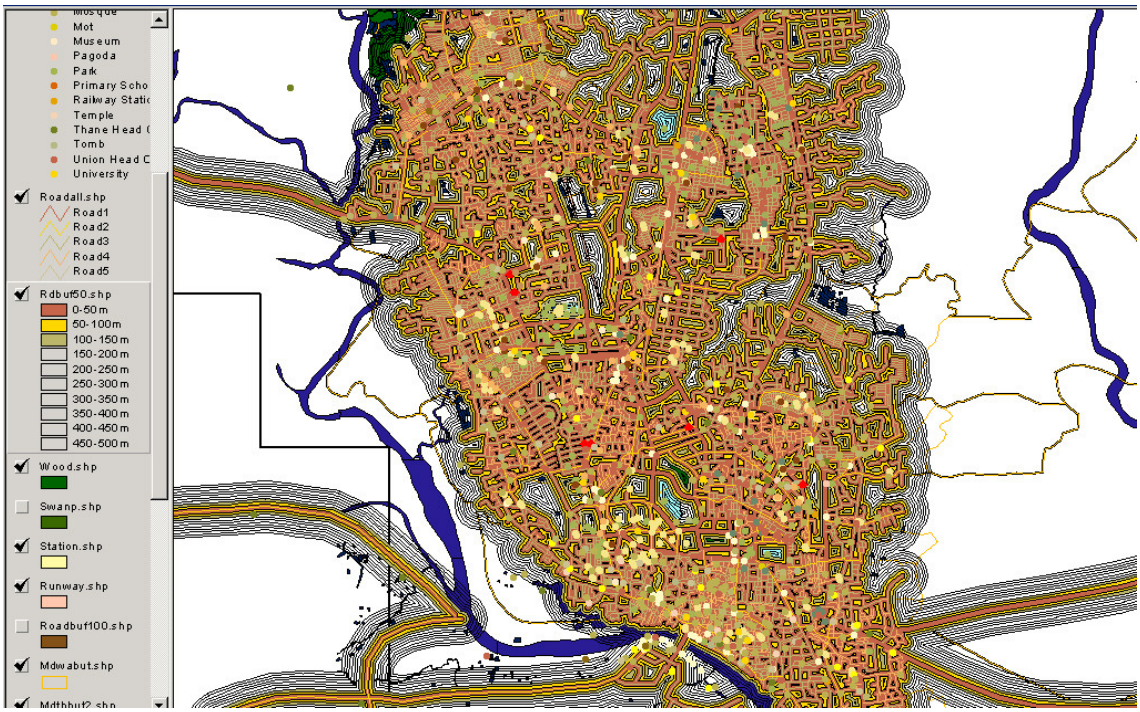
	- Vertical control point:	82 points	
6)	Number of points eliminated from calculation:		
	- Horizontal control point:	none	
	- Vertical control point:	2 points	
7)	Residual error of control point:		
	- Horizontal position:	Standard deviation	x = 0.173 m
			y = 0.169 m
		Maximum	x = 0.313 m
			y = 0.396 m
	- Elevation:	Standard deviation	z = 0.162 m
		Maximum	z = 0.363 m
8)	Discrepancies of pass points and tie points:		
	- Horizontal position:	Standard deviation	x = 0.004 m
			y = 0.004 m
9)	Allowable error of control point and other points (pass point and tie point):		
	- Control point:	Standard deviation	0.02 % (0.61 m)
		Maximum	0.04 % (1.22 m)
	- Other point:	Standard deviation	0.015 mm
		Maximum	0.030 mm

Chapter 9 Digital Plotting, Digital Compilation and Symbolization

Thematic Map of Road Density in the Dhaka

To comprehend relations between land use and road, thematic map is produced with computation of buffering area in each 50 meters against the road center using road network data in topographic map, this map is produced to make this objective focus by the display overlay on topographic map. As a result, almost all the building sites in the center parts of the Dhaka city are covered within the range of 100 meters from road, so results which there is overpopulated situation about road and residential area

show no availability for the developable site. In the urban planning, it is recommended to make a plan for necessity for park and vegetation area and the reservation of the open space for anti-fire prevention.



Relationship between the road density and building in the city

An example of the buffering analysis using road network data

Chapter 9 Digital Plotting, Digital Compilation and Symbolization

9.1 Digital Plotting

9.1.1 Digital Plotting

Based on the results of aerial triangulation, the 1:5,000 scale digital plotting covering 581 km^2 (122 sheets in total) were executed in Japan. The methodology of digital plotting is shown in "Manual for Digital Topographic Mapping (draft)". The topographic data and information necessary for the 1:5,000 scale digital topographic maps were acquired according to the revised Map Feature Code (MFC).

The sheet index, sheet number of the 1:5,000 scale digital topographic maps and horizontal coordinates of every 4 corners of each 1:5,000 scale digital topographic map are shown in Figure 3.4.2 "Final 1:5,000 Scale Digital Topographic Map Sheets and Sheet Numbers".

9.1.2 Ambiguous features found in the stage of digital plotting

Through the execution of digital data acquisition for the 1:5,000 scale digital topographic maps, ambiguous or unclear features were found. These features and also topographic features not defined in the Map Symbol and Map Style for 1:5,000 Scale Digital Topographic Mapping (Version 2.0) were listed up. SOB and the Study team discussed these features at the beginning of the 2nd year's Study (Phase 2). Also, this information was used for the field identification (3).

9.2 Digital Compilation

9.2.1 Digital compilation (1)

With the digital topographic data obtained by digital plotting, digital compilation for the 1:5,000 scale digital topographic maps was executed based on the "Map Style and Map Symbols for 1:5,000 Scale Digital Topographic Maps (version 2.0)" and "Manual for Digital Topographic Mapping (draft)". Field identification (3) was not yet executed at this stage. Therefore, some of the map symbols, especially public facilities, cannot be compiled due to the reason of time schedule for the digital plotting, digital compilation (1) and field identification (3).

Final digital compilation was executed after the completion of field identification (3), from the middle of November 2003 to the end of January 2004.

9.2.2 Digital compilation (2)

Digital compilation (2) was executed from the end of November 2003 to the end of January 2004 using the results of field identification (3). Main items executed at digital compilation (2) were as follows:

1) Correction and compilation of map symbols based on the results of field identification (3)
2) Changing the methods to show public facilities (symbol or annotation, or both symbol and annotation)

3) Correction and compilation of ambiguous and unclear features based on the results of field identification (3)
4) Add the administrative names into 1:5,000 scale digital topographic data
5) Correction of marginal information based on the discussion between SOB and the Study team

9.3 Symbolization

Using the digital data of which digital compilation was already completed, symbolization was executed to represent the map style of 1:5,000 scale digital topographic map as already defined on "Map Style and Map Symbols for 1:5,000 Scale Digital Topographic Maps (version 3.0)". Furthermore, allocation of names of districts and annotation, intermittence, transposition of symbols and so on were executed at this stage.

Marginal information data were corrected based on the discussion between SOB and the Study team. The final marginal information data for each sheet were produced by adding the sheet name, sheet number and sheet index information.

9.4 Quality Control

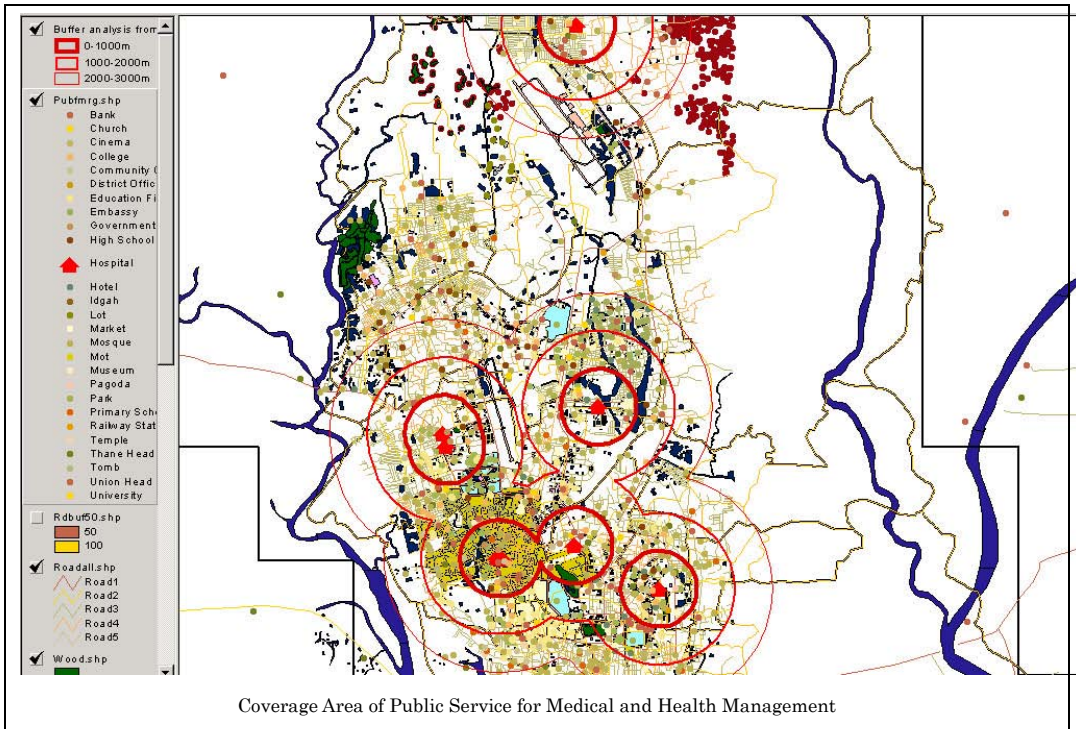
According to the ISO's methodology, check items and checking method were defined and Quality Control Sheet was prepared. Quality control for digital mapping, and digital compilation and symbolization were executed for each map sheet using this quality control sheet.

At each stage, if the mistake(s) were found, digital data were sent back to the digital plotting or digital compilation or symbolization stage, and the digital data were corrected. Final check for all the 1:5,000 scale digital topographic maps was executed after completion of symbolization.

Chapter 10 Structuralization (Production of GIS Basic Data)

Coverage Area Map of Public Service of Medical and Health Management

As the application field to be able to use mapping data into GIS database based on data item relating to public facilities in topographic map, there are several application fields for urban planning management, medical and health management and others The following shows an example to produce the coverage area map for medical and health service in Dhaka city. There are not much main hospitals in the city. Considered with number of residence population, the suitable number of hospital and health center is needed to make those facilities to plan to make the administrative services to improve for reality of the suitable residential environment.



Coverage Area of Public Service for Medical and Health Management

Chapter 10 Structuralization (Production of GIS Basic Data)

Structuralization is a step to compile digital data acquired by the digital plotting and digital compilation to conform to the structure of GIS. In the Study, data and information, which users mutually can use as spatial data were selected and produced as GIS basic data. Through the structuralization, a geographic feature catalog that described the systematizing of geographic features, the grouping of encoding and the definition of geographic features was prepared to show relationship between GIS data and digital topographic data to the users.

The digital topographic data produced by SOB until now have fatal problem that the digital topographic data has not been structulized. Therefore, SOB's digital topographic data can be used for digital topographic map data, but it is impossible to use for GIS data. Therefore, in the Structuralization as shown in Figure 10.1.1 "Role of Structuralization (From Digital Topographic Data to GIS)", it is the most important point that figure data have to be produced without any errors by the adequate structuralization in the step of digital topographic data production and this was set up as a goal for the technology transfer.

Providing the GIS data, which has been difficult so far, may become possible by the procedures. This is an important process when geographic information is prepared.

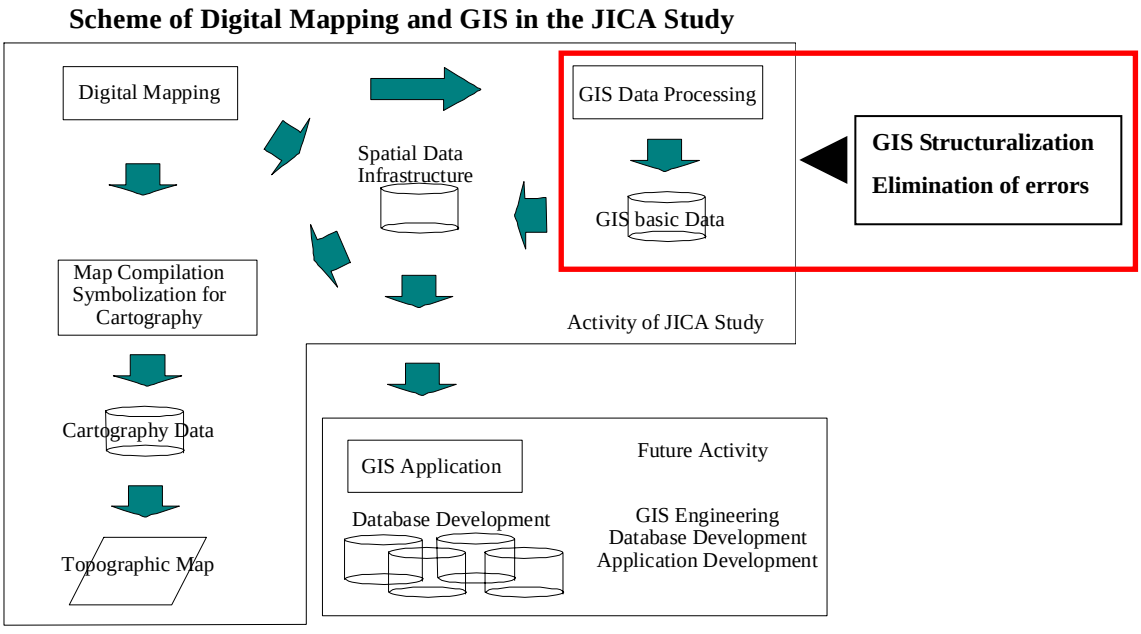


Figure 10.1.1 "Role of Structuralization (From Digital Topographic Data to GIS)"

10.1 Structuralization

Working process of the structualization to produce the GIS data is as follows:

- Import digital mapping data to GIS software as GIS data
- The connecting relations about geometry on figures, so-called topology is built according to GIS data structures such as point, line, polygon and text data.

GIS basic data is produced by the working process of the structuralization as shown in Figure 10.1.2 "Workflow of Structuralization". The procedure of data processing of figure was carried in each data feature. The general flow of data production is consisted of the following steps:

(1) Importing of digital mapping data:
Importing of the MicroStation data to ArcInfo.
(2) Cleaning of figure and building of topology:
Topology related to the connectivity of figure data of geometries is computed in each feature (point, line and polygon). Topology errors relating to the geometry including overshoots, undershoots, intersections, snapping, dangle arcs and other errors are detected to fix and data processing is done to clean those errors.
(3) Editing of figure to fix topology errors:
Data process to remove and to clean any topology errors about geometries.
(4) Data entry of attribute and importing of the related attributes.
(5) Completion of attribute data:
Complete data by the repeatedly process in the Step 2, 3 and 4.
(6) Map printing
(7) Production of export file for GIS basic data

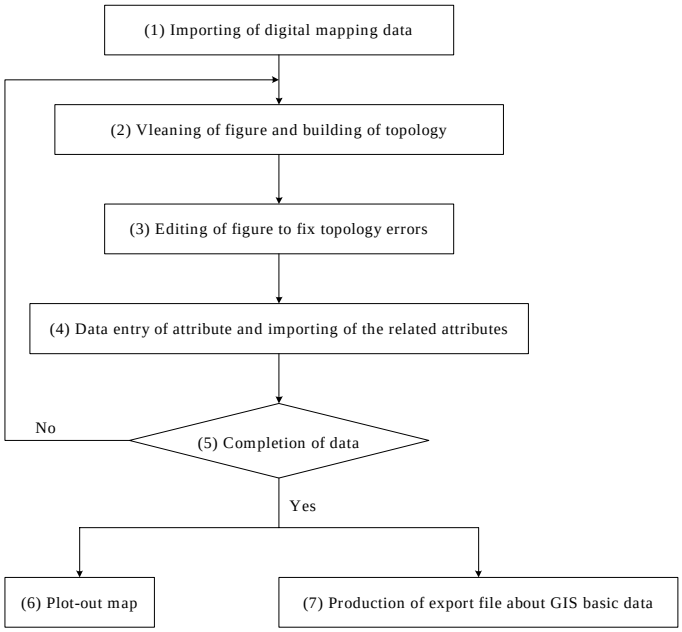


Figure 10.1.2 "Workflow of Structuralization"

10.2 Contents of GIS Basic Data

GIS basic data were limited to the items by which correspondence was possible about the contents shown in Table 10.2.1 "Contents of GIS Basic Data" for the map production, and the GIS data were produced by the Study in accordance with the guide based on results which was obtained by the inventory survey for user needs against that data in the 1st year's Study.

Table 10.2.1 "Contents of GIS Basic Data"

Contents of GIS Basic Data	Data Type	Data Production Process
1. Administrative boundary	Polygon	Because the administrative boundaries on the maps could not be officially approved, the definite boundaries were referred to the existing materials, and the administrative boundary lines were compiled on the topographic maps as reference data.
2. Road		
・Road network	Line	Road data are a network of the centerlines of main roads with double line and road properties were referred to Dhaka City Guide Map.
・Road facilities	Point	Point data to show the center position of a bridge along a main road with double line was produced as the road facilities except bridges closed to the public.
3. Railway		
・Railway	Line	Digital mapping data was directly used for route network that provided with property of railway gauge.
・Railway facilities	Point	The point data to show the center position of the facilities such as railway bridge and station were produced as the railway facilities.
4. Public facilities	Point	The point data to show the center position of facilities such as sites with the public buildings, the public society sites, the traffic site and the water control facilities were produced.
5. Water area		
・2 lines river	Polygon	Digital data were used directly for structuralization and polygon data were produced.
・1 line river	Line	Digital data were used directly for structuralization and line data were produced.
・ Lake, pond, dam	Polygon	Digital data were used directly for structuralization and polygon data were produced.
・Irrigation/drainage canal	Line	Digital data were used directly for structuralization and line data were produced.

10.3 Producing Geographic Feature Catalogue

ISO TC211 proposes to systematize and to define the data quality of geographic information to the users and also it is proposes to prepare materials about the definition of the acquired items and the codes about geographic features on the topographic maps through the production of GIS data.

In the setup of the encoding of the geographic feature, the code is given to the element, which composes a topographic map, and the code is classified and arranged in a systematic order, and the contents of each geographic feature are defined.

In the encoding of the geographic features, the category for encoding is shown in Table 10.3.1 "Category of Geographic Feature Code", the geographic feature groups are divided into nine main groups and each main group is divided into sub-group. The geographic features, which are data acquisition items in topographic map and belong to the sub-group, are encoded with 6 digits in which each 2 digits code shows each group.

Table 10.3.1 "Category of Geographic Feature Code"

Geographic Feature Group (Main category; 2 digits)		Sub-group in Geographic Feature Group (Sub-category; 2 digits)	Geographic Feature (Acquired data; 2 digits)
01	Administrative boundary	National boundary Administrative boundary	Each geographic features
02	Road and railway	Road Road facilities Railway Railway facilities	Each geographic features
03	Network	Transmission line, pipe line, etc	Each geographic features
04	Building	Artificial building： Built-up area Resident Public facility：International organization Government organization Educational organization Religion organization Private sector Warehouse, etc Utility, etc	Each geographic features
05	Water area	Water line River Lake and pond Dam River facility	Each geographic features
06	Land use	Boundary Public facilities, etc Traffic facilities, etc	Each geographic features
07	Vegetation	Vegetation boundary (Cultivation land, glass, etc) Vegetation	Each geographic features
08	Topography	Contour line Natural topography	Each geographic features
09	Control point	Geodetic control point Benchmark	Each geographic features

In the geographic feature catalog it is proposed to show the definition of data collection of the geographic features in order to make users ready to understand about contents of the topographic map data set. The geographic feature catalog data in accordance with ISO19110 is prepared for as follows:

- The geographic feature catalog information that are the information for identification and the inquiry to the geographic feature catalogue itself

- The geographic feature type, which shows the name, the definition, the identification code and

others of the geographic feature.

The geographic feature operation, which shows the function of the same geographic feature type, the attribute, the definition and etc.

- The geographic feature attributes, which show the characteristic of the geographic feature.
- The geographic feature relation, which relates between geographic features.

Refer to the supporting report on details of the geographic feature catalog.

10.4 Key Points for GIS Basic Data Production

Figure data produced by the standard MicroStation does not have topology information about figures, which is equal to ArcInfo, so it is necessary to build topology of figure in the GIS software in order to use those data as the GIS data.

In case of the direct use of MicroStation data as the cartography data of digital mapping, there is no problem about figure, but if those data are used for GIS data without compilation of topology, the following problems may be arisen:

1) Overshoot
2) Undershoot
3) Intersection, and
4) Duplications of arcs and etc.

On the other hand, GeoConcept provides useful and handy function for data entry concerning topology. If operators does not have the proper understanding, operator produce figure errors by themselves, so that it become difficult to check figure data.

Because the quality control in work was insufficient about the digital topographic data, which SOB previously produced, a geometric errors about the topology of figures and the connections among figures were not checked yet and data are in the condition that still contain this problems.

Installation of the GIS software by the Study was one of the goals of the technology transfer, and this aimed to remove any topology geometric errors and to build adequate figure data.

By converting the compiled data in MicroStation to ArcInfo, and establishing topology based on figure's geometry in each data feature, data processing were considered to correspond to the following items:

1) Computation of figure's geometry
2) Build of topology
3) Clearing figure's errors
4) Correspondence to GIS

Chapter 11 Production of Printing Film, PS Plate and CD-ROM

Buildings and Roads on Digital Map

As a reconnaissance survey in addition to the mapping of digital map in the map production, it is possible that it copes with of the measurement of building height with stores, preparations of the building database, the three dimensional measurement of the road network and the ground elevation of a pilot survey by the aerial photo and photometry surveying technology.

The below figure indicated the buildings displayed by blue color and roads with doubled lines displayed by the red color in the data acquisition items of digital map with a scale of 1 to 5,000.

The building data is expected to use as a base map for population survey in the census, urban planning, facility management of utilities including water supply, electricity, gas, telephone and etc., basic information to manage residential people and others.

Road data becomes an important data infrastructure for traffic planning, urban planning, disaster management planning. In the master plan of solid waste management, the evaluation for road accessibility of the garbage collection vehicle on road data is one of important items in the garbage collection planning.

Chapter 11 Production of Printing Film, PS Plate and CD-ROM

11.1 Production of Printing Film

Before producing PS plate, it is necessary to make negative films of each color from the digital topographic map data. This negative film is called as "Printing film". In general, the printing film is produced using the special printer for film printing color by color. In the Study, 4 printing films for each topographic map (printing film for black, red, green and blue) were produced in Japan.

11.2 Production of PS Plate

Before starting the production of PS Plate, SOB and Study Team discussed the specifications of PS Plate. The outline of specifications of PS Plate production was as follows:

1)	Printing machine:	Lithrone－40（2 colors printing machine）
2)	Available printing area:	720mm×1,020mm
2)	Size of PS Plate:	800mm×1,030mm
3)	Thickness of PS Plate:	0.30mm
4)	Color:	4 colors
5)	Relation of printing film and PS Plate:	Shown in Figure 11.2.1 "Relation between Printing Film and PS Plate".
6)	Punch hole of PS Plate:	SOB will make punch holes.

At the end of the 2nd year's Study, Printing films and PS plate for one sheet of 1:5,000 scale digital topographic maps were prepared and the test print was executed using the printing machine of SOB in Bangladesh.

By the end of the 2nd year's Study, PS plates for all 1:5,000 scale topographic map sheets were produced based on the above-mentioned specifications for the PS Plate.

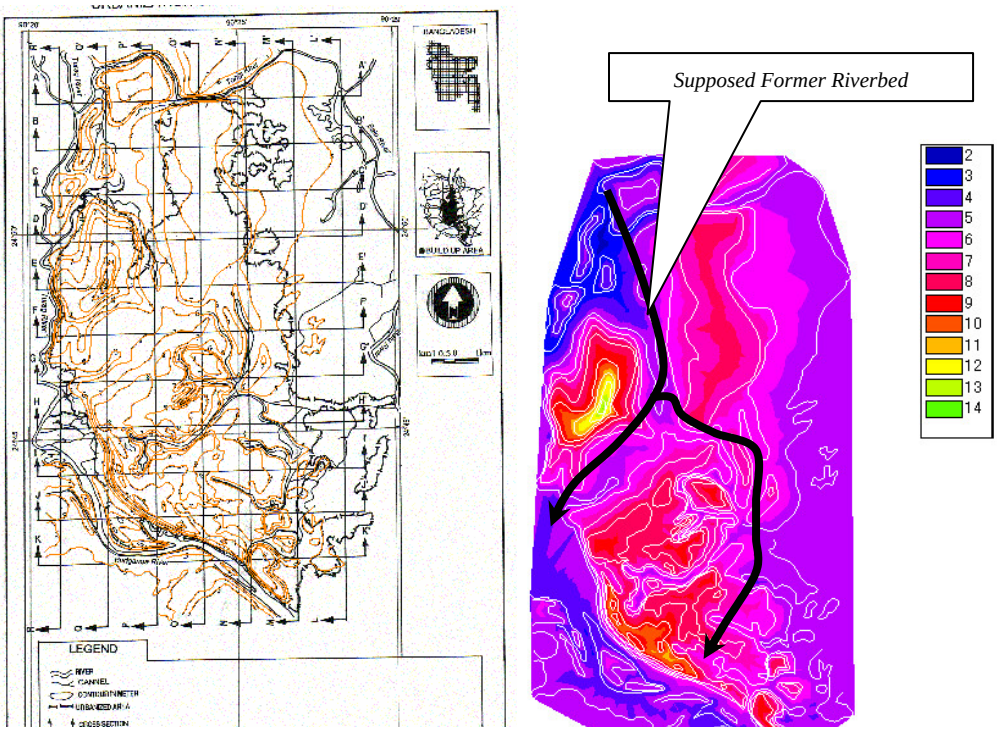
11.3 Production of CD-ROM

Following digital data are stored in CD-ROM as a part of the final products of the Study:

1)	Digital topographic map data	2 sets
2)	GIS Basic data	100 sets
3)	Digital aerial photo image	1 set
4)	1:50,000 scale digital orthophoto image	1 set
5)	1:5,000 scale digital orthophoto image	1 set

Chapter 12 Equipment Supply and Procurement of Printing Materials

Estimation of Topography and Former Riverbed in the Greater Dhaka City Area



Growth of the Dhaka city area is closely relating to the flood control and the water utilization, it is expected to develop database development of Geographic Information which is conducible for actual analysis and the future prediction by using flood condition, natural condition, social condition, regional development and so on.

Contour in the topographic map can be estimated about the grand elevation and relief so that it can expect to use and apply for data about relations among flooding and topographic surface, history of flooding and its control, estimation of the former riverbed and etc.

The Dhaka city area stands on the confluence points of rivers from Padma river, Jamuna river, Meghna river, the land form has been formed by the backwash of flood water caused by river inundation and the change of river bed. Stream gradient is extremely gentle and topography is formed by microscopic topography, natural bank and the former river bed without less relief in the whole.

The left figure shows the contour distribution of microscopic topography in the study area. Elevation is displayed from 3 m to 10 m. The right figure shows the display that is converted to grid cell of elevation (DEM) from contour in the topographic map.

Chapter 12 Equipment Supply and Procurement of Printing Materials

The JICA Bangladesh Office executed procurement and supply of equipment necessary for technology transfer at the 2nd year's Study on October 2003. Also, the Study Team executed procurement of materials necessary for the printing of topographic maps by SOB in 3rd year's Study from November to December 2003.

12.1 Selection of Equipment Necessary for Technology Transfer

On the Study, technology transfer for production of the 1:5,000 scale digital topographic maps and GIS basic data to the counterparts of SOB were planned to execute at the later half of the 2nd year's Study. For this purpose, the Study Team selected necessary equipment and software, and the JICA Bangladesh Office executed the procurement of selected equipment and software.

The necessary equipment and software were selected by the following point of view.

1) The equipment presently possessed by SOB should be use effectively as much as possible. The selection of equipment and software and necessary number of equipment and software should be decided from the viewpoint of availability of the existing equipment and software owned by SOB.

2) The equipment should be compatible to the existing equipment and software presently owned by SOB.

3) The maintenance of equipment and software condition in Bangladesh should be considered.

Considering the purpose of technology transfer and above-mentioned items, the Study team finally selected the following equipment and software for technology transfer for the 1:5,000 scale digital topographic mapping and GIS basic data production.

1)	Digital plotting system (SocetSet)	1 set
2)	Digital compilation system (Microstation)	2 sets
3)	GIS system (ArcInfo)	1 ser
4)	UPS	4 sets

The details of equipment and software procured by the Study are shown in Table 12.1.1 "Equipment of Digital Mapping System", Table 12.1.2 "Equipment of Digital Compilation System" and Table 12.1.3 "Equipment of GIS System and UPS".

Table 12.1.1 "Equipment of Digital Mapping System"

Item No.	Description	Part #	Q'ty
Software (Socet set)			
1	Core win	Win-1000-L	1
2	Core UE Win	Win-1000-UE	1
3	Stereo Win	Win-1010-L	1
4	Stereo UE Win	Wn-1010-UE	1
5	Block Win	Win-1030-L	1
6	Block UE Win	Win-1030-UE	1
7	APM Win	Win-1040-L	1
8	APM UE Win	Win-1040-UE	1
9	ATE Win	Win-1050-L	1
10	ATE UE Win	Win-1050-UE	1
11	Terrain Win	Win-1060-L	1
12	Terrain UE Win	Win-1060-UE	1
13	3D Win	Win-1070-L	1
14	3D UE Win	Win-1070-UE	1
15	True Ortho Win	Win-1080-L	1
16	True Ortho UE Win	Win-1080-UE	1
17	Ortho Mosaic Win	Win-1090-L	1
18	Ortho Mosaic UE Win	Win-1090-UE	1
19	Image Map Win	Win-1110-L	1
20	Image Map UE Win	Win-1110-UE	1
21	SPOT Win	Win-1230-L	1
22	SPOT UE Win	Win-1230-UE	1
23	Dodger Win	Win-2010-L	1
24	Dodger UE Win	Win-2010-UE	1
Hardware			
25	Work station for digital photogrammetric system Note: Pentium 4 Processor at 2.80 GHz w/8000MHz front side bus/512K L2 Cache 1 GB Dual Channel DDR SDRAM at 400 MHz (2x512M) Dell Quietkey Keyboard 19 in (18.0 in viwable) M992 CRT Monitor Additional 19 in (18.0 in viewable) M992 CRT Monitor New 128 DDr ATIRADEON 9800 Graphic Card with TV-Out and DVI 36 GB Serial ATA Hard Drive (10000RPM) 3.5 in Floppy Drive Microsoft Windows XP Home Edition Dell 2-button Scroll Mouse Integrated intel PRO 10/100 Ethernet 56K PCI Data/Fax Modem 16 Max DVD-ROM Drive Sound Blaster- Audugy 2 sound card with DVD Audio		1
26	Stereograpic Z screen non-integrated	SEBLRSVWIP1	1
27	3S Mouse	SEBLRSVWIP1	1
28	PRO600 (includes the PRODPW and PROCART items)	SEBLRSVWIP1	1
Others			
29	Data editing software Microstation J/7.1		1
30	PATB-NT for aerial triangulation		1

Table 12.1.2 "Equipment of Digital Compilation System"

Item No.	Description	Q'ty
1	**Computer Worksation for Digital Editing System**	2
	CPU :Interl Pentium 4 Processor, 2.4GHz,512/533 Front Side Bus	
	Memory: 512Mb PC1066 ECC RDRAM (2RIMMS)	
	Keyboard: Entry Level Quietkey Keyboard,PS/2	
	Graphics Card: ATI,FIRE GL E1,64MB,2VGA or 1VDA and 1DVI,(Dual monitor capable)	
	2nd monitor: 17 inch Flat Panel Monitor (17 inch vis)	
	Hard Drive: 80GB ATA-100 IDE, 1 inch(7200 rpm)	
	2nd Hard Drive: 80GB ATA-100 IDE, 1 inch (7200rpm)	
	Floppy Drive Options: 3.5 inch 1.44MB Floppy Drive	
	CD-ROM/CR Writer: 20/48 x IDE CD-ROM and 48 x/24 x /48 x CD R-W	
	Mouse: Intellimouse PS/2 (2-button, W/scroll)	
	Mouse Pad: Mouse Pad	
	Security Software: Antivirus (1 user license)	
	Operating System : Windows 2000 Professional (SP3) with Media using NTFS	
	Hardware Supports: 3yr parts with Labor	
2	**Work/Office Productivity Software**	2
	Office XP Professional	
	Word,Excel, Access, PowerPoint, OutLook Express and Other Standard tools	
	Adobe ACROBAT 5.0	
3	**CAD Software for Photogrammetric Data Editing**	2
	MicroStation /J 7.1 version	
4	**Raster and Vector Editing Software**	2
	Adobe Illustrator V 10	
	Adobe Photoshop V 7.0	
	A number of standard plug-ins and sample data inclued in the CD-ROMs	

Table 12.1.3 "Equipment of GIS System and UPS"

Item No.	Description	Q'ty
1	**Computer Worksation for GIS System**	1
	Processor: Interl Pentium 4 2.4GHz	
	Memory: 512Mb PC1066 ECC RDRAM (2RIMMS)	
	Mother board: ATX full feaatures mother board	
	RAM: 512 MB, HDD: 80 GB EIDE/AT ATAPI	
	Video Memory: Graphics Controller Built-in On Moter Board. Diskette Drive: one, 3.5 inch 1.44MB	
	Multimedia (CD-ROM Drive, Audio and Speakers: Internal Speakers and 40 x/12 x / 48 x EIDE CD WR Drive, ATAPI	
	I/O Ports: 1-Parallel, 2 PS/2 and USB Ports	
	Casing: ATX Mid Tower Casiing,	
	Key Board: Enhanced 104 Keys, PSA/2 Based	
	Monitor: 21inch NEC Color Monitor	
	Mouse & Pad: PS/2 Mouse with Pad	
	Software of Operating System: Windows 2000 Professional with License and Manual CD Media	
	Hardware Supports: 3yr parts with Labor	
2	**GIS Software**	1
	Arc/Info ArcGIS Ver 8.3 (for NT)	
3	**Security Software**	1
	Symantec Antivirus Corp ED 8.0 (5 User license)	
4	**UPS for Workstation**	4
	Model and capacity:APC Smart-UPS XL,1000V (670W),230 V	
	Runtime:3.21 hours at 41% load	
	Output&Interface: Output 2, Interface port6 DB-9 RS-232	
	Key Features: Automatic Voltage Regulator, Built-in Smartlot,Hot Batteries, Load meter, Overload indicator, Scalable runtime,Softqare an Repleacebale Batteries	
	Additioonal:Co with software, Hot swap batteries, User Manual and standard accessories	

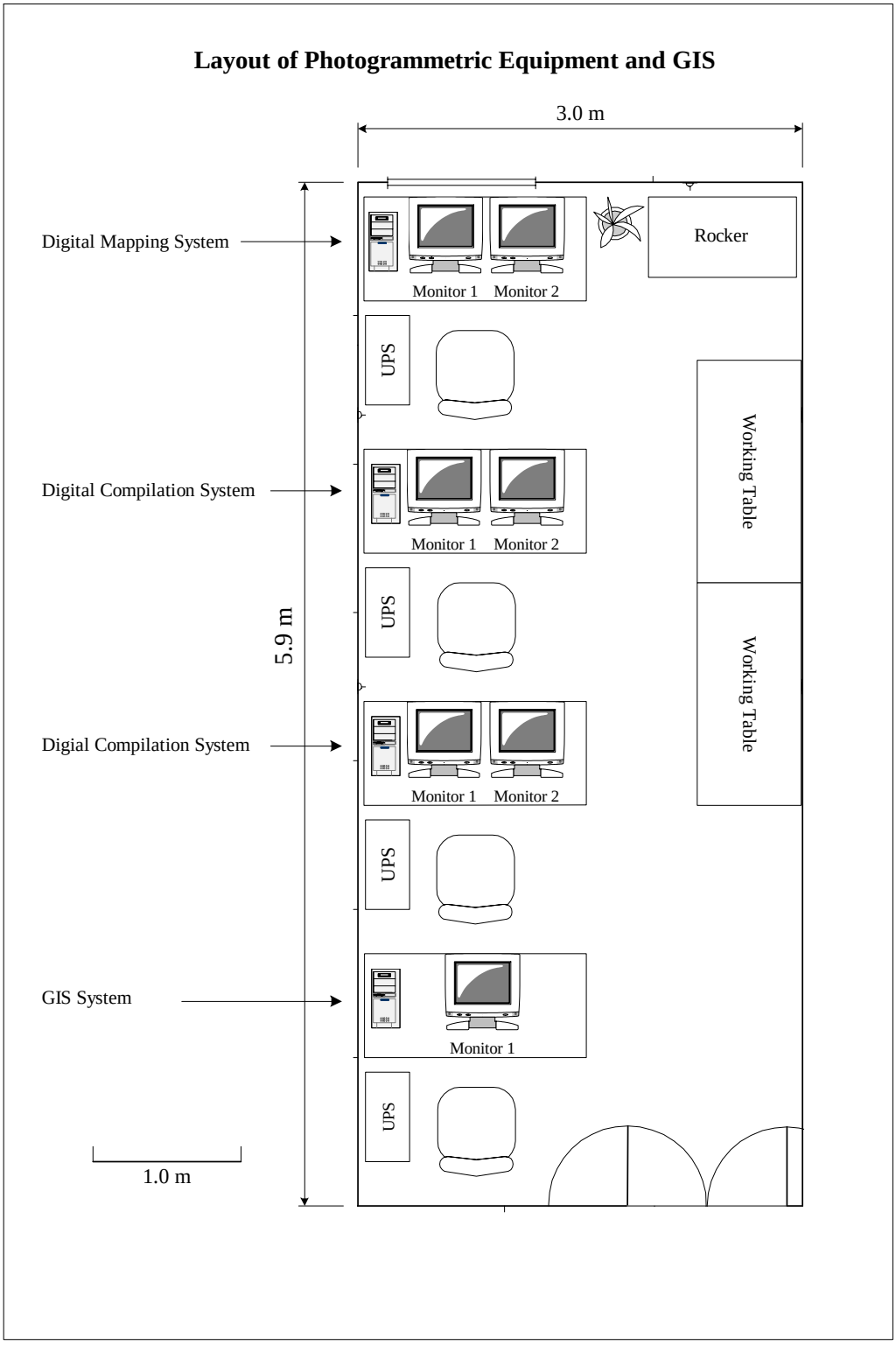


Figure 12.2.1 "Layout of Digital Mapping Room"

12.2 Installation of Equipment in SOB

SOB prepared one room of the digital mapping section for setting up the equipment necessary for technology transfer. This room already has air conditioner and enough numbers of plug outlets of electric supply to the equipment and sufficient space for installation of the equipment. SOB and the Study team agreed that the room would be used for installation of the equipment for the digital mapping system, digital compilation system and GIS system.

The Study team made a plan for layout of equipment considering the room space and location of plug outlets of electricity and size of equipments before installing the equipment in the room. The layout of equipment is shown in Figure 12.2.1 "Layout of Digital Mapping Room"

A local agent delivered the equipment and software necessary for the technology transfer to SOB in a period form the middle of November 2003 to the beginning of December 2003.

Photo 12.2.1 "Digital Mapping Room"

Photo 12.2.2 "Signboard of Digital Mapping Room"

Photo 12.2.3 "Digital Mapping Equipment"

12.3 Procurement of Printing Materials

In the Inception Report meeting, SOB requested to the Study team to provide the necessary materials for printing of the topographic maps which planned to be executed in 3rd year's Study by SOB.

The Study team was not in a position to answer for the request from SOB, because this was not mentioned in the Minute of Meeting of S/W agreed between SOB and JICA. Therefore, the Study team promised to

convey the request of SOB to the Head Office of JICA in Tokyo.

The Study team discussed with the Head Office of JICA in Tokyo concerning the request of SOB. The Head Office of JICA in Tokyo finally decided that necessary materials such as paper, ink, chemicals and so on for the printing of 1:5,000 scale topographic maps (total 122 topographic map sheets, 500 sheets each) would be procured by the Study Team in Bangladesh during the execution of 2nd year's Study, and supplied to SOB by the end of 2nd year's Study.

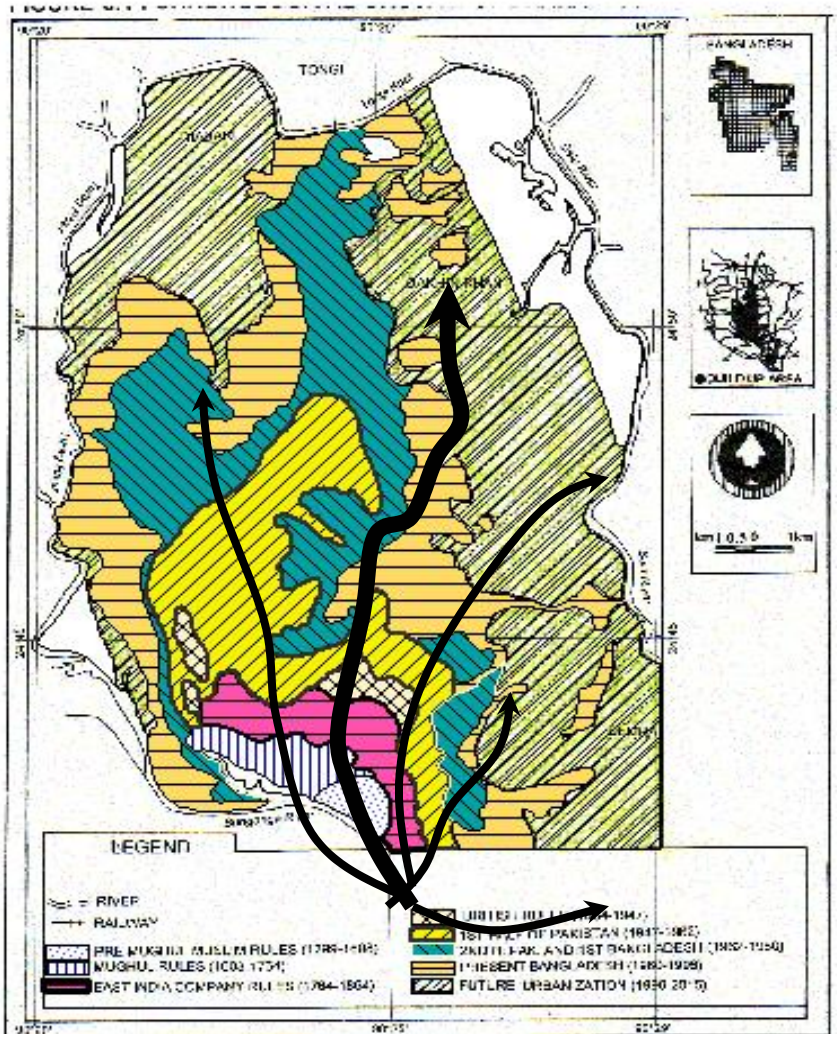
The volumes of printing materials were calculated as 700 sheets for each topographic map taking the necessary test printing and printing loss into consideration. The printing materials were procured at the end of November 2003 and delivered to SOB by the end of December 2003.

Photo 12.3.1 "Printing Materials (Part)"

Photo 12.3.2 "Printing Materials (Paper)"

Chapter 13 Technology Transfer

Transition of Urbanization in the Grater Dhaka City Area



The urbanization growth in the grater Dhaka had been spread from the OLD Dhaka located in the center at the southern part of the Dhaka to the north and to the surrounding area. The urban transition is the history of the urban planning and the figure shows a time series of results about master plan for urban planning and development in each sector in the Dhaka. In the regional planning it is important for the information infrastructure in fields relating to regional development and social infrastructure, it is also proposed to cooperate database among development agencies and to develop database of Geographic Information to support their planning.

Chapter 13 Technology Transfer

13.1 SOB's Digital Topographic Mapping Methods and the Technologies it Lack

SOB is in the process of digitizing existing 1:50,000 scale topographic maps using the digital compilation system introduced through the cooperation from France. Prior to the start of the transfer of technology, the Study team analyzed the digital topographic mapping method that SOB is using to digitize the topographic maps and compared that method with the digital topographic mapping method to be used in the Study, in order to identify technologies SOB needs to learn.

The results of the comparison of these workflows are as outlined below.

1) What SOB is doing is map digitizing, which is data acquisition in two dimensions, not three.

2) In map digitizing, the topographic maps as such are digitizing directly; basically, the operator doe not need to sort the data to be acquired. In photogrammetric method, on the other hand, the data to be acquired has to be sorted and selected from photo images. For this reason the operator has to have knowledge of and experience in subjects such as cartography, topography and photogrammetry. Such expertise is not required of an operator engaged only in map digitizing.

3) Aerial triangulation is not being carried out.

With regard to topographic mapping by photogrammetric method, SOB has the following problems in terms of human resources and organization:

1) SOB has little experience in creating topographic maps using analog photogrammetric method, and has few engineers experienced in creating topographic maps using an analog plotter. SOB possessed 6 analog plotters, but most of these are out of order at present; only one is usable, and that one is barely functional.

2) Some of SOB engineers have completed the training course for photogrammetry at ITC, the Netherlands, and elsewhere. But since they could not have any chance to use and test their knowledge in practical work at SOB, it is no exaggeration to say that there is almost no one with practical experience in topographic mapping by photogrammetric method.

SOB's problems in digital topographic mapping, as the Study team understood from technical discussion with the counterparts, are as follows:

1) The digital topographic mapping SOB has carried out so far has basically been map digitizing (2 dimensions data acquisition), and they have had no experience in 3 dimensions data acquisition.

2) Digital topographic mapping carried out by SOB is for the production of paper maps. Therefore, data structures of map features are not suitable for GIS. For example, in the process of digitalization, the Structuralization of features is not perfect and existing data have problem about the un-adjustment of the figure in data use to GIS.

   All these problems were caused by the shortage of understanding by SOB counterparts about the data structure and also by their miss-operations in the working. Furthermore, a problem about the quality control of the work of SOB need to be noted.

3) Since SOB has produced only small-scale topographic maps in the past, they have no understanding about the difference between medium- to large-scale topographic maps and small scale maps. For this reason they try to apply the images of the small-scale topographic maps directly to the medium to large-scale topographic maps. In short, they have no understanding of the method of concrete data acquisition by photogrammetric method and the basics of map compilation.

4) One digital plotter (SocetSet, Unix version) has been provided to SOB through the cooperation of France, but it is not being used effectively.

5) As a digital editing system, SOB is using software named GeoConcept which was introduced in French technical cooperation program. While GeoConcept has various functions ranging from map digitizing and map symbolization to GIS analysis, the software is not suitable for editing of large-scale topographic maps.

6) GIS software that other public agencies in Bangladesh are using is mainly ArcView/ArcInfo, and most of those agencies have not introduced GeoConcept. Therefore, there is some incorrect knowledge about the compatibility of the data exchange between SOB and other organization and experiences of data exchange also are insufficient.

7) As mentioned to the above, in order to make SOB to utilize digital data produced by GeoConcept as a property, SOB must make it clear to orientate the use of GeoConcept in consideration of the easy operability to use and its merits.

In considering the transfer of digital topographic mapping technology using the digital plotters and the digital compiler under the circumstances facing SOB, the Study team determined that it would be important to pay attention to the following points in carrying out the transfer of technology:

1) SOB must become to be able to acquire data three-dimensionally for digital plotting. However, 3D data acquisition differs from 2D data acquisition in that it requires a considerably high level of proficiency, and the aptitude of the counterparts muse be considered. The transfer of technology

to counterparts with little aptitude or capability would be a waste of time.

2) SocetSet and Microstation possess various functions, but in the production of the digital topographic maps the minimum functions necessary for digital topographic mapping should be used. SOB counterparts should master the other functions through private study.

3) The transfer of basic technology should be carried out through the actual production of at least one sheet of the 1:5,000 scale topographic map, under the guidance of the Japanese engineers of the Study team.

4) There is an interval of about 2 months between the end of the 2nd year's Study and the start of the 3rd year's Study. During this period, SOB counterparts should produce at least one sheet of 1:5,000 scale digital topographic map through their own efforts. In the 3rd year's Study, the Study team should inspect and evaluate the digital topographic map produced by SOB counterparts in order to check their level of understanding and to implement additional technology transfer as follow-up activities.

5) It was observed that still many errors, particularly relating to the geometry of features, exist in digital topographic data made by SOB. This indicate that SOB need to implement strict data management measures. Data need to be cleaned and arranged by using ArcInfo.

13.2 Preparation of Work Manuals

Since SOB has had no experience in producing medium to large scale digital topographic maps by photogrammetric method, for the purpose of carrying out the transfer of digital topographic mapping technology to SOB counterparts using the equipment and materials provided in the Study, work manual drafts as descried below were prepared in Japan following the work processes for digital plotting, compilation and GIS basic data creation used in Japan.

In drawing up the draft work manual, since actual key operations are given in detail in the manuals that come with the software provided by JICA, it was decided that the work manuals should mainly cover items not covered in the software manuals.

It is expected that these work manuals will be used as work guidelines when SOB produces medium to large scale topographic maps in the future, and also as reference books for training programs within SOB.

The work manuals prepared in the Study are as follows:

1) Digital plotting and compilation work manual
2) GIS basic data work manual

13.3 Technology Transfer of Digital Plotting Technology

13.3.1 Training by BAE systems engineer

BAE Systems supplied a digital plotting system through JICA's procurement of the equipment for technology transfer, and an engineer from BAE Systems set up the SocetSet at SOB, after which the engineer provided SOB staff with one week's training in SocetSet operations.

13.3.2 Technology transfer of digital plotting technology by the Study team

The transfer of digital plotting technology by the Study team to SOB counterparts was carried out through the counterparts themselves producing 1:5,000 scale digital topographic maps, using the digital aerial photo image and aerial triangulation results that were the products of the 1st year's Study.

In the technology transfer, specifically, the Japanese engineers gave the counterparts instructions in the method of concrete data acquisition item by item using SocetSet, and the counterparts produced two sheets of 1:5,000 scale digital topographic maps (map sheet No. 39 and No.53).

Because there was a blank period of about 2 months with no fieldwork between the 2nd year's Study and the 3rd year's Study, the Study team made a request to SOB for SOB staff to produce by themselves one sheet of 1:5,000 scale digital topographic map covering a new area.

Through the evaluation of the 1:5,000 scale topographic map produced by SOB counterparts themselves, it was possible to check the counterparts' level of understanding of the content of the technology transfer in the 2nd year's Study, and to implement in the 3rd year's Study a follow-up technology transfer of those parts of the technology transferred in the 2nd year's Study that were lacking or had been misunderstood.

13.4 Technology Transfer of Digital Compilation and Symbolization

The transfer of the specific technologies of digital compilation and symbolization was carried out first in Japan using the data acquired in the digital plotting work because this was easier with the data for which digital plotting was finished.

As described in the section of digital plotting, the method of technology transfer was for SOB counterparts to produce by themselves an actual 1:5,000 scale digital topographic map. When the counterparts had completed the digital plotting of map sheet No. 52 and 53 (work sheet number), the technology transfer moved on to the stage of digital compilation and symbolization in which the topographic map sheet was digitally compiled and symbolized, to produce the 1:5,000 scale digital topographic map.

As for digital plotting, for digital compilation and symbolization too, a request was made to SOB for SOB staff to produce by themselves one new sheet of the 1:5,000 scale topographic map during the interval period between the 2nd year's Study and the 3rd year's Study, during which there was no field survey.

The purpose of this request was, as for the digital plotting, to enable the counterparts' level of understanding of digital compilation and symbolization technologies to be evaluated, in order to determine what should be done in the 3rd year's Study in the follow-up to the technology transfer. Thus, the 1:5,000 scale digital topographic maps sheet No. 52 and No. 53 (work sheet number) were produced by SOB counterparts.

13.5 Transfer of Technology of the Creation of GIS Basic Data

As for the technology transfer about the preparation of the GIS basic data, the priority target aimed to produce the structure GIS data without any errors of figures by using GIS software, the on the job training were carried out to practice as follows:

1) GIS Structuralization of digital mapping data
2) Restructuring of the existing GeoConcept data by the cleaning of figures
3) Data exchange among system

In the training four counterparts were divided into two groups, and the training was carried out by the following approaches: alternately the repetition operation not only in the group but also between groups and crosses check of level of understanding.

Also, the practical training was done about not only data processing of digital topographic map produced by the Study but also other themes about the followings:

1) Cleaning of figures on digital data produced by relevant organizations
2) Editing of attribute
3) Arrangement of data such as administrative code, and so on.
4) Arrangement of map for data entry for GIS data

The GIS operation is not only for software operation of GIS. It is requested that the operation of GIS needs not only the operation of mere software but also the extensive knowledge including design of database and the understanding of database, system management, data's arrangement quality control management and the working management, so the technology transfer was instructed concretely with cooperative work with counterparts in SOB.

13.6 Counterparts Training in Japan

The counterparts training in Japan was executed two times (the middle and end of 2nd year's Study). The names of counterparts participated in the training in Japan and the purpose of training were as follows:

13.6.1 The 1st counterparts training in Japan

The outline of 1st counterpart training in Japan was as follows:

1) Name of counterparts

・Ms. Jahanara Sultana Sub-Assistant Superintendent
・Mr. Alauddin Draftman

2) Period and location

・Period: from 6th September 2003 to 28th September 2003
・Location: Asia Air Survey Co., Ltd.

3) Purpose

The purpose of counterpart training in Japan at this stage is to give the fundamental information of 1:5,000 scale digital topographic mapping and GIS basic data creation to the counterparts for smooth implementation of the technology transfer in Bangladesh. For this purpose, lectures and training of the following items were executed.

- Outline of aerial triangulation
- Outline of digital mapping
- Outline of digital compilation
- Outline of GIS basic data creation
- Visiting survey and mapping organizations in Japan

13.6.2 The 2nd counterpart training in Japan

The outline of the 2nd counterparts training in Japan was as follows:

1) Name of counterpart

・Brig Gen Muhammad Shafiqul Islam Surveyor General

2) Period and location

・Period: from 7th March 2004 to 24 Mach 2004
・Location: Asia Air Survey Co., Ltd.

3) Purpose

The purpose of the counterparts training in this stage is to confirm the contents of 1:5,000 scale of digital topographic maps created in the Study before making PS plates, and also to make understood the present situation of publishing and utilization of topographic maps and digital topographic data in Japan to the counterpart.

- Visiting to survey and mapping organizations in Japan
- Situation of utilization of topographic maps and digital data in Japan
- Situation of publishing of topographic maps and digital topographic data in Japan
- Final confirmation of 1:5,000 scale digital topographic maps

Photo 13.6.1 "Visiting to GSI Japan"

Photo 13.6.2 "Check of 1:5,000 Scale topographic Map by Surveyor General of SOB (at Asia Air Survey Co., Ltd.)"

13.7 Follow Up of Technology Transfer

The fundamental knowledge and technique of digital topographic mapping, digital compilation and symbolization and creation of GIS basic data was already transferred to the counterparts by the end of the 2nd year's Study. However, from the viewpoint of quality control and production management, the staff of SOB are still low level due to the reason of lacking of actual work experience in digital topographic mapping by themselves.

From now on, the staff of SOB have to executed the actual digital topographic mapping and GIS data creation under the condition of limited time and also limited budget using the equipment and software donated by JICA effectively. Therefore, the Study team requested the counterparts of SOB to produce the three sheets of 1:5,000 scale digital topographic maps by themselves during the period of the middle of March 2004 to the end of May 2004 by themselves.

In general, when facing the problem, the staff of SOB has a tendency to ask the members of the Study team or other person for help and do not try to solve the problems by themselves. Frankly to say, several staff of SOB has no intension to study by themselves and they are always passive. The most important matter for the staff of SOB is to study by themselves and also to solve the problems faced by themselves from now on. Therefore, the Study team requested SOB to create the 1:5,000 scale digital topographic maps and GIS basic data by the counterparts during the absence of the member of the Study team in Bangladesh.

At the 3rd year's Study, the Study team evaluated products of the 1:5,000 scale digital topographic maps and GIS basic data created by the counterpart by themselves. Based on the evaluation, the Study team executed the additional technology transfer to rectify the misunderstanding points or lacking of understanding in the production of digital topographic mapping and GIS basic data creation were executed by the Study team to the counterpart.

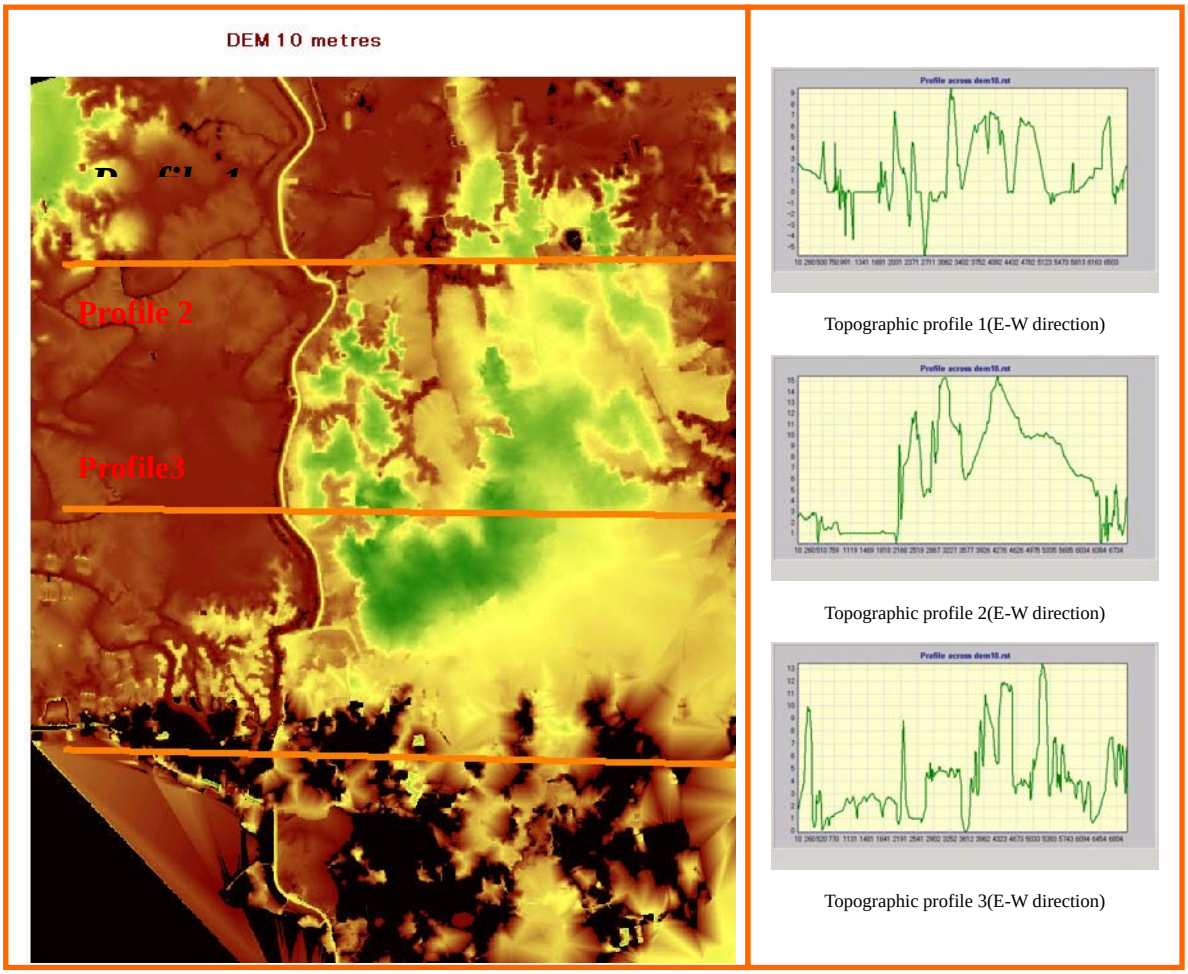
13.8 Evaluation of Counterparts

Paper test and operation test were executed at the end of 2nd year's Study and 3rd year's Study to judge and evaluation the technology transfer of digital topographic mapping and GIS basic data creation to the counterparts.

The evaluation of each counterpart was summarized and evaluation report of counterparts was submitted to the Surveyor General directly from the Study team.

Chapter 14 Seminar

DEM and Topographic Profile



Topographic profile 1(E-W direction)

Topographic profile 2(E-W direction)

Topographic profile 3(E-W direction)

The left figure was produced as a DEM, so called Digital Elevation Model, by using the contour line with the 2 meters interval in the digital map and three profiles from East to West are drawing in the DEM. The right figure shows the drawing of profiles about the cross sections on geographical features from East to West. As for Dhaka city area, a city area has been developing in the natural embankment, and that development is the history of the flooding and the flood countermeasure. It is imagined that there are situations of the reclamation of the river bed and the development of the town according to the geographical cross section in the natural condition as shown in the above.

It is expected that elevation data and profile of geographical section are utilized to the geographic information in the social infrastructure including road, water supply and sewerage, drainage, urban landscape and the flood control and so on.

Chapter 14 Seminar

At the end of the 3rd year's Study, seminar inviting the officials of authorities and organizations, personnel and so on concerning the Study was held jointly by SOB and the Study team on the end of June 2004 at Dhaka to explain the contents and the final products of the Study to them.

14.1 Objectives of the Seminar

The objectives of the seminar were:

1) To make understand the contents of the Study, workflow and significance of the Study for SOB and also vital issues of SOB to not only counterparts participating the Study but also other staffs of SOB who are not participating in the Study directly.

2) To show and explain the final results of the Study such as the 1:5,000 scale digital topographic maps and digital data and GIS basic data produced by the Study to the agencies and organizations expected to be users in Bangladesh and also to promote these final results to be used effectively by them.

3) To held the meeting between staff of SOB and other agencies and organizations in Bangladesh for exchanging the opinions and requests to SOB especially concerning the future SOB's activities.

For the above purpose, guest speakers were invited and the guest speakers were requested to explain the importance of basic data such as an accurate large to medium scale digital topographic maps, GIS data to solve the various kinds of problems arising in Dhaka Metropolitan Area. For this purpose, SOB and the Study team invited following tow persons for guest speakers for the seminar.

14.2 Agenda of the Seminar

The agenda of the seminar was as follows:

1) Time and date: 10:00 – 14:00, 26 July 2004, Monday
2) Venue: Ball Room, Dhaka Sheraton Hotel
   1, Minto Road, G.P.O. Box 504, Dhaka 1000
3) Agenda

09:30	Registration
10:00	First session
11:30	Tea break
12:00	Second session
13:40	Prayer time/Leg stretch break

14:00 Lunch
15:00 End of seminar

14.3 Participants to the Seminar

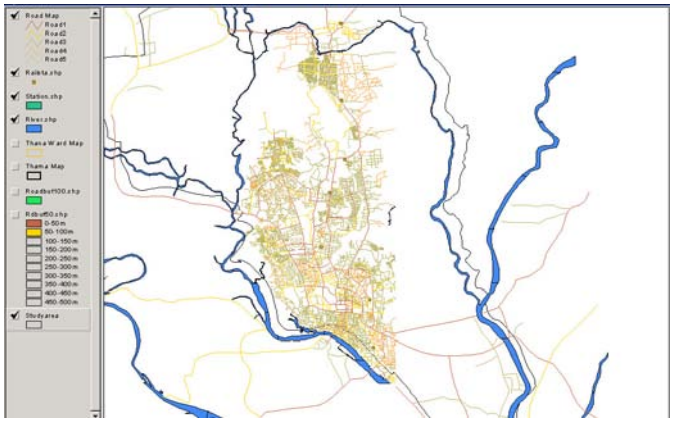
Approximately 180 persons from about 80 authorities and organizations including medias were participated in this seminar.

Chapter 15 Final Products of the Study

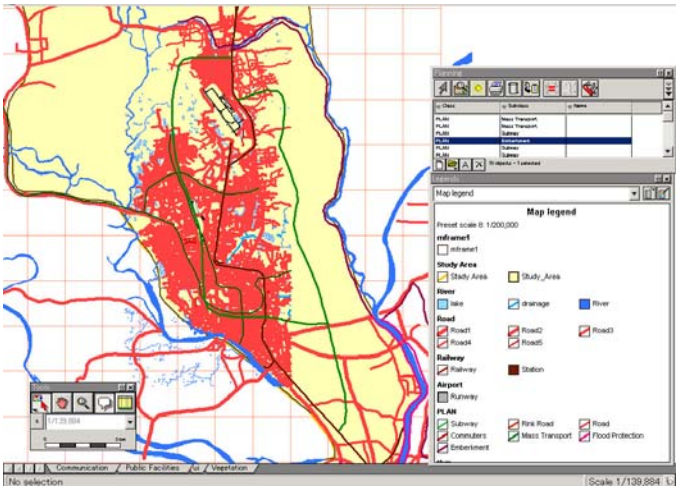
Thematic Map Relating to the Traffic Network

Road and railway are major transportations ways mainly in the Dhaka city area and road data based on the large map scale is expected to utilize for the infrastructure management. The below map was compiled to the thematic map of the traffic and the transportation about

Data were compiled about a traffic route and road information and the information on the social infrastructure that a plan is scheduled about the road network which influences a traffic infrastructure based on the topographical map, and those data were produced as a thematic map by making future plan to plot on the base map.



The present situation of traffic infrastructure in the Dhaka Metropolitan area



Future plan of social infrastructure in the Dhaka Metropolitan area Subway plan, mass transportation plan, bypass road plan, construction plan of embankment

Chapter 15 Final Products of the Study

15.1 Final Products of the 1st Year's Study

The final products of the 1st year's Study are as follows:

1) Aerial photography

- 1:20,000 scale negative film	1 set
- 1:20,000 scale positive film	1 set
- 1:20,000 scale contact print	1 set

2) Ground control point survey

- Description of control point	1 set

3) Scanning

- Scanning data of positive film	1 set

4) Report

- Inception report	20 sets

15.2 Final Products of the 2nd Year's Study

The final products of the 2nd Year's Study (Phase 1 and 2) are as follows:

1) Aerial triangulation

- Aerial triangulation results	1 set

2) 1:5,000 scale topographic map

- Printing film	1 set
- PS plate	1 set

3) Digital data

- 1:5,000 scale digital topographic data	2 sets
- 1:5,000 scale GIS basic data	100 sets
- 1:5,000 scale orthophoto data	1 set

4) Report

- Progress report	20 sets
- Interim report	20 sets
- Draft final report	
Main report	30 sets

Summary	30 sets

15.3 Final Products of the 3rd Year's Study

The final products of the 3rd year's Study are as follows:

1) Final report

- Main report	50 sets
- Summary	50 sets
- Supporting report	50 sets

2) Printing map

- 1:5,000 scale printed topographic map	500 sets (printed by SOB)

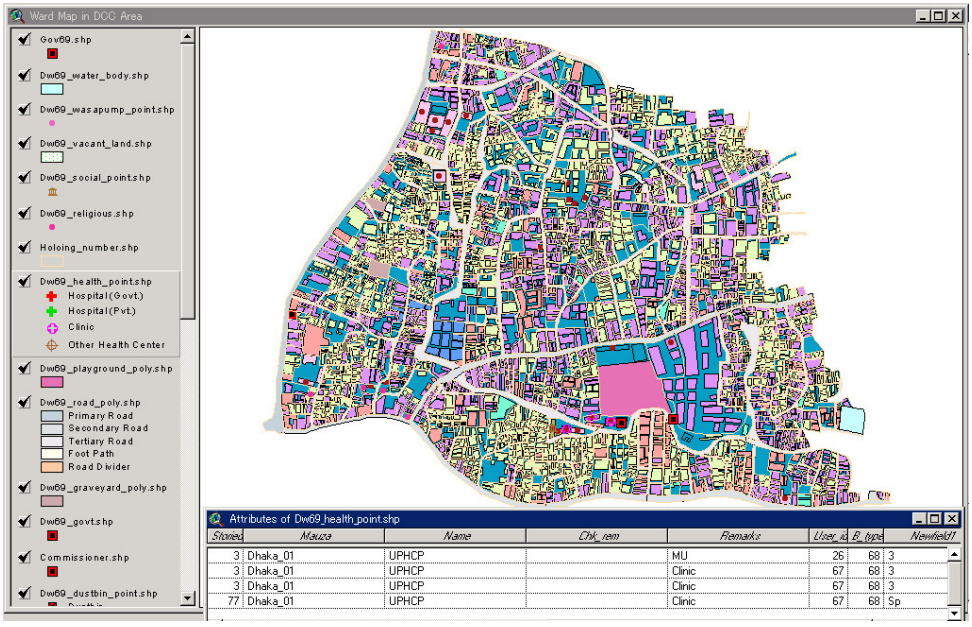
Chapter 16 Recommendations to SOB

Ward Map in the Dhaka City Corporation

The DCC so called Dhaka City Corporation, carry out the investigation of utility survey including to buildings, public facilities, utilities in each ward about 90 wards in the whole in addition to the measurement survey for the mapping survey.

The below figure is the Ward map compiled as the GIS data.

This data was produced by the field survey, so the completion of the data is high, but the large scale topographical map to manage investigation data, and the supporting system are required to manage the urban information.



Chapter 16 Recommendations to SOB

The Study team has drawn up its recommendations to SOB as described below from the implementation of the Study.

16.1 The Role of Survey Agencies in Various Countries

The following trends are currently apparent in survey agencies in countries around the world:

1) Government survey agencies in the developed countries used to be regarded as survey and topographic mapping agencies, but they are being switched over to planning or data management agencies. The system is shifting to one that the actual work of survey and topographic mapping is contracted to private organizations.

2) In the developing countries, there are two trends; there are some countries in which the governmental survey agency is in the process of shifting from being a survey and topographic mapping agency to being a planning agency, as in the developed countries; and other countries in which the survey agency retains its position as implementing agency.

   The countries in Central Americans and ASEAN switched their survey and topographic mapping agency to a planning agency. This tendency is often seen in those countries where the technical capabilities and production capacity of private survey organizations have reached a certain level.

3) In those developing countries where no private survey and mapping organizations have developed, or even if there are private survey organizations, but problems in technical capabilities or production capacity exist, the governmental survey and mapping agencies are regarded as the implementing agencies for survey and topographic mapping.

4) The above-mentioned trends regarding the governmental survey agencies are a question of national policy –whether the aim is for large government, or small. Basically, in an economic situation in which increase in the government budget cannot be anticipated, the working inefficiency of government agencies is seen as a problem, resulting forces pushing for the switch to a more efficient social structure.

Considering from the above viewpoint, SOB of Bangladesh is regarded as the implementing agency for survey and topographic mapping. Considering the present state of affairs regarding private survey organization in Bangladesh, it can be said that there is no private survey company capable of photogrammetric mapping, judging from the present regulations in the country of Bangladesh, and it is also hard to imagine that any private survey company capable of photogrammetric mapping can be developed in the near future.

However, if we consider SOB's present problems, especially its work efficiency, costs, work implementation capabilities and human resource education, there are doubts as to whether SOB should continue to be the implementing agency for survey and topographic mapping or not.

In most of the developed countries, the Government survey agency has moved from being an implementation agency to being a planning agency, and in some developing countries too the same trend can be seen. In Bangladesh also, it may be inevitable that the future form of SOB will shift from the implementation agency to a planning agency.

In consideration of the survey-related conditions SOB facing in Bangladesh, it would be necessary to consider the following middle- and long-term policies:

1) Definition of the roles and position of SOB as a government agency
2) Establishment of middle- and long-term plans for SOB
3) Establishment of a cooperative relationship between SOB and other government agencies in survey and topographic mapping
4) Training of engineers capable of planning and work management in survey and topographic mapping
5) Prevention of exodus of talent
6) Technology transfer between the staffs of SOB
7) Quality control and schedule management
8) Fostering of private survey companies in Bangladesh

16.2 SOB's Organization and Contents of Work

The present situation of SOB and the contents of work to be implemented, together with the form SOB will take in the near future, can be summarized as follows:

16.2.1 Aerial photography

Judging from the record of aerial photographs taken in Bangladesh in the past, it is unthinkable that there will be aerial photography to be done every year. In addition, huge expenses are required to maintain the aircraft and aerial camera for aerial photography, and to hire the pilots and mechanics needed for the job, and unless there is a certain quantity of work it would be practically impossible to keep facilities and manpower for the aerial photography. Therefore, for the time being it will be realistic to commission foreign aerial photography companies to do the aerial photography.

16.2.2 Photo processing

As it has already been stated, the photo processing equipment possessed by SOB is quite old, and because of a lack of maintenance funds a lot of the photo processing equipment is out of order and remains un-repaired. At the same time, under the regulation of the Ministry of Defense, the processing of aerial photographs is

limited to do only in the SOB's photo processing facilities or a designated facility. Thus, as far as the regulation exists, the SOB's photo processing facilities cannot be destroyed.

However, when we consider the actual condition of SOB's photo processing equipment, it is difficult to say that it would be possible to develop, print and enlarge aerial photos using SOB's equipment. On the other hand, since the scanning of aerial photo images has become the main method in the digital photogrammetry, now it is time to revise the approach to photo processing facilities. Specifically, SOB's photo processing facilities should be operated in the following way:

1) So long as the Ministry of Defense of Bangladesh regulations prohibit the developing process of aerial photos being undertaken in any facility other than SOB's or a designated facility, SOB's photographic processing facilities cannot be destroyed.

2) Therefore, it is necessary to provide SOB's facilities with the minimum equipment needed for the development and contact printing of aerial photographs. However, looking at the quantity of aerial photography work and considering the costs of maintenance and operation, the introduction of automatic developing equipment is deemed to be impracticable.

3) However, with the development of digital photogrammetric method, aerial photo images are increasingly being used as digital data. In the production of enlarged photo mosaic and orthophoto, the enhanced performance of the plotter means that processing can be done perfectly using outputs from the plotter, without printing them on paper. It follows that the equipment for enlargement etc. will lose its importance in the future, and any of the equipment that breaks down should not be repaired but discarded as it breaks down.

4) Under these conditions, the size of the staff in the photo processing section can be kept to a minimum.

16.2.3 Aerial triangulation

In implementing photogrammetric mapping, it is necessary to carry out aerial triangulation using the results of ground control point survey. With the development of GPS, the main method of aerial photography at present is the GPS aerial photography in which aerial photography is carried out with measurement of the coordinates values of principal points by the GPS installed in the aircraft. This technology makes it possible to reduce the number of ground control points needed for aerial triangulation.

The GPS aerial photography makes it possible for the aircraft to fly exactly on the planned courses, and for photographs at the location of planned principal points and eliminating the problems of gaps of stereo models, and insufficient side-laps between flight courses. In addition, photo index map can be produced automatically.

Considering the advantages of GPS aerial photography in ensuring a high degree of accuracy in aerial triangulation using a smaller number of ground control points, there is no doubt that future aerial photography will increasingly use the GPS aerial photography. However, should SOB wish to carry out aerial triangulation in the future, SOB must solve the problems described below.

1) In the Study, the problems of equipment and software programs were solved by the procurement and provision of equipment, and it makes implementation of aerial triangulation possible with the (SocetSet) and the necessary programs.

2) However, in order to carry out aerial triangulation using SocetSet the aerial photographs must be digitized, but the aerial photo film scanner at SOB is out of order and there is no prospect to be repaired. The cost to repair this film scanner is considerably high.

3) Considering the present situation of SOB, it is difficult to imagine that aerial triangulation will be carried out several times a year, and so it would be very difficult for SOB to maintain the technical level of aerial triangulation. As the accuracy of aerial triangulation has a great influence on the accuracy of topographic mapping by photogrammetric method, it is essential that the technical level be maintained at all times at a certain level.

Considering these problems, for the time being a realistic way for SOB to deal with aerial triangulation will be to commission the work of aerial photography to a foreign aerial photography company, under the following conditions:

1) An order to combine the following three types of job should be issued to the aerial photography company:

   - GPS aerial photography
   - Film scanning
   - Aerial triangulation

2) Aerial triangulation should be carried out by the aerial photography company using the results of a ground control point survey necessary for aerial triangulation.

For the time being, aerial photography including aerial triangulation should be carried out using this scheme. When the amount of topographic mapping work by photogrammetric method within Bangladesh increases to the extent that there is enough work for SOB to carry out aerial triangulation, then it would be desirable for SOB to be able to do the aerial triangulation by himself. When the time comes, SOB will have to decide whether to repair the film scanner that is out of order, or to purchase a new film scanner.

16.2.4 Cartography

In topographic mapping using the analog method, scribing and drawing were carried out in the cartography section, but in topographic mapping by digital photogrammetric method, the skill of scribing and drawing have become unnecessary. With the development of digital photogrammetric mapping method, it is natural that the techniques needed should change. It is, therefore, necessary for SOB to go with the current and modify its organization and personnel structure. SOB's cartography section may need from now on to become specialized in map inspection.

16.2.5 Digital mapping and GIS

If SOB is to shift to the digital photogrammetric mapping method, the analogue plotting equipment owned by SOB may not be as necessary as before. If broken equipment is left un-repaired, it does not make any sense to own it. However, the analog plotting equipment is a useful device to study and understand the principles of plotting and plotters, and with exception of the one set of plotting equipment that is at present not out of order, it may be practical thought to dispose the other equipment.

In the future, the introduction of digital mapping equipment to replace the analog mapping equipment should be considered; but even if the price of digital mapping equipment has been falling, it is still expensive so that it will be necessary to work out a long-term plan for the introduction, and for the effective program to train the personnel needed to do the actual work. For this it is absolutely essential for SOB to draw up a long-term plan.

About the topographic maps of 1:50,000 already produced with GeoConcept, it is necessary to restructure data in consideration of the correspondence of mapping data to the GIS data. To succeed to the previous data resources in SOB, it is necessary to prepare data without errors according to the adequate editing of data structure.

Background of an extensive knowledge is necessary for persons in charge of GIS and also persons in charge of digital mapping and digital compilation and symbolization. It is necessary to understand the structuralization of data and actual work experience and it is demanded for technology management and quality management to supply precise data there is no waste.

16.2.6 Geodetic survey

The geodetic section is an active section in SOB, and it is needed to continue to establish the second and third geodetic control point network and benchmark network. There is no difference in the basic observation technology for a GPS observation for establishment of geodetic control point network and ground control point survey for photogrammetric mapping, but a ground control point survey requires the skill of identifying the observation points on an aerial photos (pricking skill).

The ground control point survey is a survey done in order to establish points to provide the heights and horizontal positions for the aerial triangulation. To distinguish this from the GPS observation for

establishment of geodetic control network that is the mainstay of the survey system, it is necessary to prepare an operation manual or rules for ground control point survey for photogrammetric mapping to fulfill the purpose and accuracy of the survey.

In ground control point survey, pricking skill are indispensable, but only a limited number of SOB geodetic engineers and surveyors are able to carry out pricking work reliably. Thus, for SOB to go on in the future to produce medium to large scale topographic maps, the SOB geodetic engineers and surveyors will be required to master pricking skills.

At the same time, recent advance in surveying equipment have made it possible for anybody to obtain the survey results easily if they use expensive equipment and the latest computation and analysis software. However, the engineers and surveyors have to decide whether the computed results are suitable or not. For this reason too, it is necessary to implement accuracy control and process management for each work process, and to train up middle class engineers and surveyors who can do these jobs.

It follows that the engineers and surveyors in the SOB geodetic section will need to have the following knowledge and experience:

1) Photo interpretation skill
2) Topographic map interpretation skill
3) Pricking skill
4) Field identification skill for medium to large scale topographic mapping
5) Accuracy control and process management

16.2.7 Printing

Like the geodetic section, the printing section in SOB is also an active sector. If we consider the present situation regarding the use of topographic maps in Bangladesh, it is hard to imagine that the volume of map printing will drop in the future. However, with the spread of digital topographic maps, the worldwide trend is changing the data providing method from paper maps to digital topographic map data, and there is no doubt that Bangladesh will be in the same direction in the future.

Within this trend, it is necessary for the printing section to consider at this moment what kind of work it should do in the future. For example, work that should be implemented by SOB in its role of survey and topographic mapping agency could include the production and printing of atlases and the production, printing and publishing geography textbooks to be used in elementary and secondary schools in Bangladesh.

16.2.8 Provision of topographic maps and data

By the fact that it has produced only small scale topographic maps, it appears that SOB has make no effort to build a close relationship with other agencies in Bangladesh. The same kind of tendency is seen in all the government agencies of Bangladesh.

As previously described, the production of medium to large scale topographic maps involves work that cannot be carried out by SOB alone, which makes tie-ups and cooperation with other related agencies indispensable. Further, when the medium to large scale topographic maps are used by the various agencies, the maps will become significant, and through their use, SOB will receive requests for medium to large scale topographic maps to cover new areas, and the revision of secular changes from the user agencies.

In addition to working to deepen connections with other Bangladesh agencies, SOB must strengthen the sections in charge of the provision of topographic maps and map data, and must revise procedures so that it is easier for the other agencies to use them.

At the same time, in order to make SOB profitable, it is also necessary to review the selling prices of topographic maps and digital maps data, and to deal with unauthorized copying in the future. Furthermore, it is necessary to revise the present regulation for the provision of topographic maps and survey data of SOB because there are no rules for digital topographic data.

16.3 Recommendation of Operation

16.3.1 Necessity of formulating of long-term plan

At the present time, when survey technology is so advanced, the huge amounts of money and time required in the past to establish geodetic control points and produce topographic maps are no longer needed. However, the cost and time required for these tasks are still not small. In addition, although the spread of digital topographic mapping through the use of GPS, digital levels and digital photogrammetric method has contributed to higher accuracy and efficiency in surveying and topographic maps production, the electronic equipment needs higher maintenance costs but has shorter life of performance than that of analog equipment, results increase in expenses for equipment renewal, and higher indirect costs for survey and topographic map production.

Against the background, it is considered important for SOB to continue to make efforts to lay down laws, regulations and standards of survey and map production that SOB carries out, and to prepare the standards, the basic specifications of topographic mapping, and the qualifications rules for survey engineers and surveyors in Bangladesh; and also for SOB to formulate plans for the survey and topographic map production projects to be implemented over the next 5 to 10 years. Show them to the users and the other related agencies and have them approve the SOB project plans.

This will allow the users to estimate when the basic survey products and topographic maps will be completed, and to use the data effectively to determine their own plans. In addition, this will bring advantages for the country of Bangladesh as a whole; a reduction of the duplicate costs incurred separately by individual ministries and agencies in producing digital topographic data and GIS data, standardization of the accuracy of the data produced by individual ministries, shared use of data between the ministries and agencies, etc. At the same time, on the basis of these plans SOB will be able to draw up medium- and long-term budget

plans which will be able to use as basic materials when requesting budgets for the budgeting authorities. This will make it possible for SOB to coordinate overall survey and topographic map production and to cooperate with the related agencies to secure budgets, human resources and equipment for the medium- and long-term plans and to put them to effective use.

16.3.2 SOB's role and its relationship with related agencies

In Bangladesh, SOB carries out the establishment of geodetic control point network and benchmark network, and topographic map production in accordance with the work rules of the Ministry of Defense Bangladesh, and the use of products of these surveys is also in accordance with the rules of the same Ministry. The use of aerial photographs and topographic maps is restricted for reasons of national defense, and as a general rule the use, for which a charge is made, is restricted to those national government agencies and related public corporations. The agencies have to apply to use the maps and data in the prescribed form with official documents and obtain the permission in the name of the Surveyor General of SOB.

Meanwhile, because of the strict restrictions on the use of topographic maps and aerial photographs, the other government ministries and agencies of Bangladesh have developed digital topographic data by themselves using simple methods (satellite images, existing cadastral data, etc) and have built the GIS they needed, based on the digital topographic data created. For this reason, various problems have arisen, including the duplication of the costs of producing the digital topographical data, inconsistency in accuracy, and because of this inability of the agencies, sharing data.

To solve these problems, the Government of Bangladesh and SOB must take the following measures immediately:

1) The government of Bangladesh must establish SOB as the agency for the planning of surveying and mapping and data production, and for the supply of topographic maps and data.

2) As the agency for surveying, production of topographic maps and the supply of data, SOB must be responsible for supplying the necessary data in line with the requests of the agencies needing the data.

3) To this end, the present restrictions on the use of aerial photographs and topographic maps must be deregulated in order to establish a system that will make it easier for the agencies that require the data to use.

4) For the above purpose, some organization such as a committee must be set up where the surveying and topographic mapping agency and user agencies can meet regularly or as needed, to exchange information and requests.

5) It must be possible to discuss in this committee the medium- to long-term plans for surveying and

topographic maps production in Bangladesh, and the standards for surveying and topographic mapping in Bangladesh.

The mapping data and the geographic information data supported by SOB must be corresponded to the standardization (ISOTC211) of the geographic information that is worldwide trend. In Bangladesh there are dispersions and confusions in the Geographic Information data that each organization produced because the large scale map as a base map for GIS is not supplied.

Therefore, it is necessary to establish spatial data infrastructure to be able to become data arrangement in order to absorb the dispersions of Geographic Information because there is no existence of accurate topographic map. As for the data on the Geographic Information, it is important to compile the data on digital topographic data SOB supplies, which data resources are from government agencies, administrative organizations and private companies.

There are following important data resources in relation to the spatial data infrastructure in Bangladesh.

1) Administrative boundary maps in the national census survey in the Statistics Department,
2) Administrative boundaries in regulating authorities,
3) Election districts and those relating statistic data, and
4) Existing Geographic Information data and so on.

16.3.3 Shortage of maintenance budget

The changes in SOB's budget are described in paragraph 2.3.3 and shown in Table 2.3.1. Although the personnel expenses have slightly increased over the past 5 years, project expenses have fallen. In 2002 and 2003 the budgets were recovered a little. What is seen as a particular problem in the budget of SOB is that in terms of the percentage of the total budget and as a total amount, expenses for maintenance are very low and have no increase at all.

It is unclear whether the maintenance costs are budgeted only for maintenance and repair of equipment or include the maintenance and running costs of the SOB building and other facilities; but from the state of repair of the equipment and materials possessed by SOB, it is patently clear that a sufficient budget has not been allocated to the maintenance and procurement of the equipment and materials owned by SOB.

On the other hand, the electronic equipment now used for surveying has shorter performance life than that of analog equipment. This means that because of the regular renewal of equipment and the use of more computers and plotters, the expenses for supplies and the necessary maintenance costs tend to be higher compared to the time when analog equipment was used. From the above reasons, increased maintenance expenses are absolutely necessary in order to maintain and manage the present surveying equipment.

However, as maintenance expenses are restricted to execution within Bangladesh, it is impossible to order

any maintenance work directly to an overseas manufacturer; domestic agents should do the arrangement on the orders.

For equipment such as computers, there do exist the proper agents in Bangladesh, but for special equipment such as surveying equipment, there is often no agent in Bangladesh. If an agent has sufficient technology and experience with regard to the products, there may be no problem, but when the agent functions only as an importer and marketer, any after-sales services or maintenance are virtually impossible.

In addition, if there is no import and sales agent in Bangladesh, it is practically impossible to procure any repair parts within the country. For this reason, it can be pointed out that there are so many cases that minor trouble makes expensive equipment inoperable and unable to be repaired, and the equipment is thus left unused. Some typical cases in SOB of defective equipment remaining out of order and un-repaired for the above reasons are given below:

1) Plotter in the digital mapping section
2) UPS in the digital mapping section
3) Scanner for negative films in the digital mapping section
4) Equipment in the photo processing section

16.3.4 Provision of data and income

In the interview survey for the users of digital topographic data and GIS held in the Study, the principal comments of the user agencies regarding to the use of the topographic maps and digital data produced by SOB were as follows:

1) The procedures to use the SOB topographic maps and data are burdensome and time-consuming.

2) As the topographic maps and digital data supplied by SOB do not contain coordinates values, their use is limited.

3) The topographic maps produced by SOB are mainly small-scale topographic maps, but the other agencies want to have large-scale topographic maps.

For these reasons, the other agencies in Bangladesh produce for themselves the topographic maps they need, but because of the problem of accuracy and the problem of the duplication of budgets, the Government of Bangladesh considers that it will be a national interest of the entire country to promote the immediate provision of topographic maps and digital data from SOB. For this reason, the present various rules and regulations for the provision and sale of topographic maps and digital data should be revised into a more user- friendly forms and contents.

In carrying out the work of producing new topographic maps and digital data and revising and correcting

them, naturally SOB needs expenses proportioned to the volume of work. These expenses are for the most part allocated each year by the Government of Bangladesh as a budget, but a system should be adopted whereby the minimum necessary expenses (including the cost of materials and supplies) can be assigned to SOB as an additional budget from the Government of Bangladesh when the work of providing topographic maps and digital data exceeds the planned volume of work (for example, the number of printed sheets, or the replication/processing of digital data) in each fiscal year.

16.3.5 Education program

In order to fulfill its function, officials in SOB will need the following abilities.

1) High-level personnel

- The ability to maintain and manage SOB organization
- The ability to plan and promote SOB project
- The ability to make appropriate decisions on general technical issues in surveying and topographic mapping
- A basic knowledge of survey and photogrammetric mapping

2) Middle-level personnel

- The ability to make appropriate decisions on individual technical issues in specific jobs
- The ability to lead and manage a work team on individual jobs
- The ability to coordinate the work processes among the proceeding and following the process and that they are in charge of
- The ability to control accuracy and progress of job
- A general knowledge of surveying and photogrammetric mapping

3) Low-level personnel

- The technical capability and experience necessary to execute each job
- In particular, the ability to interpret aerial photographs and topographic maps

An evaluation of the abilities of each member of SOB staffs that participated in the Study made it clear that every member of the staffs, from high-level personnel to low level, lacked the necessary abilities in a variety of aspects. From now on, a training program must be drawn up for SOB personnel to improve the following abilities.

1) For high-level personnel

In view of the future activities of SOB, the most necessary of the abilities required to the high-level personnel is the ability to plan and promote SOB projects. The basic knowledge of surveying and topographic mapping necessary to plan and promote SOB project is indispensable for high-level personnel. It cannot be denied that in the Study too, the obvious lack of an ability in high-level engineers to make a decision on a basic technical problem was in some cases an

impediment to the smooth implementation of the Study.

2) For middle-level personnel

The most generally found lack in the abilities required in middle-level personnel is an all-round knowledge of surveying and photogrammetric mapping. In particular, there is a crucial lack of knowledge of the relationship between the work process that they are in charge of and the processes preceding and following it. This makes them incapable to make an appropriate decision to solve individual technical problems.

Another problem concerning the middle-level SOB personnel that can be pointed out is unevenness of ability. It may also be pointed out that this unevenness in ability has a high potential of being the cause of such problems as unevenness in the accuracy of products, and delays in the entire process due to the unevenness of the work processes of each work item.

3) *For low-level personnel*

As SOB has had no experience in the full-scale production of topographic maps by photogrammetric methods, it must be said that the ability of the low-level SOB engineers and surveyors to interpret aerial photographs and topographic maps is quite low. In the future, if SOB is to produce medium to large-scale topographic maps by photogrammetric method, an improvement in the ability of the low-level engineers and surveyors to interpret aerial photographs and topographic maps is essential.

16.4 Recommendation on Management

16.4.1 Anti-virus measures

As the world is linked via the Internet, the damage caused by computer virus has become a worldwide problem. Developing countries in particular often have taken no measures against computer viruses, so that many computers may be contaminated with viruses.

When topographic mapping was done using the analog method there was no problem in this matter; but since digital data once damaged is difficult to recover, as the production of topographic maps using the digital method and the digital production of various types of data and documents become more common, anti-virus measures have become really important.

No major problems have arisen in SOB so far because the communication of digital data does not occur so often either SOB or between SOB and the outside. But in the future, since SOB will be making more digital data exchanges with the outside, it will be necessary to take the necessary measures to protect SOB computers against the viruses infection.

The following anti-virus measures are needed to take to the SOB computers:

1) The installation of anti-virus software in every computer in SOB.

2) It is necessary to prepare for the dial-up environment (a telephone line to the outside, dial-up modem and the provider of the Internet use) in order to update the pattern file of virus countermeasure software.

3) Regular updating of anti-virus software.

4) Computers used for digital topographic mapping (digital plotting, digital compilation, GIS data creation, etc.) should not be connected to the Internet.

5) Virus check must be done before the installation of the data to the computers, especially the data obtained from the outside of SOB.

16.4.2 Digital data backup

As it is difficult to recover digital data once it has been damaged, backups must be taken. It is also necessary to pay due attention to the fact that computer hard disks and CD-ROMs have a limited life. Special attention should be paid to the fact that the recording section of a CD-ROM is sensitive to ultraviolet rays.

16.4.3 Filing system

SOB stores various types of data necessary for surveying and topographic mapping including tidal data, geodetic control point data and interim products in the production of topographic maps. However, in the present situation it also has various problems needed to solve, such as losing the location of needed data or missing data.

There are difficulty to keep data on paper for long time in Bangladesh because of such problems as high humidity in the rainy season, dust in the dry season, poor air conditioning in SOB building, the poor quality of paper available in Bangladesh, etc.

If SOB is proceeding to the digitalization of mapping, then in the future the data should be stored in digital form. In such case it will also be necessary to make back-ups of all data.

16.4.4 Operation system of computer

It is recommended that the operation system of the PC will be shifted to Windows 2000 or NT4.0 and Windows XP, taking the recommendation version of software into consideration. In order to improve the working efficiency, it is necessary to select operation system corresponding to multi task (Windows 95 and 98 is a single task operation system).

In the digital mapping section in SOB, the server operated by Windows 98 has been used, but it is not

suitable to correspond to the network management enough, so it is recommended to install the server which manages the network communication specially.

As for the workstation of UNIX, to avoid a trouble in computer system, proper operation at the time of start-up and shutdown is indispensable.

16.4.5 Strengthen the system management

In order to manage PC properly it is necessary for operator and system administrator to master the basic knowledge for proper operation of the PC and system administrator instructs the operation to operator and also system administrator must manage equipment properly.

It is necessary to strengthen system management to prevent any troubles of the PS such as troubles of PC and the crash of the hard disk. The duty of system administrator will be as follows:

1) Hardware maintenance (PC, peripheral device and network)
2) Trouble shooting
3) Software management
4) Data back-up
5) Anti-virus protection

16.5 Technical Recommendation

The technical problems SOB faces at the present time and our recommendations are described in Chapter 13 “Transfer of Technology”. Those are summarized again below.

1) The production and revision of small-scale topographic maps carried out so far by SOB has been through two-dimensional data acquisition, and SOB has had no experience in three-dimensional data acquisition. In medium to large-scale topographic mapping, however, the technology of 3D data acquisition by photogrammetric method is indispensable. The staffs of SOB digital mapping section must be familiar with 3D data acquisition, if SOB continues to produce medium to large scale topographic maps in future.

2) Some of the SOB personnel lack the photogrammetric mapping skills and a basic understanding of topographic maps. In particular, if SOB continues to produce medium to large scale topographic maps in future they should have a clear understanding of the characteristics of small, medium and large scales topographic maps and of the differences among them.

3) Some high-level SOB personnel have a knowledge of surveying and topographic mapping but lack practical experiences, so that they do not have the necessary understanding of the problems involved in undertaking the work, and cannot make decisions for the appropriate solutions.

Therefore, personnel with knowledge of photogrammetry and lots of practical experiences should be appointed as high-level personnel.

4) At the same time, the middle- and low-level SOB personnel do have practical experiences, but that experiences are limited to a narrow sphere, and not extended to wider-ranging. In addition, as they do not have knowledge on the whole of topographic mapping, they do not understand the relationship between their own work process and the processes preceding and following it. They do not have clear idea of what kind of data should be handed over from the preceding process, how that data should be processed in their own process, or what kind of data should be passed on to the next process.

5) The change in equipment and staffing necessitated by the shift from an analog to a digital topographic mapping system has not yet been made. This is not a problem that arises only in developing countries; in the past, Japan has faced the same kind of problem. In any case, the recent rapid advances in technology (especially computer-related technology) mean that any technology or piece of equipment becomes obsolete in a much shorter time than in the past. SOB must consider the future personnel structure and understand when the equipment is renewed. And the skills of the people concerned also have to be changed.

6) The entire SOB staff lack a basic knowledge of computers. This problem is related to item 5) above and for the digitalization of survey and topographic mapping technology, SOB must bring in or train up personnel so that a majority of the staffs have the minimum necessary basic knowledge of computers.

7) A lot of the equipment are out of order because of careless use. In particular, it is thought that most of the breakdowns in the equipment in the SOB digital mapping section have been caused by rough use of the equipment. The SOB personnel must be retrained to begin with how to handle precision machinery.

   Considering the already small SOB maintenance budget, the first step to take before increasing the budget is to consider how these breakdowns can be prevented.

16.6 Items to be Implemented Urgently

The Study team hopes that SOB will urgently implement the following items after the completion of the Study.

16.6.1 Production of 1:5,000 scale digital topographic maps covering the remaining area

The Study was started around the end of November 2002 and completed around the end of August 2004. In the Study, 122 sheets (581 km^2) of 1:5,000 scale digital topographic maps were produced and aerial

photography, ground control point survey and aerial triangulation were carried out for the area covered by aerial photography (960km^2).

Thus, as soon as it received the products of the Study from JICA after completion of the Study, SOB will be in a position to produce the 1:5,000 scale digital topographic maps covering the remaining area (379 km^2) using the equipment provided by JICA.

The aerial photographs in the Study were taken on 3rd January 2003. As the Dhaka Metropolitan Area has a strong inflow of population from the surrounding areas, progressive changes in this area is also acute. Thus, from the standpoint of using the products from the Study effectively, it is required that SOB will carry out without delay the work of producing the 1:5, 000 scale digital topographic maps to cover the remaining area. In planning the 1:5,000 scale digital topographic mapping project for the remaining area, it is important that SOB consider the following points:

1) Priority in the area covered by the 1:5,000 scale topographic maps should be determined through discussion with the users of the topographic maps and digital data, and plans drawn up to produce the topographic maps in the order of priority.

2) The 1:5,000 scale digital topographic maps produced under the Study are first to SOB. As these are medium to large-scale topographic maps by digital photogrammetric method (with 3D data acquisition) it cannot be denied that the maps are in many ways the result of trial-and error. Therefore, before planning the topographic mapping project for the remaining areas, it will be necessary to review the contents of the Study and the way with which the work was carried out, and on the basis of the experience gained in the Study to consider how to improve the contents and the methods of implementation.

3) In drawing up the work plans, it will be necessary to ensure proportional balance between: a) budget; b) necessary equipment and skills; c) period of work and d) human resources. If the balance between these items is not proportional, problems such as delay, short of budget, insufficient accuracy, etc. will arise when the work is under way.

16.6.2 Determination of administrative boundaries and revision of digital topographic maps

As described in Section 3.11 “Conference on Administrative Boundaries with Related Agencies”, it was decided through discussions with the related agencies that the 1:5,000 scale digital topographic maps produced by the Study would not include administrative boundaries.

However, accurate data on administrative boundaries are absolutely essential for each agency, and a basic agreement has been reached that the related agencies will cooperate to implement the work to show the accurate administrative boundaries on the 1:5,000 scale digital topographic maps.

There are some parts of the work to produce medium to large scale topographic maps that cannot be implemented by the surveying and topographic mapping agency SOB alone, and the cooperation of related agencies is indispensable particularly in the incorporation of data such as the administrative boundaries and administrative names.

As mentioned previously, the primary purpose for the production of the medium to large scale topographic maps is for their effective use by the various agencies, and even after the completion of the maps, tie-ups and cooperation between SOB and the other related agencies will be needed for the production of the various types of thematic maps, revision of secular changes, etc.

In addition, on the basis of this kind of tie-up and cooperation with the related agencies, it will be the role of SOB as the survey agency of Bangladesh to discuss with the other agencies that what kind of data should be produced based on the products obtained in the Study, and their requests and plans for the production of medium to large scale topographic maps for new areas; and to propose such requests to the Government of Bangladesh as the representative of the opinions of the related agencies.

On this matter, the actions SOB should implement in the future are as follows:

1) In order to show the accurate administrative boundaries on 1:5,000 scale digital topographic maps, an official committee consisting of SOB and other related agencies should be established to discuss technical issues, acquire the necessary budget and implement the actual work. It will be important for this committee to be officially recognized by the Government of Bangladesh.

2) On the basis of the results of the future meeting with the related agencies, SOB and the related agencies will hold technical discussion as to how the necessary administrative boundaries are shown on the 1:5,000 scale digital topographic maps. In these discussions, it will be necessary to bear in mind that the necessity of administrative boundaries will differ depending on the agency.

3) On the basis of the results of the technical discussions, the time, cost and personnel needed for the implementation should be examined and a detailed working plan should be drawn up. In particular, it will be important to study how much of the field verification survey will need to be implemented.

4) It will also be necessary to ascertain whether it will be possible for the necessary personnel to be dispatched from each related agencies to implement the field verification survey.

5) On the basis of the above discussions, a concrete working plan and the estimated budget should be prepared, and SOB on behalf of all the related agencies should make a request for the budget to the Government of Bangladesh. A request for technical assistance form foreign countries may also be made through the Government of Bangladesh.

16.6.3 Formulation of a maintenance plan for equipment owned by SOB

As already mentioned several times, the state of maintenance of the equipment owned by SOB, especially the equipment in the digital mapping section and the photo processing section are in negative conditions. If SOB does not implement a survey of the conditions of all the equipment owned, draw up a maintenance plan and start to repair the equipment, it is obvious that SOB's wok will run into difficulties in the very near future. The following items should be considered when drawing up an equipment maintenance plan:

1) Preparation of a list of the equipment and materials possessed by each section (name of item, date of purchase, etc.)

2) Examination of the condition of each piece of equipment

3) Examination of the state of any pieces of equipment that are out of order (location and condition of each fault, etc.)

4) Estimation of costs and time to repair

5) Decision on necessity of repair

16.6.4 Promotion of the use of topographic maps and digital topographic data

The production and provision of small-scale topographic maps covering the whole country is one of the basic jobs that the government should undertake. The first objective is to provide maps to cover the entire country so that they can be useful.

On the other hand, medium to large scale topographic maps are produced mainly to cover the city areas, and they are produced because various agencies and organizations need them. The first objective is not to produce such maps; the maps are produced because they are badly needed. Thus it follows that such medium- to large-scale topographic maps have no significance until they are utilized by the users.

The 1:5,000 scale digital topographic maps produced in the Study too, become worth the making when they are used by various kinds of users. Therefore, it is the role of SOB not only to store away the topographic maps and data within SOB, but to actively promote their use by other agencies.

In addition, if the 1:5,000 scale digital topographic maps and digital topographic data in the Study are utilized by many other agencies, the value and evaluation of SOB as an agency producing and supplying topographic maps and digital topographic data will be higher among the governmental agencies of Bangladesh. In the future, it is expected that SOB will work in a useful direction in the drawing up of middle- and long-term projects and the securing of budgets for them.

It is essential for SOB's further development that SOB make effective use of the products of the Study, to

actively highlight the value of its existence to the Government of Bangladesh and other agencies.

Chapter 17 Recommendations for the Use and Application of Data Created in the Study

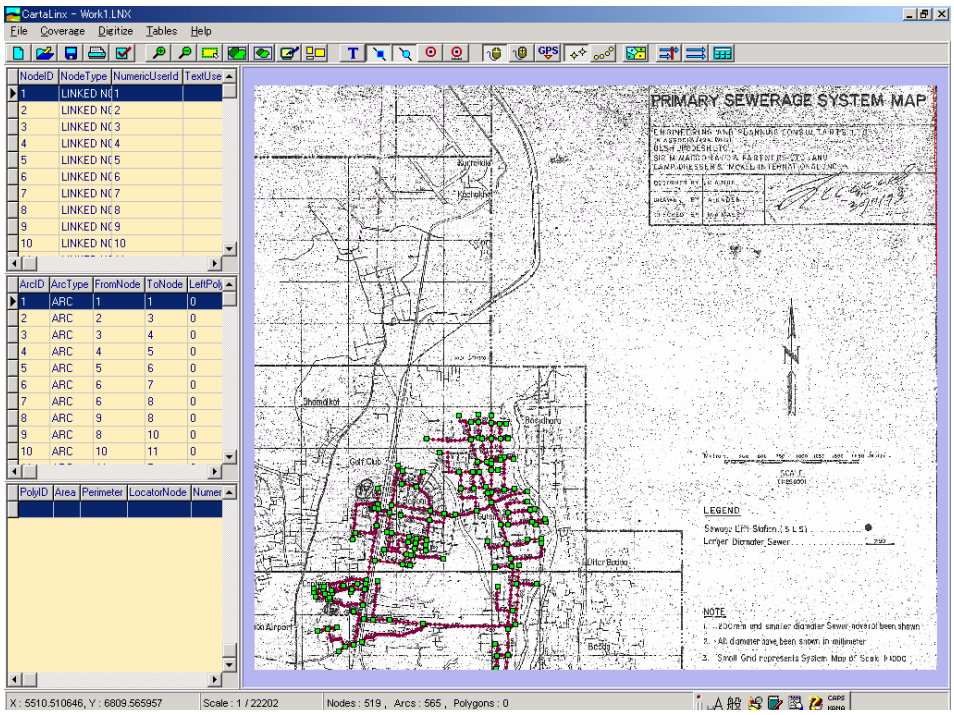
Thematic Map of Main Pipe Line in Sewerage

The development of the sewerage is also an important theme in the social infrastructure as well as the water supply. In the sewerage management, it is the important themes of the operation about the drainage of the drainage and the water management to reduce water pollution.

In the point of view of facility management, it is also an important point about the rehabilitation relating to the maintenance including a water pollution countermeasure caused by decaying of the sewerage pipe and the leak, the improvement of the water management facilities in consideration of the environment and the improvement of the operation of the sewerage. As for the layout planning of the sewerage pipe, it is the information about topographic longitudinal.

As shown in the following figure, the distribution of main pipe of the sewerage in Dhaka city is compiled in the base map as a thematic map.

As for the present conditions, sewerage facilities are insufficient because the maintenance hasn't been catching up with the urban development, so the development is a pressing need urgent subject. A large-scale map is expected the advantage use of the geographic information as well as the management of the water supply and the rehabilitation.



Chapter 17 Recommendation for the Use and Application of Data produced by the Study

In addition to bringing together the types of topographic maps and their features, and defining the relationship between SOB and the users of topographic maps and digital topographic data, specific examples of the recommendation of the Study team regarding how the digital topographic map data produced by the Study should be used and applied in future are summarized below.

These recommendations are being made assuming ordinary circumstances; before the data are put to specific use, it will be necessary to examine in detail the objectives of the project, how the data will be used, how the project will be implemented, etc., before drawing up a concrete working plan for the project.

17.1 Classification of Topographic Maps and Objectives of Production

Although there are many approaches to the classification of topographic maps, the following two methods are commonly used:

1) Classification of topographic maps according to scales
2) Classification of topographic maps according to objectives

Definitions in the classification of topographic maps according to scales differ from country to country or person to person, but generally the classifications are as follows:

1) Small scale topographic maps: Topographic maps at a scale of 1:20,000 or smaller
2) Middle scale topographic maps: Topographic maps at scales of 1:10,000 to 1:2,500
3) Large scale topographic maps: Topographic maps at a scale of 1:2,500 or larger

The classification of topographic maps according to the objectives of production is generally as follows:

1) General maps: Also called “base maps”: maps on which various types of maps are based
2) Objective maps: Map produced for a particular objective such as thematic maps; often produced from a general map

This relation is shown in Figure 17.1.1 “Classification of Topographic Map”.

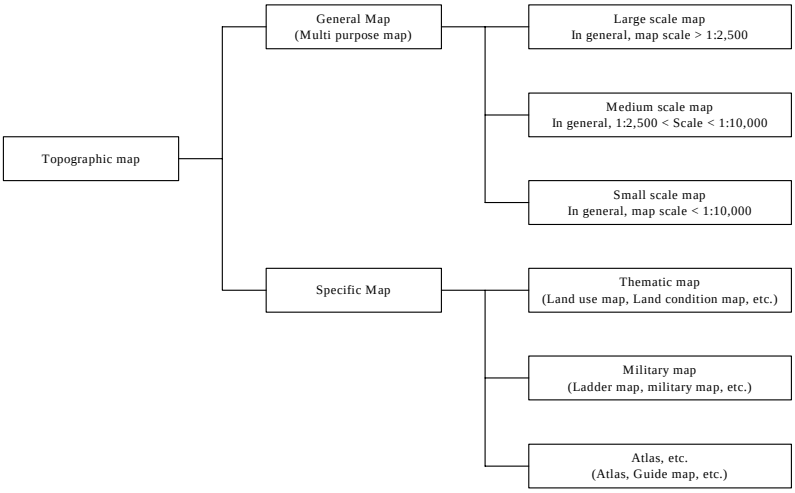


Figure 17.1.1 “Classification of Topographic Map”

Of the general maps, the 1:25,000 or 1:50,000 scale topographic maps (the scale is determined by the surveying agency of each country) are also called national base maps, and these basic topographic maps cover the entire land area of each country at the same scale and at the same level of accuracy. In Bangladesh, the national base maps are topographic maps at the scale of 1:50,000.

It is important that the national base maps cover the entire national territory at the same scale and at the same level of accuracy, and that they are always maintained, being modified and revised as necessary. This is one of the basic tasks the Government must undertake. Medium to large-scale general maps, on the other hand, necessitate a large number of map sheets to cover the entire territory of the country, and require a huge amount of time and expense to produce and maintain. Therefore, these medium- to large-scale maps are produced mainly to cover city areas where human economic activities are vigorous.

In short, with small-scale national base maps, emphasis is placed on the coverage of the entire national territory. However, the main purpose of producing medium to large-scale base maps is to be used as basic information for the drawing up of various plans and policies concerning mainly city areas. That is to say, the final objective is not the production of medium to large scale base maps; the final objective is to have the topographic maps produced put to effective use by various users.

The 1:5,000 scale digital topographic maps data produced by the Study, in terms of the above description, falls in the medium scale general map data category, and its final objective is naturally to be put to effective use by various users. It is when they are put to effective use by various users that the 1:5,000 scale digital topographic maps of the Dhaka Metropolitan Area produced by the Study will be worth to produce.

Some specific examples of usefulness in future of the 1:5,000 scale digital topographic maps and GIS basic data produced by the Study described above from the standpoint are discussed below.

17.2 Forms of Using Topographic Maps

Seen from the relationship between the producer and the users of topographic maps, there are three forms of use as described below.

1) Using topographic maps as such

This is the use of the maps as the base maps described in Section 17.1, "Classification of Topographic Maps and objectives of Production", the topographic maps are used as they are, without any processing. Usually the maps are sold as printed maps.

In this case, the producer of the topographic maps provides them to the users as printed maps; and when using the maps in their present form, basically the users do not alter the actual contents of the maps.

2) Use of topographic maps as basic maps for processing into objective maps

This is the use of the map as the base map for the production of objective maps as described in Section 17.1 "Classification of Topographic Maps and Objectives of Production". Usually, the maps are sold as printed maps.

In this case, the producer of the topographic maps collects the data necessary for production of the objective maps, and the collected data is added or processed to produce, for example, land-use maps, land condition maps, guide maps, etc., which are usually provided as printed maps to the users. The users may process the provided topographic map data, but only to add necessary information.

3) Processing of digital topographic maps by the user to produce the necessary original digital data

The producer of topographic maps sells and distributes the digital topographic data to the users. The user collects the additional data needed for his own purpose and produce data to meet his own objectives, based on the data collected and using the digital topographic data provided by the map producer. Usually the contents of the data are processed, as the provided map data are processed as GIS data.

In this case, the producer of topographic maps is in the position of supplying digital topographic data, and in his role as map producer is required to amend and revise the digital topographic data and to supply the data without a hitch. At the same time, since the user is required to process and use the digital topographic data at his own expense and using his own skills, the user is required to maintain a certain level of technical ability, equipment, personnel and budget.

The producer of topographic maps as described in 1) and 2) above is in the position of both producing and supplying data, while the user is a passive user from the viewpoint of data production and processing, because the data provided is used as is.

The position of the map producer in 3) above is a data supplier rather than a data producer. What is required of this type of map producer is not to produce new data, but to make maintain and manage the data available. Meanwhile, the position of the user in 3) differs from that in 1) and 2) in. He processes the data himself and is recognized as an active user of the data. These points are summarized below in Table 17.2.1.

Table 17.2.1 "Forms of Use of Topographic Maps"

Form of Use	Map Producer (SOB)	Map User
1) Use of topographic maps as they are	・Work done by SOB up to now ・Producer and supplier of data	・No processing of data ・Passive use of data。
2) Use of topographic maps as base maps for processing to produce objective maps	・Work done by SOB up to now ・Producer and supplier of data	・No processing of data ・Passive use of data
3) User process digital topographic data to produce necessary data。	・Supplier of digital topographic data。 ・requires continuous data maintenance and management	・Processing of digital data by user ・Requires a certain level of technical ability, equipment, personnel and budget ・Active use of data

17.3 Relationship between the Producer and User of Topographic Maps

Of the forms of use as descried above, the "use of topographic maps as such" in 1) above is the most simple method, in which the main users are individuals, not organizations such as governmental agencies, universities and various kind of study team.

However, the "use as base maps for processing" in 2) above, in which the producer of the topographic maps is also at the same time a user processing the data, has a more complicated relationship between the topographic map producer and the user than in 1) because there are other users of the processed data, both individuals and organizations.

Depending on the circumstances, the topographic map producer may commission another agency to do the data processing, and that agency may provide or sell the processed data to users. In any case, the main users are individuals and not organizations such as governmental agencies, universities and various kinds of study team.

The main users in 3) "processing of digital topographic data by the user to create the original data needed" are not individuals, but organizations such as government organization, university, research institute and various kinds of study team.

A summary of these relations is shown below.

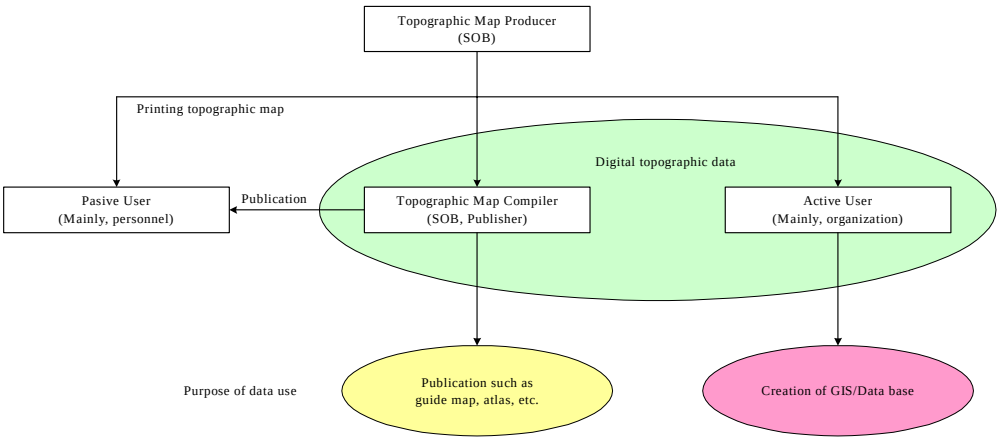


Figure 17.3.1 “Relationship between Topographic Map Producer and the User”

17.4 Assumed User Agencies

From the relationship between the topographic map producer and the user, with the exception of passive users, the specific user agencies in Bangladesh in the other two forms of use are assumed as follows:

1) SOB produces guide maps, land-use maps etc., and supplied them to the users.

2) SOB provides digital topographic data as basic data to processors who produce and sell guide maps, land-use maps and other types of maps. At present, the Mappa Ltd. publishes guide maps etc., for Dhaka city, Chittagong City and so on.

3) Organizations receive digital topographic data from SOB and produce the GIS data based on the digital topographic data, as needed by each agency.

Of the above cases, here we will consider the user agencies in Bangladesh included in 3). From the results of the questionnaire survey held by SOB, the interview survey carried out by the Study team and the discussion held between the Study team and the other government agencies of Bangladesh during the period of the Study, it is clear that many agencies including the Dhaka City Cooperation, Road Bureau and so on that are responsible for the administration of the Dhaka Metropolitan Area want to use the products of the Study in their own work.

In order to use effectively the 1:5,000 scale digital topographic data and GIS basic data produced by the Study, it is necessary to examine the types of additional data needed for the purpose, how it is collected and how it is processed, based on the contents of the data produced in the Study.

The specific procedure is as follows:

1) Define the purpose of use in the project where the data to be used.
2) Define the data judged necessary for the purpose of the project
3) Examine the contents of the additional data considered necessary
4) Examine the method of collecting the additional data
5) Examine the data processing method, the thematic map to be produced, system etc.

17.5 Specific Use Plan

An examination of the contents of data necessary to formulate various development projects, in general, shows that there is common data required for any project. With the exception of very specific projects, the following 4 types of data are deemed to be common data necessary for the formulation of various development projects. These 4 types of data form the basic information used in formulating the development projects, but many other types of data will be required for actual projects.

In using the products of the Study for various development projects, the first step is to collect the following types of data and process them as GIS data.

1) Statistical data

Statistical data, including the land area and number of residents in each administrative district, is widely used as the basic information for the drawing up of various development plans. GIS data linking the administrative boundaries, population statistics, physical areas etc., is the basic data used in the initial stage of all kinds of development project.

2) Land use

Actual land use conditions have to be understood in order to formulate all kinds of development project. However, it should be noted that land use categories differ depending on the development project.

3) Land conditions

As basic information, the land conditions of an area or region to be developed in a development project are also the minimum necessary data. In particular, land conditions are important data in formulating development projects for extremely flat areas such as Dhaka City, which suffers flooding every year and for mountainous area where landslide disasters occur frequently.

4) Social conditions

In formulating various development projects in the Metropolitan areas of developing countries, it is necessary to consider the social conditions unique to the country. In particular, the gap between rich and poor in each area is one of the factors to be considered in formulating various development projects.

The above 4 types of data are to some extent common to all kinds of development projects, so that such data should not be provided individually by the related agencies; instead the data provided by each agency should be disseminated to other related agencies in order to cut waste in spending. If we consider how the products of the Study other than the above 4 items can be put to effective use in a specific project, the following is a broad outline.

17.5.1 Use in waste disposal projects

Probably, there have been few examples of the use of GIS in waste disposal projects. However, if we consider its use in the waste disposal project of the Dhaka metropolitan Area the following GIS data will be useful.

1) Land use

Naturally, the types of waste and the quantity of discharge are different in resident districts and industrial districts. It is necessary to separate the types of rubbish generated according to the land use. If another agency has already prepared land use data that can be used, but it should be noted that land use categories differ somewhat depending upon the purpose of land use.

2) Social conditions

In the Dhaka Metropolitan Area, it is thought that the quantity of rubbish is greater in economically affluent districts. Therefore, the quantity of rubbish discharge should be estimated from the category of the economic condition of the residents. A field survey based on the GIS basic data as one of the products of the Study should be made if necessary, in order to produce the social condition category maps reflecting the economic conditions of residents.

3) Population

If the economic and land use conditions are the same, the quantity of rubbish discharged should be proportional to the number of residents. Thus, the population in any unit (administrative unit or rubbish collection unit) is needed in order to estimate the quantity of rubbish discharged.

The basic population statistics are issued by the statistics Bureau, but these statistics cannot be deemed to be absolutely accurate. Therefore, it is necessary to estimate the population of each district basically by the counting the number of houses and house types, which will be multiplied by a given coefficient in order to compare the product with the statistical data.

4) Rubbish collection points and routes

In considering effective rubbish collection, it is necessary to examine the rubbish collection routes. For this purpose, present rubbish collection points and routes, data on road width enough for the rubbish trucks to pass along and on which traffic regulations are enforced should be collected and processed to produce GIS data.

17.5.2 Use in sewage projects and facility maintenance

In Japan, GIS has been used in many aspects of the sewage project and facility maintenance and the necessary systems for those have been completed. Basically, if the existing systems are used it will not be difficult to build up the GIS for the sewage project and facility maintenance in Dhaka City, as far as the systems are concerned.

For building the GIS, data on the sewage pipe network is needed, but the reliability and accuracy of the existing data on the sewage pipe network may cause a problem. If it is necessary for sewage pipe network to be verified section by section in the field, the amount of work involved might be enormous.

17.5.3 Use in water supply projects and facility maintenance

In Japan, GIS has been used in many aspects of the water supply projects and the facility maintenance and the necessary systems for those have been completed. Basically, if the systems existing in Japan are used it will not be difficult to build the GIS for the water service project and facility maintenance in Dhaka City, as far as the system is concerned.

Similarly to the sewage project, data on the existing water supply pipe network is also needed, but the reliability on location accuracy for the pipe network to be verified section by section in the field, the amount of wok involved might be enormous.

17.5.4 Use in urban planning

The minimum necessary data to formulate city planning are the 4 types of data described in Section 17.5, which should be provided first.

Other necessary data includes social infrastructure data (hospitals, schools, mosques, water service and sewage pipe networks, gas pipeline network, power transmission lines, etc). It may well be expected that some of this data has already been produced or will be provided from other projects in the near future.

In considering the use of data in city planning, therefore, a wider range of data is required than in other development projects and it is not easy to screen the necessary data contents. Thus, it is necessary to implement a study of data if the necessary GIS data is produced for drawing up the city plans for the Dhaka Metropolitan Area.

17.5.5 Use in land management

The land management is based on the preparation of a land ledger, for which the dimensions of the land of each owner are measured by a ground survey known as cadastral survey to calculate the area and produce the land data.

Recently, the land data of each landowner is produced by computer also in the developing countries. To arrange the land data of all the landowners, it is necessary to prepare a digital topographic map that indicates

all the data and the location of the land of each owner. By indicating the boundary of the land of each owner on this digital topographic map, the cadastral survey data is attached to the cell of each landowner's land as attribute data.

As to the scale of this topographic map, scales of 1:1,000 to 1:2,000 are adequate to indicate each house definitely. For this purpose, the height data (or accuracy) in the topographic map is not needed and the accuracy of horizontal position that is the usual accuracy of 1:1,000 to 1:2,000 scales topographic maps are also unnecessary. Symbols and annotations are also basically unnecessary information.

The digital topographic maps produced by the Study are at the scale of 1:5,000, which is a little smaller for the purpose of this discussion. Although the digital map data can be enlarged, it is important in using the enlarged map data to understand that the accuracy of the topographic maps is not enhanced.

Therefore, it will be rather difficult to use the 1:5,000 scale digital topographic maps produced in the Study for preparation of the land ledger. If the Government of Bangladesh prepares a full-scale land ledger, it will be necessary to produce new digital topographic maps at the scales of 1:1,000 to 1:2,000, and the 1:5,000 scale digital topographic maps produced in the Study will be used in drawing up the plan for producing the 1:1,000 to 1:2,000 scales digital topographic maps.

17.5.6 Use in anti-flooding measures

The most important problem in making use of the products by the Study for anti-flooding measures is height accuracy. In the 1:5,000 scale digital topographic maps produced by the Study, the contour intervals are 2.0 m, but the specialists in planning anti-flooding measures would probably request that the contour lines should be 0.5 m or less.

Observing the topography of the Dhaka Metropolitan Area, the request for the contour interval of 0.5 m or less can be understood, but if the accurate contour lines in the interval of 0.5 m or less are depicted in photogrammetric method, it is necessary to substantially change the parameters of the Study (scale of aerial photos, scale of maps to be produced, number of control points, density of leveling points and routes, etc). However, the Study could not handle such changes.

For applying the products by the Study to anti-flooding measures, the first step is to substantially enhance the height accuracy of the 1:5,000 scale digital topographic maps by additional surveys as follows:

1) Execute a leveling survey using the existing benchmarks

2) Acquire as many leveling points as possible during the leveling survey, if possible, at the rate of about one point to every 100 square meters. It is important to acquire leveling points not only roads but also outside the road.

3) Prick the acquired leveling points on the 1:5,000 scale digital topographic maps.

4) Indicate the elevation values of the pricked leveling points in the 1:5,000 scale digital topographic maps, and correct the contour lines based on these elevation values. However, it may be physically difficult to depict the contour lines with the accuracy of 0.5 m on the scale of 1:5,000 topographic maps because the Dhaka Metropolitan Area has an extremely flat terrain.

5) Implement a field survey in parallel to these works in order to determine the elevation values of the maximum flood water surface through the hearing survey of the flooded areas and the leveling survey from the existing benchmark to flood marks and show these results on the 1:5,000 scale digital topographic maps.

In taking countermeasures against floods, it is also effective to make the following surveys using the 1:5,000 scale digital topographic maps produced by the Study.

1) Acquire the satellite image data in case of flood disaster and input the flooded areas from the satellite images on the 1:5,000 scale digital topographic maps to predict the future flooding areas.

2) Implement hearing survey to learn the water levels at a flood disaster from local residents, determine the water levels from the benchmarks in the vicinity by leveling survey and determine the absolute elevation values of the flood, and at the same time, predict the future flooding areas by inputting the elevation values and their positions on the 1:5,000 scale digital topographic maps. These results should be compared with the results in 1) above in order to ensure the more accurate flooding areas to be predicted.

3) By using the DTMs produced in the process to produce the digital topographic map data or contours and photogrammetric height points, it is possible to simulate how a flooding area expands as the water level rises. In using the DTMs, the DTM data of the points at which buildings and houses exist should be eliminated in advance because the rooftop heights of these buildings and houses may be acquired.

4) As the Dhaka Metropolitan Area lies in the sedimentary plain that extends in the mouth of a large river, the elevation difference is very small and the water discharge conditions depend upon natural and artificial dikes, roads and discharge pumps. It will be useful for the anti-flood project to prepare a land condition map taking these into account. Dhaka City is located approximately 220 km up the mouth of the Padma River, but it is affected by the tide levels because its elevation is so low that discharge pumps are used to drain water. Thus, the land condition map incorporating the data such as positions, quantity and performance of discharge pumps will be useful for a water discharge plan.

5) If data such as rainfall, river flow, evaporation quantities, penetration quantities, inflows, basin areas, sewage or drainage routes are available, it may be possible to simulate the water level changes in flooding because there are accurate 1:5,000 scale digital topographic maps. However, the water level changes cannot be simulated with simple models because the floods in the Dhaka Metropolitan Area are caused by three factors; the rise of the river water level due to the melting snow in the Himalayan Mountains, flooding due to poor drainage of rainfall in the rainy season and high tide caused by hurricane at Bengal Bay.

17.5.7 Use in road and traffic measures

The 1:5,000 scale digital topographic maps can be applied to the planning of construction such as the flyover project to reduce traffic congestion and the new road construction project.

On the other hand, it is necessary to review the transport system in Dhaka city including the bus stops near intersections in order to reduce the traffic congestion. For this purpose, plans to change the positions of bus stops and rickshaw pools that have caused the present traffic regulations and congestions should be drawn up and implemented.

Dhaka Transport Co-ordination Board (DTCB) has planned a project for the transport infrastructure in Dhaka Metropolitan Area and pointed out the necessity of detailed medium to large-scale digital topographic maps and GIS data. The area under the control of DTCB is 1,542 km^2 in total covering Dhaka City and its surrounding areas, including the area covered by the 1:5,000 scale digital topographic maps produced in the Study.

For DTCB, the first step is to create GIS data on the roads, including information on road width, road length, road type, bridge and culverts, as well as information on bus stop positions and traffic regulations, based on the 1:5,000 scale digital topographic maps produced by the Study.

17.5.8 Use in police administration

The products of the Study can be used by the police administration in the following way:

1) Production of police precinct map

There are cases in which a dispute on the precinct of a police station may arise in an event of traffic accident or crime because the precinct of each police station is not clearly defined. The first task is to prepare each police station's precinct map using the 1:5,000 scale digital topographic maps produced by the Study.

2) Traffic regulation database

Inadequate traffic regulation (right-turn, left-turn, U-turn, etc) is the cause of traffic congestion. Therefore, the next task will be develop a database containing information on various traffic regulations using 1:5,000 scale digital topographic maps produced in the Study, and to review the

present traffic regulations in order to establish more appropriate traffic regulations.

Chapter 18 Conclusion

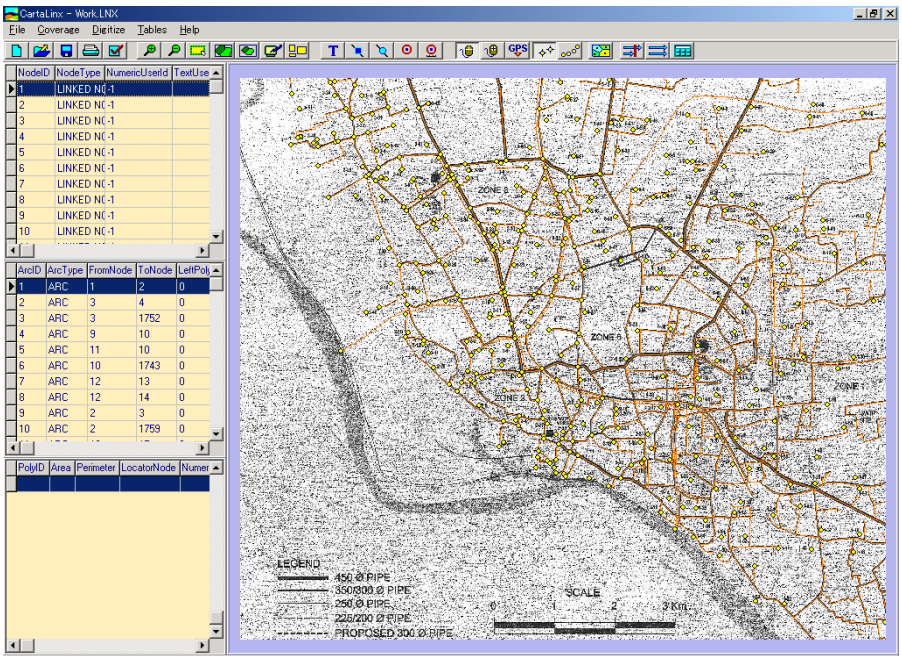
Thematic Map of Main Pipe Line about Water Supply

The development of the water supply is an important theme in the social infrastructure. In the urban water supply, it is the important themes of the stable supply of the drinking water and those operations in consideration of the future water demand prediction.

In the point of view of facility management, it is also an important point about the rehabilitation relating to the maintenance including the improvement of water quality and correspondence to the leak of water caused by decaying of the water pipe, and the improvement of the operation of watering.

As shown in the following figure, the main pipe network of the water supply in Dhaka city which attribute uses pipe diameter is compiled in the base map as a thematic map.

As for the facility management of the water supply and the rehabilitation as well, a large-scale map is expected the advantage use of the geographic information.



Chapter 18 Conclusions

The Study was implemented in the joint work by the Study team and SOB counterparts over a period of approximately 21 months from the end of November 2002 to the beginning of July 2004. With respect to the ground control point survey and the field identification in particular, SOB counterparts took the initiative in actual implementation. In the second half of the 2nd year's Study, technology transfer in the production of 1:5,000 scale digital topographic maps by digital photogrammetric method and in the creation of GIS basic data was carried out using the equipment provided by JICA.

SOB had no experience in producing medium to large-scale digital topographic maps by digital photogrammetric method, and the Study was the first experience in such a work for SOB. For this reason, it took time for SOB counterparts to understand that the production of small scale topographic maps that SOB had undertaken so far is different in content from that of the medium to large scale topographic maps in the Study.

In particular, SOB counterparts may need to understand that the production of the medium to large-scale topographic maps involves subtle problems that were problematic in the production of the small-scale topographic maps. In particular, with regard to the administrative boundaries and names that were the map compilation data, the accuracy of their horizontal positions had not been so important in the small scale topographic maps; but in the medium to large scale topographic maps the accuracy of the horizontal positions is quite important.

In the 1:5,000 scale digital topographic maps produced in the Study, roads were basically shown according to actual dimensions and houses were depicted individually as much as possible, so that therefore, great care was needed in depicting administrative boundaries on the 1:5,000 scale digital topographic maps.

The 1:5,000 scale digital topographic maps produced in the Study were the first medium to large scale topographic maps that SOB had ever produced, and it goes without saying that it is difficult to expect the perfection on the first try. Therefore, the 1:5,000 scale topographic maps produced in the Study should be regarded by SOB as prototype medium to large-scale topographic maps.

The 1:5,000 scale topographic maps produced are in the form of digital data, so that they can be easily revised. In the future, SOB will need to update the 1:5,000 scale digital topographic maps, taking into consideration the contents and methods of work better suited for actual conditions in Bangladesh, and also drawing on their experiences in the production of the digital topographic maps. In this way, it will be possible for SOB to maintain and enhance SOB's technical capabilities in the production of medium to large-scale topographic maps.

In Japanese culture, technology and traditional art, a process has long been in effect made up of the three steps, namely, "SHU (protect)", "HA (destroy) and "RI (break away)". "SHU (protect)" means to study in

earnest, to learn adhering strictly to the basic techniques. The next step is "HA (destroy)" in which the basic techniques (that can also be expressed as "tradition") are broken down. Through the destruction of old forms and techniques we arrive at last at the final step of "RI (break away)" in which we move away from what we have learned and establish something original.

Since old times, Japan has developed its own technology based on technology imported from overseas, through the process of these three steps, "SHU (protect), HA (destroy) and RI (break away)".

The method used in the production of the 1:5,000 scale digital topographic maps that the Study team employed in the Study is basically Japanese system modified by engineers of the Study team who have experience in topographic mapping in a variety countries.

Basically, the method the Study team employed has its foundation in Japan. Although there is no basic difference in the mapping technology, there is a need to alter actual method of execution depending upon the conditions of the country such as local conditions, equipment owned, technical capabilities, etc., of country in question.

It is important for SOB now to review the working method used in the Study by considering local conditions of Bangladesh, local qualities, equipment owned, technical capabilities, available budget, etc., in order to establish within Bangladesh a specific working method suited to the actual conditions of SOB. In other words, the Study was the "SHU (protect)" step for SOB, and now SOB needs to move on to the "HA (destroy)" step.

Through the implementation of the Study, SOB was able to experience the chain of work for the production of medium to large scale digital topographic maps by photogrammetric method, and was able to equip itself with the equipment and software necessary to produce medium to large scale topographic maps. As we have mentioned several times through the execution of the Study, the ground control point survey and aerial triangulation have been completed in the Study for the entire area covered by aerial photography (960 km^2), and SOB is in the position to be able to produce by itself its own digital topographic maps to cover the area (approximately 389 km^2) not covered by the 1:5,000 scale digital topographic maps, using the products of the Study.

After the completion of the Study, the Study team expects that SOB will establish a working method suited to the actual conditions of Bangladesh, based on the experience obtained through the implementation of the Study, and will by its own efforts produce 1:5,000 scale digital topographic maps to cover the remaining area.

The reason why medium to large scale topographic maps are produced mainly for city area is that the huge effect of human economic activities in city areas causes all kinds of problems, such as environmental problems and urban problems, and, the small scale topographic maps covering the entire national land are insufficient as basic material for solving these problems. The medium to large-scale topographic maps,

therefore, are produced because there is a need for them. It can be said that the topographic maps have no value until they are actually used by the users.

SOB needs to make efforts to ensure that the 1:5,000 scale digital topographic maps produced in the Study are put to effective use by many users; and the study team firmly believes that by having many users make use of the maps the reputation and value of SOB as an agency producing and supplying topographic maps are enhanced.

Finally, the Study team wishes to express sincere appreciation for the great support and cooperation rendered, during the period of implementation of the Study, by the Surveyor General and Directors of SOB, SOB counterparts, the Japanese Embassy in Bangladesh, the JICA Bangladesh Office and JICA expert.