CIVIL AVIATION AUTHORITY, BANGLADESH
MINISTRY OF CIVIL AVIATION AND TOURISM
THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

PREPARATORY SURVEY FOR DHAKA INTERNATIONAL AIRPORT EXPANSION PROJECT

FINAL REPORT

March 2017

Japan International Cooperation Agency (JICA)

Nippon Koei Co., Ltd.

Preparatory Survey for the Dhaka International Airport Expansion Project in the People's Republic of Bangladesh

EXECUTIVE SUMMARY

1. Background and Objective of the Project

In recent years, Bangladesh's economy has experienced an average annual growth rate of more than 6%. Against this background, the aviation demand at the international airport for the capital Dhaka has increased rapidly at an average pace approaching 10%. The Dhaka International Airport or the Hazrat Shahjalal International Airport (HSIA) handles nearly 70% of all domestic and international flights in Bangladesh and plays an important role as infrastructure supporting the rapidly growing economic activity.

The HSIA was planned for a capacity of 8 million passengers annually, but based on the data collection survey conducted in April 2016, the passengers for 2015 were approximately 6.5 million passengers per annum (mppa) (international: 5.57 mppa, domestic: 0.91 mppa) and the passenger handling capacity of the passenger terminal building (PTB) is expected to be saturated by 2019. In order to respond to this situation, the Government of Bangladesh (hereinafter referred to as “GoB”) is considering the construction of a new international passenger terminal, the refurbishment of the cargo terminal and the construction of peripheral infrastructure including the approach road to the National Highway. The construction of the new international passenger terminal and the construction of peripheral infrastructure in particular are expected to be implemented quickly, having been prioritized as important projects in the Seventh Five-Year Development Plan by GoB. Furthermore, HSIA is located approximately 17 km north of central Dhaka and there are plans to make the approach to HSIA into a multimodal hub connected with urban railways and expressways planned for the future.

The Japan International Cooperation Agency (JICA) has been conducting a data collection survey for this project since April 2016. It has been confirmed that there is an immense amount of reference materials including the design drawings for civil and architectural works, which requires detailed review prior to the implementation of the project. The GoB has requested the early commencement of the project for completion by the end of 2019, requiring an immediate response. In addition, in the Japan-Bangladesh Summit Meeting held on May 28, 2016, the importance of the project was mutually confirmed.

The improvement of the navigation aid system at HSIA has been implemented under the Japanese grant aid scheme project entitled “The Project for Improvement of Airport Safety and Security Systems” (2014), which is expected to secure safety of aircraft guidance to destination airports and landings and improve responses to aircraft accidents and acts of terrorism. In order to respond to the future increase in demand and to secure convenience and safety, it is urgently necessary to implement the mid-term expansion projects for HSIA, as described above. Acting on this background, GoB has requested JICA to implement the study on the expansion projects of HSIA with the intention to secure future yen loans.

The objective of the present study is to conduct the necessary studies to review the appropriateness of the project for implementation under Japanese government loan. It includes the objectives of the project, general composition, project finances, implementation schedule, implementation method (procurement and construction), organization for project implementation, organization for operation and maintenance, and environmental and social considerations based on the existing Master Plan (M/P) for expansion of HSIA

2. Social and Economic Condition

Bangladesh is one of the poorest countries in Asia with a population of approximately 160 million people. According to the International Monetary Fund (IMF), Bangladesh's nominal gross domestic product (GDP) in 2013 was USD 161.3 billion, and the nominal GDP per capita was USD 1,030 (World Economic Outlook Database, April 2016). It is categorized as a least developed country (LDC) based on the standards of the United Nations.

Bangladesh has an eminently fertile land nurtured through the flooding of the Padoma River, the Jamuna River, and the Meghna River, and has been referred to as "the Golden Bengal". From the fact that the country has an enormous population and workforce, the economic potential is high; however, under the influence of natural disasters such as floods and cyclones, the development of its industries are delayed

Furthermore, even though Bangladesh has received technical and financial assistance over a long period, the country still faces challenges of economic and social development due to these natural disasters, excessive population, undeveloped infrastructure, and political confusion. However, they have shown a continuous steady economic growth after 2006 and are expected to achieve a nominal GDP per person of USD 1,900 in 2020 and to shift from LDC to middle-income country by 2021.

Table 2-1BasicSocioeconomic Indicator

Indicator	2012	2013	2014
Real GDP Growth Rate	6.26%	6.04%	6.31% (Estimation)
Current GDP	USD 141.71 billion	USD 161.30 billion	USD 184.00 billion (Estimation)
Current GDP per Capita	USD 916.03	USD 1,030.03	USD 1,163 (Estimation)
Consumer Price Growth Rate	6.23%	7.54%	7.01%
Unemployment Rate	6.52%	6.01%	6.06%

Source: World Economic Outlook Database, April 2016
Source (Unemployment Rate): Institute of Developing Economies, Japan External Trade Organization

3. Aviation Traffic Forecast

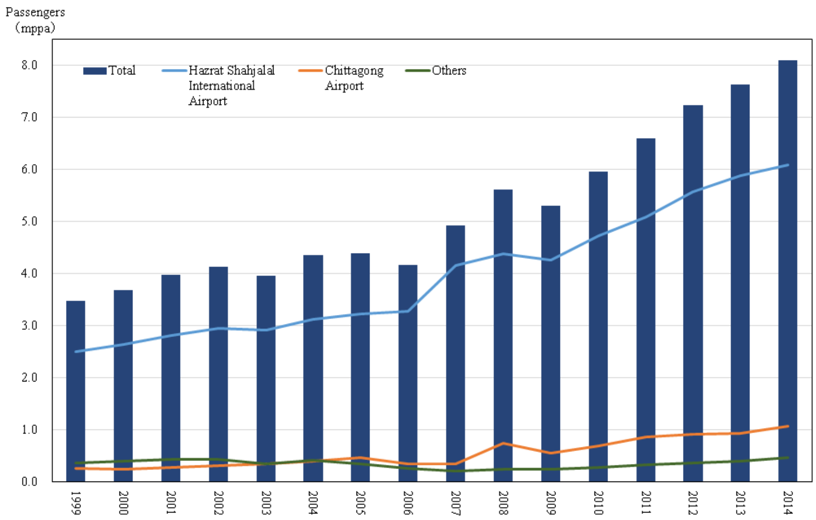
3.1 Aviation Demand in Bangladesh

HSIA handles approximately 75% of the total passenger demand and 90% of the total cargo demand in Bangladesh. Local airports such as Chittagong, Cox's Bazar, Jessore, and Sylhet handle the remaining demand. The passenger handling volume in 2014 at HSIA was approximately 6 million passengers per annum (mppa) and Chittagong Airport was second with approximately 1 mppa. The other airports handle much fewer passengers with annual passenger handling of less than 0.2 mppa each.

The annual average growth rate of the real GDP of Bangladesh has shown steady growth of 6% after 2004, achieving 6.85% in 2006. The rate in 2007-2008 decreased slightly and dropped to 5.3% in 2009 due to the financial crisis starting in September 2008. However, it recovered after 2010 and has maintained a growth rate of 6% or more.

The number of air passengers for Bangladesh as a whole and HSIA both increased in 2007 and 2008, but declined by approximately 300,000 passengers and 100,000 passengers, respectively, in 2009 due to the financial crisis. However, it has continued to grow by 6% after 2010 in step with economic growth.

Furthermore, although the annual average growth rate of passengers from 1999 to 2015 at HSIA was 6.17%, the growth rate after 2006 has increased to 7.88%, showing a prominent increase in demand in recent years.



Source: Statistical Year Book of Bangladesh 2014 and CAAB, JICA Study Team

Figure 3-1 Growth of Air Traffic Passenger Traffic in Bangladesh

In HSIA, the international passenger ratio was 77.2% in 1999, but the ratio has increased in recent years and international passenger has come to occupy approximately 90% of all passengers after 2011.

Domestic passenger numbers at HSIA have not seen major change from 1999 to 2009; while 0.7 mppa nationwide was recorded in 2007, it maintained approximately 0.6 mppa during this period, reducing to 0.52 mppa at its lowest in 2010. However, demand is now recovering after 2010 and the annual average growth rate from 2010 to 2015 was 5.84%.

3.2 Passenger Demand

The results of the passenger traffic forecast conducted by this study compared with the CAAB Master Plan forecast are shown in Table 3-1. The passenger numbers for high /low cases are derived by adjusting the GDP growth rate for base case by ±1.24% and forecasting the passenger demand numbers for each growth rate.

・The actual international passenger numbers for 2015 were approximately 5.6 million pax, but the CAAB Master Plan has assumed 6 million. Therefore, the CAAB forecast starts from a slightly inflated figure.

- ✈ The actual international passenger numbers for 2015 were approximately 5.6 mppa, but the CAAB Master Plan has assumed 6 million. Therefore, the CAAB forecast starts from a slightly inflated figure.

- The domestic passenger demand has previously trended from 10% to 15% of the international passengers, but the ratio has increased after 2010 and the domestic passenger numbers are expected to show further increase in the future. Based on the results of the forecast, the domestic passengers are expected to reach almost 5.2 mppa in 2035, approximately 20% of international passengers. This is a large revision of the CAAB Master Plan forecast.
- The combined demand for international and domestic passengers does show a large difference between the JICA Study Team and CAAB forecasts, but the differences can be explained by the following reasons:
- CAAB's forecast is based on aviation traffic demand data up to 2013, but the JICA Study Team was able to utilize data up to 2015.
- CAAB's forecast assumes GDP growth, which has a strong influence on aviation traffic demand, of 7% for 2015-2025, 6% for 2025-2030 and 5% for 2030-2035. In contrast, the JICA Study Team has assumed slightly lower GDP growth of 6.67% for 2013-2021, 6% for 2021-2025, 5.5% for 2025-2030, and 5% for 2030-2035, based on the latest data/forecast by IMF published in April 2016.

Table3-1Comparison of Passenger Demand Forecast (Million Passengers)

Category	Year	JICA Study Team (JST)			CAAB Master Plan		
		High Case	Base Case	Low Case	High Case	Base Case	Low Case
International Passenger	2015	5.569	5.569	5.569	6.120	5.997	5.875
	2020	9.252	8.669	8.112	9.312	8.671	8.069
	2025	13.662	12.042	10.583	14.206	12.564	11.100
	2030	19.366	16.082	13.295	20.623	17.313	14.513
	2035	26.611	20.835	16.214	28.451	22.659	18.012
	CAGR (2015-2035)		6.82%			6.87%	
Domestic Passenger	2015	0.913	0.913	0.913	0.691	0.685	0.679
	2020	1,493	1.379	1.270	0.820	0.796	0.773
	2025	2.410	2.086	1.793	0.974	0.926	0.881
	2030	3.632	2.959	2.388	1.134	1.056	0.983
	2035	5.226	4.017	3.050	1.294	1.179	1.073
	CAGR (2015-2035)		7.69%			2.75%	
Total	2015	6.482	6.482	6.482	6.811	6.682	6.554
	2020	10.745	10.047	9.382	10.132	9.467	8.842
	2025	16.072	14.127	12.376	15.180	13.490	11.981
	2030	22.997	19.041	15.683	21.746	23.838	19.085
	2035	31.837	24.852	19.264	29.746	23.838	19.085
	CAGR (2015-2035)		6.95%			6.57%	

Source: JICA Study Team
Note: CAGR: Compound Average Growth Rate; the mathematical average for the indicated period

3.3 Cargo Demand

Based on the actual numbers for international cargo, the cargo demand has shown a steady increase and a stable demand for cargo services can be assumed. However, the domestic cargo demand is very small and unstable compared with international cargo demand, having less than 1% of the volume and exhibiting violent fluctuations in demand. The combined cargo volume of international and domestic cargo for 2015 was approximately 260 thousand tons.

The following observations are made based on the comparison with the CAAB forecast:

- As shown in Table 3-2, the volumes for international cargo for 2015 in the JICA Study Team's and CAAB's forecasts are almost the same, but the growth rate afterwards is greater in the JICA Study Team forecast.
- The actual domestic cargo volume for 2015 is recorded at 1,900 tons, substantially larger than the 760 tons forecast by the CAAB Master Plan.
- The difference between the JICA Study Team and CAAB's forecasts for cargo volumes is due to the following reasons:
- The CAAB Master Plan is based on cargo demand data up to 2013, but the JICA Study Team was able to utilize data up to 2015.
- The growth in cargo volumes after 2010 is large and since the JICA Survey Team utilized the available data up to 2015 to build its forecasting model, the regression formula with the growth rate higher than that of CAAB model was derived.

Table3-2 Comparison of Cargo Demand Forecast (tons)

Category	Year	JICA Study Team (JST)			CAAB Master Plan		
		High Case	Base Case	Low Case	High Case	Base Case	Low Case
International Cargo	2015	258,010	258,010	258,010	261,000	257,000	254,000
	2020	449,790	418,152	387,953	350,000	333,000	317,000
	2025	689,105	601,172	522,012	472,000	433,000	396,000
	2030	998,588	820,411	669,181	615.000	543,000	479,000
	2035	1,391,731	1,078,310	827,570	773,000	662,000	479,000
	CAGR (2015-2035)		7.41%			4.84%	
Domestic Cargo	2015	1,888	1,888	1,888	770	760	750
	2020	3,732	3,447	3,174	950	900	860
	2025	7,231	6,257	5,380	1,170	1,070	980
	2030	12,710	10,357	8,359	1,380	1,220	1,070
	2035	20,902	16,068	12,201	1,550	1,360	1,120
	CAGR (2015-2035)		11.3%			2.95%	
Total	2015	259,898	259,898	259,898	261,770	257,760	254,750
	2020	453,523	421,599	391,127	350,950	333,900	317,860
	2025	696,336	607,429	527,392	473,170	434,070	396,980
	2030	1,011,299	830,768	677,539	616,380	544,220	480,070
	2035	1,412,633	1,094,378	839,771	774,550	663,360	559,120
	CAGR (2015-2035)		7.45%			4.84%	

Source: JICA Study Team

3.4 Aircraft Movement

The number of aircraft movement between 2011 and 2015 showed a marked increase from 56,000 to 57,000 movements annually in 2010 and 2011 to 73,000 movements annually for 2015.

The general aviation (GA) (sightseeing flights and training flights, aircraft owned by private companies and individuals) and military aircraft accounted for 5,000 to 7,000 movements annually with little variation. The records separately obtained from ATC for 2015 showing monthly movements of aircraft by category showed that GA and military aircraft movements are stable at around 200 and 430 movements per month, respectively.

The forecast for aircraft movements is calculated based on the passenger numbers forecast by the JICA Study Team and formulating an aircraft mix and the average numbers of passengers on each craft (load factor).

Based on this analysis, when the aircraft movements are determined using the aircraft mix and passenger forecast, movements reached approximately 17.1 million in 2030. The JICA Study Team forecast exceeds the CAAB forecast by approximately 10%. This was caused by assuming a lower number of passengers on each flight due to the small upsizing of the aircraft compared with the CAAB Master Plan.

Table 3-3 Comparison of Aircraft Movement Forecast (including GA and Military Aircraft)

Year	JICA Study Team			CAAB Master Plan		
	High	Base	Low	High	Base	Low
2015	73,235	73,235	73,235	70,400	69,400	68,500
2020	118,556	110,830	103,455	94,400	89,600	85,300
2025	165,430	145,460	127,483	129,100	117,700	101,400
2030	206,196	171,130	141,367	172,000	150,000	131,300
2035	264,178	206,900	161,077	222,100	185,000	154,900

Source：JICA Study Team

In addition, the JICA Study Team conducted a forecast for freighter aircraft movements. Freighter aircrafts are not used for domestic cargo in Bangladesh and are carried as belly cargo on passenger flights (permissible cargo on passenger flights). Domestic cargo volume will continue to be extremely low compared with international cargo even in 2035, accounting for only 1.5% of total volume. Since domestic cargo will continue to be carried as belly cargo in the future, the aircraft movement forecast for cargo was based on international cargo volume using freighter. The forecast for the base case is shown in Table 3 4.

Table3-4 Freighter Aircraft Movement Forecast

	2015	2020	2025	2030	2035
Freighter	1,248	2,023	2,908	3,969	5,216

Source: JICA Study Team

3.5 Peak Hour Traffic

Based on the statistical data of HSIA, the numbers of passengers and aircraft movements during peak hour in the traffic demand base case were calculated. The aircraft movement numbers are exclusive of GA and military aircraft.

Table 3-5 Passengers and Aircraft Movements during Peak Hourand Peak Day (Base Case)

			2015		2020		2025		2030		2035	
			Intl'	Dom	Intl'	Dom	Intl'	Dom	Intl'	Dom	Intl'	Dom
Passenger (mppa)		Intl'/Dom	5.569	0.913	8.669	1.379	12.042	2.086	16.082	2.959	20.835	4.017
		Total	6.482		10.047		14.127		19.041		24.852	
A/C Movement		Intl'/Dom	37,192	32,212	56,289	47,540	75,260	63,200	96,880	67,250	121,133	78,767
		Total	69,404		103,830		138,460		164,130		199,900	
Average Daily Flight			102	89	155	131	207	174	266	185	332	216
Passengers	Peak Day Ratio (Terminal Building)		1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300
	PAX at Peak Day	Intl'/Dom	18,563	3,043	28,895	4,596	40,138	6,952	53,607	9,863	69,450	13,390
		Total	21,607		33,491		47,091		63,470		82,840	
	Peak Hour Ratio		0.1225	0.138	0.1196	0.1145	0.1182	0.102	0.1173	0.0997	0.1166	0.0946
	PAX at Peak Hour	Intl'/Dom	2,273	402	3,456	526	4,744	709	6,285	984	8,098	1,267
		Total	2,694		3,982		5,453		7,269		9,365	
A/C Movement	Peak Day Ratio (Apron, Utilities, etc.)		1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330
	Peak Day Flight	Intl'/Dom	113	98	171	144	228	192	294	204	367	239
		Total	210		315		420		497		606	
	Peak Hour Ratio		0.1233	0.1305	0.1202	0.1099	0.1186	0.0985	0.1176	0.0964	0.1169	0.0917
	Peak Hour Flight	Intl'/Dom	14	13	21	16	28	19	35	20	43	22
		Total	27		37		47		55		65	
A/C Movement (Freighter)			1,248		2,023		2,908		3,969		5,216	
Peak Day Flight (Freighter)			4		6		9		12		16	

Source: JICA Study Team

4. Review of the Past Study on HSIA Expansion Project

In this chapter, information of the study, planning, and design works done by CAAB is organized, and the results of the review of each item are described.

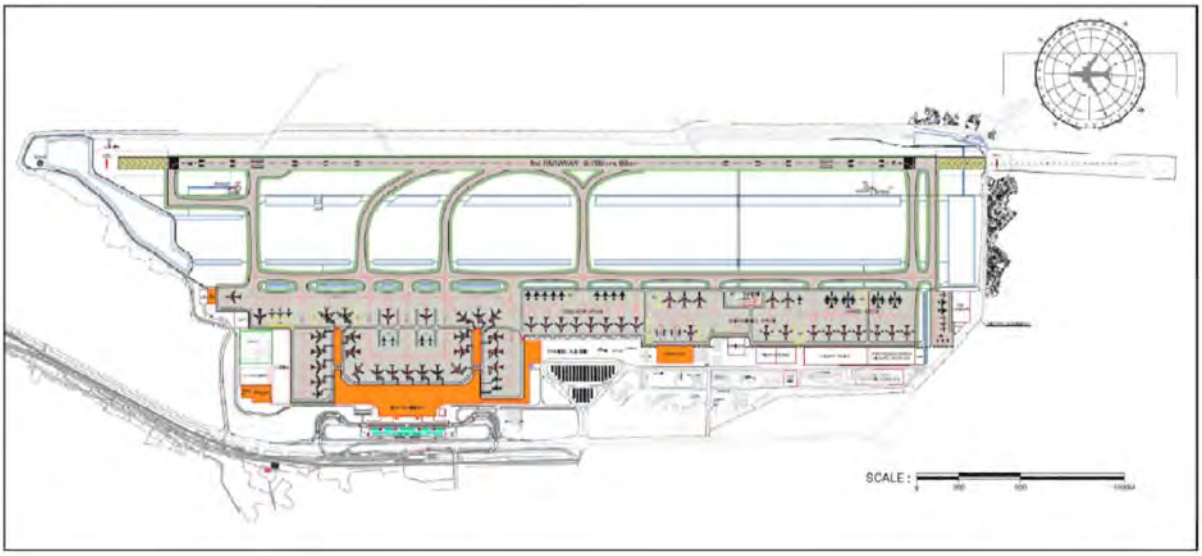
Table 4-1 Review on HSIA Expansion Project Made by CAAB

No	Title	Table of Contents	Date	Format	Remarks
1	MASTER PLAN AND FEASIBILITY STUDY	Executive Summary 1. Introduction 2. Overview of the Existing Airport 3. Aviation Demand Forecast 4. Conceptual Design 5. Land Use Plan 6. Environmental Screening 7. Economic Analysis	February 2015	PPT	"5. Phased Development Plan" and "9. Financial Analysis" are not in this version
2	MASTER PLAN REPORT	Executive Summary 1. Introduction 2. Overview of the Existing Airport 3. Aviation Demand Forecast 4. Conceptual Design 5. Phased Development Plan 6. Land Use Plan 7. Enviromental Screening 8. Economic Analysis 9. Financial Analysis	June 2015	PPT	The latest one of the Master Plan Report
3	FEASIBILITY STUDY REPORT	1. Economic Analysis 2. Financial Analysis	June 2015	PPT	Chapters 8 and 9 of No. 2
4	BASIC DESIGN REPORT (TERMINAL and LANDSIDE)	01 Project Background and Brief Description 02 Chapter: I Terminal Planning and Design 03 Chapter: II Structural: Terminal Buildings 04 Chapter: III Structural: Elevated Drive Way (EDW) 05 Chapter: IV Plumbing 06 Chapter: V Heating and Ventilation and Air Conditioning System	No information	PDF Report	The design report of Terminal 3, EDW, New VVIP, New Domestic Terminal,and OtherInfrastructures
5	BASIC DESIGN REPORT VOL. 1 Airside	Chapter I. Introduction Chapter II. Executive Summary of Master Plan and Feasibility Study Chapter III. Design of Civil Works Chapter IV. Design of NAVAIDS and AGL System	June 2015	PPT	The Civil Works, NAVAIDS and AGL System
6	TENDER DOCUMENT	Section - 1 Instruction to Tenderers (ITT) Section - 2 Tender Data Sheet (TDS) Section - 3 General Condition of Contract (GCC) Section - 4 Particular Conditions of Contract (PCC) Section - 5 Tender and Contract Forms Section - 6 Bill of Quantities Section - 7 1 General Items 2 Preliminaries 3 Earth and Pavement Works 4 Concrete and Reinforcement 5 Sealing 6 Marking 7 Airfield Ground Lighting System and Navigation Aid 8 Drainage and Protective Works 9 Civil Works 10 Plumbing and Sanitary Works 11 Electrical Works 12 Substation Equipment 13 Diesel Generator 14 Installation of Passenger Lifts 15 Fire Protection Works 16 Air Conditioning System 17 Installation of Deep Tube Well 18 Gas Connection System 19 Communication and CCTV 20 Steel Truss 21 Wastewater Treatment Plant 22 Siphonic Drainage System 23 Cargo Terminal 24 Intake Power Station 25 Pump House and Out Station 26 Landscaping / Particular 26 Specification / Drawings	June 2015	Word PDF CAD	

Source: JICA Study Team

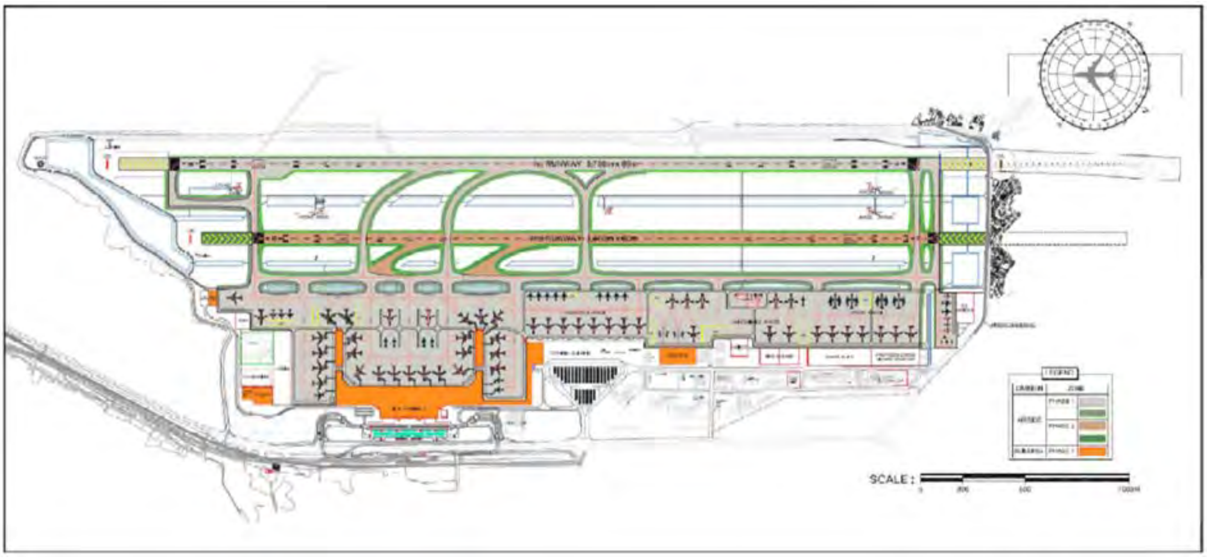
The CAAB conducted the "Master Plan and Feasibility Study, Construction of Second Runway and Other Infrastructure Development Works at Hazrat Shahjalal International Airport" for the Dhaka International Airport Expansion Project in February 2015. Thereafter, the study was updated in June 2015. In the updated study report, the phased development plan has been proposed. According to the phased development plan, the second runway will not be constructed under the phase-1 development (completion in 2019), but will be constructed under the phase-2 development. The completion year of phase-2 is not mentioned in the report.

Based on the report (June 2015 version), the scope of the expansion project is shown in Table 4-2, and the layout plans are shown in Figure4-1 and Figure4-2.



Source: CAAB

Figure4-1Master Plan Layout (Phase-1, Completion in 2019)



Source: CAAB

Figure4-2Master Plan Layout (Phase-2)

Table 4-2Scope of the HSIA Expansion Project by CAAB

Facilities	Contents	Remarks
Existing Runway	Extension and Widening 3,200 x 46 m → 3,692 x 60 m	
New Runway	3,292 x 60 m	For dependent operation
New Taxiway	Rapid exit taxiways and other taxiways	
Access Road	- New construction for new Terminal 3 - Improvement for existing Terminal 1 and Terminal 2 and new domestic terminal	
Apron	- Expansion and Reconstruction Area: around 1,000,000 m^2 - Apron Spot: 29 → 64	
New Terminal-3	Around 260,000 m^2	
New Domestic Terminal	Around 15,000 m^2	1.4 mppa
Existing Terminal-1 and Terminal-2	Following renovations: - Check-in Counter nos.: 56 → 84 - Gate nos.: 15 → 20 - Increase Number of Arrival Immigration Counter	
Navigation Aids	- Upgrade of ILS from CAT-I to CAT-II - New Installation of AWOS - Relocation of PSR/SSR	
Support Facilities	Relocation, expansion, and/or new construction of the following facilities: - VVIP Complex - RFFS - Sewage Treatment Plant - Intake Power Plant - PSR/SSR - Airport Traffic Control Tower - Maintenance Hangar - Catering Building - Cargo Complex - GA Apron and Hangar	

Source: CAAB

5. Analysis of Airport Capacity and Validity of the Project

5.1 Analysis of Capacity of Current Airport Facilities

The JICA Study Team clarifies the capacity limit of HSIA by analyzing the capacity of the current facilities, which include the runway, taxiway, passenger terminal building, cargo terminal, and car parking. The capacity analysis is conducted for the demand in 2020 when the development project of the Bangladeshi government will be completed. The summary of the capacity analysis is shown in Table 5.1.

Table 5-1 Summary of Capacity Analysis of Each Facility of HSIA

Items		Current Condition/ Capacity	Requirement in 2020	Evaluation
Runway	Nos.	Approximately 170,000 movements/year	103,830 movements/year	It is possible to meet the demand until 2030 with one runway by maximizing the capacity for one runway.
	Length	3,200 m	3,200 m	All flights, except for long-haul flights with some large aircrafts, can be operated.
	Width	46 m	46 m	Width of 60 m is unnecessary although it is desirable for the operation of Code F aircrafts.
Rapid Exit Taxiways and Connection	Peak hour aircraft movements	35 movements/hour	24 movements/hour	Peak hour aircraft movements in 2015 was 18 and in 2020 will increase to 24, therefore, there will be no problem with

Items		Current Condition/ Capacity	Requirement in 2020	Evaluation
Taxiways				the capacity of existing facilities.
Taxiway	Width	23 m	23 m	Width of 25 m is unnecessary although it is desirable for the operation of Code F aircrafts.
Apron	Spot Nos.	29	32	Although the demand will exceed the current capacity in few years later, other apron infront of the cargo terminal and maintenance area could be used in peak hour.
International Passenger Terminal Building	Check in Counter	56	60	The capacity of the existing international terminal building (Terminal 1/Terminal 2) is 8 mppa. According to the aviation traffic demand forecast in this study, the demand of international passengers in 2020 will reach to 8.7 mppa. Although it is concerned that the low service level will be found temporarily in peak hour, the exceed demand will not considerably affect the growth of future demand.
	Security Check Point	19	19	
	Emigration Counter	38	21	
	Immigration Counter	22	25	
	Baggage Claim Counter	8	8	
Domestic Passenger Terminal Building	Check in Counter	12	11	The capacity of the existing domestic terminal building is 640,000. Domestic passengers have already reached beyond 910,000. Therefore, severe congestion will be found in 2020.
	Security Check Point	3	4	
	Baggage Claim Counter	1	4	
Cargo Terminal Building	Area	27,800 m^2 Export: 12,800 m^2 Import: 15,000 m^2	42,000 m^2 Export: 14,000 m^2 Import: 28,000 m^2	According to future demand requirement, the capacity of cargo terminal is expected to be short in 2020.
Car Parking	Car Nos.	1,000 cars	1,008 cars	Although excess capacity at peak hour is concerned, it will not considerably affect the growth of future demand.
Utility	Power Supply	8 MVA	TBD	Temporary capacity and over load of each facility areconcerns since the required capacity will exceed the capacity of T1/T2 in 2020. However, it will not considerably affect the operation of the airport.
	Water Supply	Tube well	TBD	
	Waste Water Treatment	TBD	TBD	
	Fuel	TBD	TBD	
Confidential due to security reasons.				

Source: JICA Study Team

5.2 Confirmation of the Necessity and Validity of the Expansion Project

Based on the capacity analysis of the existing HSIA and the CAAB Master Plan, the necessity and validity of the project planned by the Bangladeshi government are shown in Table 5-2.

Table 5-2Summary of the Project Scope and Evaluation

Facility	CAAB Master Plan (Target Year: 2035)	Phase 1 Plan (Target Year: 2025)	Evaluation
Existing Runway	Extension and widening From “3,200 x 46 m” to “3,692 x 60 m”	None	Importance and priority are low although extension and widening are desirable by considering Code F aircraft

Facility	CAAB Master Plan (Target Year: 2035)	Phase 1 Plan (Target Year: 2025)	Evaluation
			operation in the future.
New Runway	3,292 x 60 m	None	Currently, these are not important although it will be necessary for long-term plan from the view point of future demand.
New Taxiways	Rapid exit taxiways and the other taxiways	Rapid Exit Taxiway: 2 Attached Taxiway (RWY 14): 1 Attached Taxiway (Parallel Taxiway): 9	It is reasonable for maximizing the capacity for one runway.
Landside Service Road	Landside service road for the new T3	Landside service road for the new T3	It is necessary for the operation of the new T3
Apron	Area of expansion and reconstruction: approximately 1,000,000 m^2 Apron spot nos: from 29 to 64	Apron expansion: Approx. 520,000 m^2 Apron spot Nos: 42	Apron expansion and increase in apron spot are needed to meet the future demand in phase 1. In addition, the current apron improvement project is not included in phase 1 scope, because the project is progressed by CAAB.
New T3	Approximately 260,000 m^2 3 Stories Passenger Capacity: 16.2 mppa	Approximately 220,000 m^2 3 Stories Passenger Capacity: 12 mppa	Based on the future demand, the scale of expansion should be decided in 220,000 m^2 in phase 1. In phase 2, Terminal 3 needs to be expanded to 260,000 m^2.
New Domestic Terminal	Approximately 15,000 m^2	None	Considering priority of facilities, the new domestic terminal needs to be built in phase 2. In phase 1, the existing domestic terminal will be continuously used, a part of T1/T2 will be used temporarily, if necessary.
Existing T1 & T2	Following renovation works: - Nos. of check-in counter: from 56 to 84 - Addition of immigration and emmigration counter	None	Although the expansion of facilities is needed since it will be insufficient for future demand, it is not urgent if the new T3 will be constructed.
Cargo Terminal	40,000m^2 (Existing export cargo terminal: 12,800 m^2, Import cargo terminal: 27,200 m^2)	47,000 m^2 (Export cargo terminal: 27,000 m^2, Import cargo terminal: 20,000m^2)	Developing cargo terminal is necessary for increasing cargo capacity and operational improvement. Need to study about the necessary facility capacity.
VVIP Terminal	Approximately 5,000 m^2	Approximately 5,000 m^2	Relocation is needed according to the construction of new Terminal 3.
Car Parking	1,948 lots (T1/T2: 800, T3: 1,148)	T3: 1,148 lots	In phase 1, the capacity of new car parking for Terminal 3 is sufficient with demand of all passengers, who access the airport by car.
It contains information that may be harmful to the safety of the country so it is Confidential.			
Supply Facility	- RFFS	RFFS	New construction is reasonable considering the response time.
	- Waste water treatment plant	Waste water treatment plant	Expansion of facilities is needed according to the expansion of the airport.
	- Intake power plant with distribution system	Intake power plant with distribution system	

Facility	CAAB Master Plan (Target Year: 2035)	Phase 1 Plan (Target Year: 2025)	Evaluation
	- Maintenance hangar	Maintenance hangar	The upgrade and improvement of these facilities are progressed by CAAB.
	- Catering facility	Catering facility	
	- GA apron and hangar	GA apron and hangar	

Source: JICA Study Team

6. Basic Airport Plan

As to the scope of the project as shown in Table 6-1.

Table 6-1 Details of Scope of Works (Phase - 1)

Works	Division	Facilities
Building	New Passenger Terminal Building (Terminal 3)	3-story building with an area of approximately 220,000 m^2 including supply of related equipment capacity of 12.0 mppa
	Multi-level Car Parking with Tunnel	Area of approximately 62,000 m^2
	New Cargo Complex	Area of approximately 42,200 m^2
	VVIP Complex	Area of approximately 5,000 m^2
	Rescue and Fire Fighting Facilities	
Civil	Parking Apron (Terminal 3 Area)	Approximately 520,000 m^2
	Taxiways Landside Service Road with Elevated Road	9 connecting taxiways connecting to the Terminal 3 apron: approximately 35,000 m^2
	Taxiways (two rapid exits and one connecting taxiway for the runway 14 threshold)	Approximately 60,000 m^2
	Improvement of Drainage System	
Utility	Water Supply System	
	Sewage Treatment Plant	Area of approximately 3,000 m^2
	Intake Power Plant with Distribution System	Area of approximately 7,000 m^2
	Hydrant Fuel Supply System	
	Communication System	
	Security and Terminal Equipment	

Source: JICA Study Team

6.1 Passenger Terminal Building

In the improvement plan for Terminal 3, the contact stand will secure 12 spots in accordance with the improvement plan area (about 220,000 m^2) corresponding to the target planning year (2025) of Terminal 3. The case that C1 line in Figure 6-1 is set as the boundary line of Phase-1 was confirmed in a meeting with CAAB. The result of confirmation with CAAB is shown in Figure 6-2 to Figure 6-4.

In case the scale of Phase-1 is up to the C1 line, the area is minimal, and passenger flow is not to be troublesome. However, it is necessary to consider the adjustment of the gate lounge area on the first floor and the concession area since the gate lounge area on the first floor is not large enough in this case. For this adjustment, a meeting with CAAB is necessary. Also, in the next stage, the detailed design based on the Phase-1 function is necessary.

In the 2nd meeting with CAAB held on 6th Feb 2017, the above scope of Phase-1 facilities was reconfirmed. The necessity for rearrangement of layout to satisfiy functional requirements of a 12 mppa terminal, especially the detailed design of M&E, TE, Security and Police Rooms required in the next stage was also comfirmed.

Confidential

Figure 6-1 Improvement Area of Phase-1（Up to Grid Line C1）

Confidential

Figure 6-2 Second Floor Planigure 6-2 Second Floor Plan

Confidential

Figure 6-3 First Floor Plan

Confidential

Figure 6-4 Ground Floor Plan

6.2 Cargo Terminal

More than a decade has passed since the construction of the current export cargo terminal, based on the explanation of CAAB and a structural evaluation is necessary regarding the soundness of the building.

In addition, unused equipment is left abandoned inside the building and layout of some equipment is not appropriate for operations.

In addition, part of the existing export cargo terminal building is included in the scope of the apron construction plan, and partial removal is necessary at the time of apron constraction.

Even if the existing building is kept available for the export cargo terminal, a drastic change of the layout, removal of some equipment, and installation of new equipment are considered necessary.

On the other hand, it is not permitted to close an existing export terminal during operation. Therefore, the new export cargo terminal will be built on the right side (northwest side) of the existing export cargo terminal. After moving export cargo operations to the new facility, the new import cargo terminal will be constructed on the left side (southeastern side).

At present export and import cargo terminal are operated separately. On site inspections revealed serious issues with the space for breakdown and build-up operations. Rebuilding the import and export cargo terminals as a single integrated structure is essential for the improvement of basic handling unit.

6.3 VVIP Building

The policy of the improvement plan for the VVIP building is as follows:

- The function of the new VVIP building will follow that of the existing VVIP building.
- In the interview with CAAB, the existing drawings of the new VVIP building are only general drawings (plan view, elevation view, sectional view), and since there are no more drawings, detailed designs including suggestions are required.

6.4 Fire Fghting Facility

Confidential due to security reasons.

Table 6-2 Planning Scale of Fire Fighting Facility

Confidential due to security reasons.

6.5 Apron

Based on aircraft movement forecast in this survey, the aircraft traffic volume for apron pavement design is calculated. The design period for apron pavement is 20 years, from 2016 to 2035.

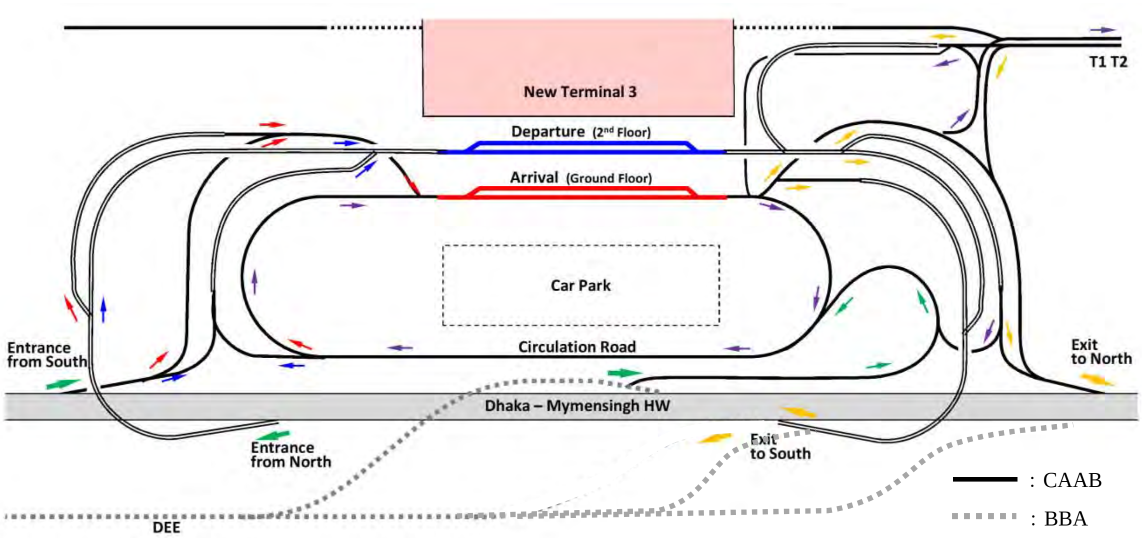
6.6 Taxiway

Since only 10% of aircrafts depart from the end of runway 32, the design traffic volume for the north rapid exit taxiway of the taxiway constructed in Phase1 is 10% of total arrival aircrafts. Based on the aircraft movement forecast in this survey, the aircraft traffic volume for the north rapid exit taxiway pavement design is calculated. The design period for rapid exit taxiway is 20 years, from 2016 to 2035.

6.7 Internal Road

The basic policy for planning the internal road is shown below.

- The road layout will follow the past conceptual design.
- The crossing of a major road should adopt elevated crossovers for smooth traffic.
- The circulation road should be provided for functional access in internal area.
- Highest possible service level should be provided in the limited landside space.
- The roads and bridges should be designed for easy recognition of directions.



Source: JICA Study Team

Figure 6-5 Traffic Line of Access / Approach Road

7. Airport Facility Plannning（Summary of Airport Facility Design）

7.1 Passenger Terminal Building（T3）

Meetings with Civil Aviation Authority, Bangladesh (CAAB), were held to confirm the scope of Phase-1 and requirements. The confirmed issues and conditions will form the basis for the airport facilities design.

(1) Results of Interview with CAAB

- There was no explanation by consultants (CPG and Yooshin) of final drawings and function of the Master Plan.

- The VIP arrival flow through the boarding bridge is mixed with ordinary passenger flow in the original design. The VIP arrival flow should be reconsidered.
- BHS design, especially VIP BHS circulation, in the original design is not clear.
- The mosque indicated in the original layout plan is independent from the terminal structure. It is not a prayer room and whether to include it in the scope of the project should be confirmed.
- After the meeting, JICA confirmed the mosque is part of the scope of this project, since the mosque is considered as one of the facilities in this airport.
- The required rooms of CIQ were verbally instructed by CAAB to CPG; however, the final drawings are not adequate. This issue shall be clarified.
- CAAB recognizes the need to confirm functions and the design intent in the original design for the Master Plan with the M/P consultant.

(2) Definate Design Requirement

JICA Study Team presented about the following matters at the 2nd CAAB meeting and confirmed that further re-check and re-arrangement shall be continued in the next stage.

- The Functional Occupation List to confirm the requirement of each room.
- The colored layout plans which show the function of airport facilities.

7.2 Cargo Complex Terminal

(1) Required Area of the Cargo Terminal Building

The required area of the cargo terminal building for the estimated cargo volume is set according to Table 7-1 and Table 7-2.

Table 7-1 Area of Cargo Terminal (Import)

Import Area	Area (m^2)	Remarks
ULD storage	4,500	477 ULD
Breakdown	3,650	
Storage, Custom, Dispatching	12,250	
Delivery	2,100	
Truck yard	6,150	
Total	28,650	Unit rate 7 tons / m^2

Source: JICA Study Team

Table 7-2 Area of Cargo Terminal (Export)

Export Area	Area(m2)	Remarks
Truck yard	6,150	
Unloading	3,300	
Ramp	2,700	
Security inspection	1,250	
Buildup	3,400	
ULD storage	1,900	
Total	18,700	Unit rate 21.4 tons/m2

Source: JICA Study Team

(2) Cargo Terminal Building Equipment

Confidential due to security reasons.

Table 7-3 Cargo Terminal Equipment (Full automated)

Confidential due to security reasons.

Table 7-4 Cargo Terminal Equipment (Semi automated)

Confidential due to security reasons.

Confidential due to security reasons.

Figure 7-1 Example of MHS (other airport)

Figure 7-2 Example of ETV (other airport)

Confidential due to security reasons.

Figure 7-3 Example of ASRS (other airport)

Figure 7-4 Example of large inspection machine (other airport)

The layout for the detailed design and the confirmation of necessary equipment for both cases (Full automated and semi automated) will be carried out in the future.

Confidential due to security reasons.

ource: JICA Study Team

Figure 7-5 Draft Cargo Terminal Layout (Semi automated)

7.3 VVIP Terminal

The survey and interview about existing VVIP Terminal were implemented during the first meeting with CAAB. The new VVIP Terminal shall be designed as suitable for the VVIP based on the functions of the existing facility. CAAB will continue to be consulted on future development of proposed facilities.

In the meeting with CAAB held on 6th February, CAAB requested that barrier free design for handicapped or elderly passenger flow to be considered. Further discussion and study will be continued in the next stage.

7.4 Fire Station

Confidential due to security reasons.

Table7-5 Plan of Fire Station

Confidential due to security reasons.

Confidential due to security reasons.

Figure7-6 FFS Layout

7.5 Car Parking

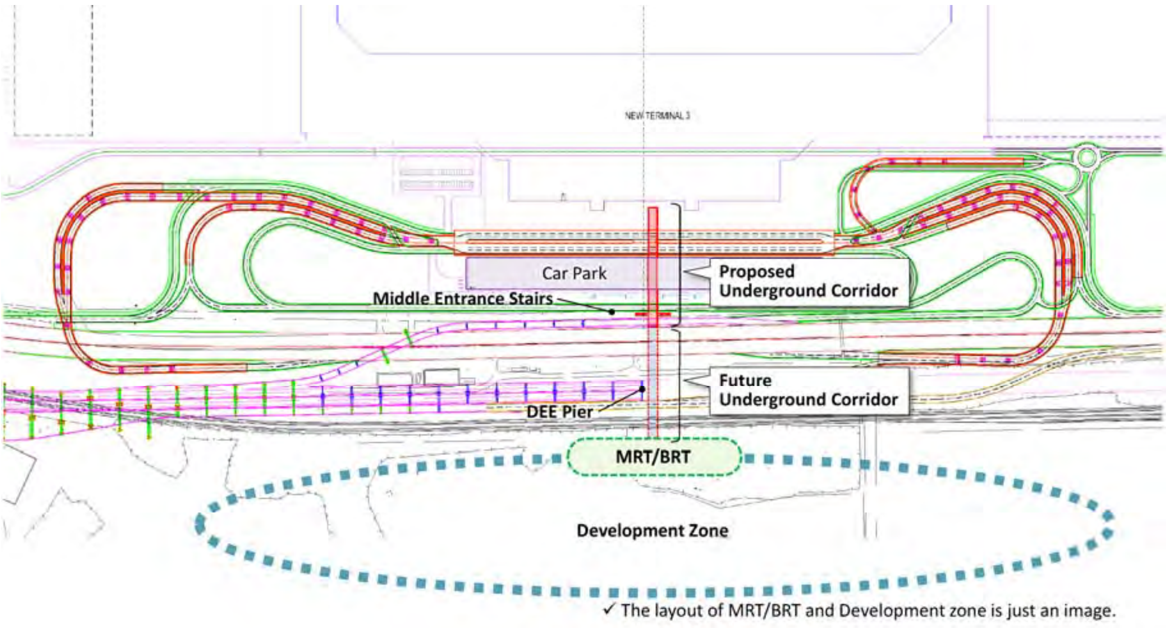
There are no indication of car parking system and details in the original drawings. The following item of design conditions and requirement shall be clarified. In the meeting held on 6th Feburuary 2017, JICA survey team explained about the summary of Car Parking Control System. The design will be developed further in the next stage.

- Car Parking Control System
- Security System in Car Parking
- Security Zoning as Airport Facility
- Demarcation of Scope of Work for Construction of Car Parking, Bridge (Elevated Road), and Terminal Building
- Requrement of Room in Car Parking
- Main Access from Car Parking to Terminal Building

7.6 Underground Pedestrian Corridor

(1) Corridor Layout

In front of Terminal 3, the new MRT/BRT station and other developments are under separate studied to ensure public traffic access. Although the layout of a new station plaza and a development plan are still undecided, the underground pedestrian corridor should be provided for airport users' convenience between Terminal 3 and the new station plaza. On the other hand, the new parking building is planned over the underground corridor. Therefore, the underground corridor take into account future development and should be constructed in the airport landside in advance. Along with the new terminal construction. In addition, the DEE pier is expected opposite the center of the Terminal 3 building. Thus, the layout of the underground corridor should be adjusted to avoid the DEE pier.



Source: JICA Study Team

Figure7-7Layout of Underground Pedestrian Corridor

(2) Interior Dimensions

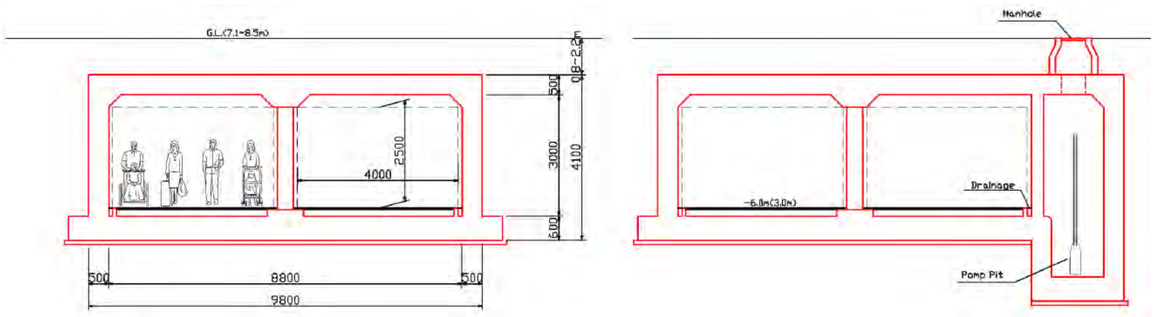
Working width should be planned with enough margin in consideration of future effective utilization.Vertical clearance, 2.8~3.0 m, should be ensured in consideration of some margin such as lighting and advertisement in addition to 2.5 m of pedestrian space. The passageway width is as follows, in case of the number of MRT users is assumed to be 30% of airport visitors in 2035.

Number of MRT users in 2035 : 75,500 per/day (JICA Study 2016)

In case of peak 10%,

Number of Pedestrian :	Q = 7,550 per/h	(126 per/min)
Pedestrian Density :	k = 0.3per/m^2	
Walk Speed :	v = 60 m/min	
Traffic Capacity :	q = k・v	= 18 人/min・m
Required Width :	w = Q / q	= 7.0 m (3.5m x 2)

For the effective width of one side, 4.0 m is recommended in consideration of person width and margin in addition to the above required width.



Source: JICA Study Team

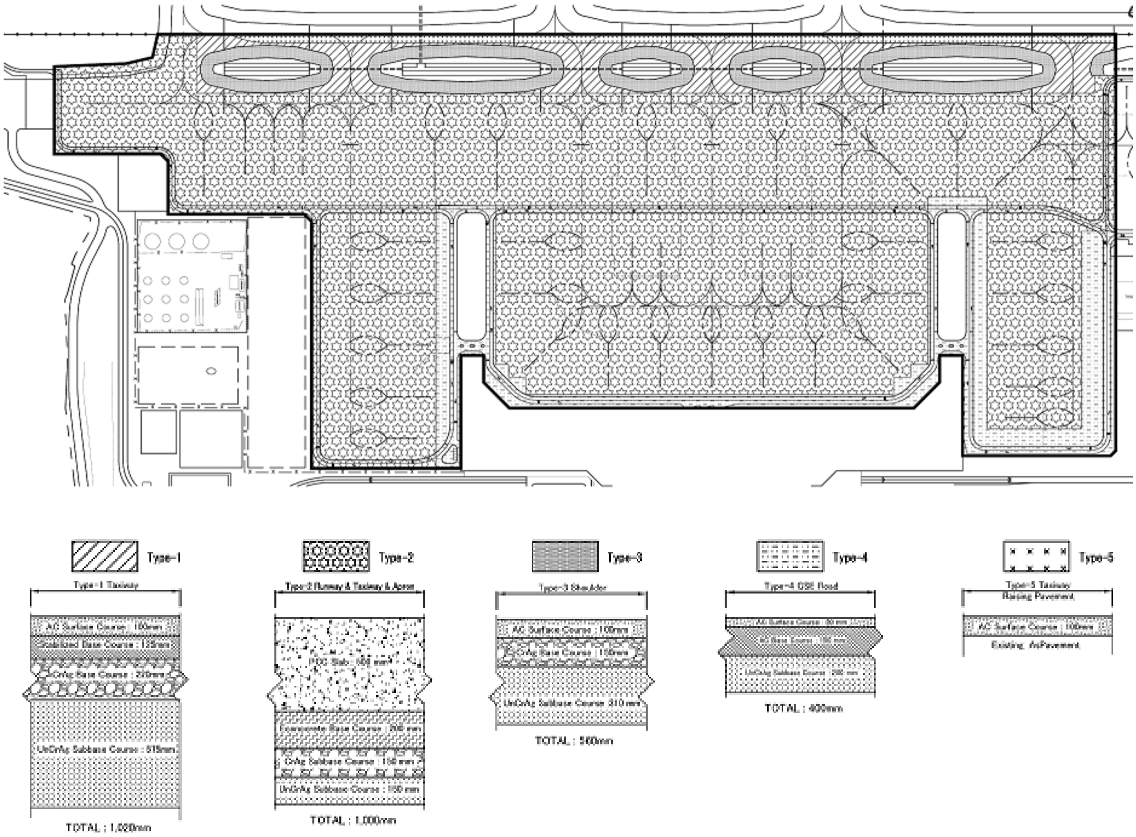
Figure 7-8 Cross Section of Underground Pedestrian Corridor

(3) Future Tasks

In the detailed design stage of this project, it is necessary to examine the design and location of the underground pedestrian corridor while adjusting with MRT line 1 project.

7.7 Apron

Pavement thickness is calculated by pavement program, FAA RFIELD v1.41 - Airport Pavement Design. The pavement thickness is different from the thickness in the master plan under the same design condition. In the detailed design, the pavement thickness should be recalculated.



Source: JICA Study Team

Figure 7-9 Pavement Type of Apron

7.8 Taxiway

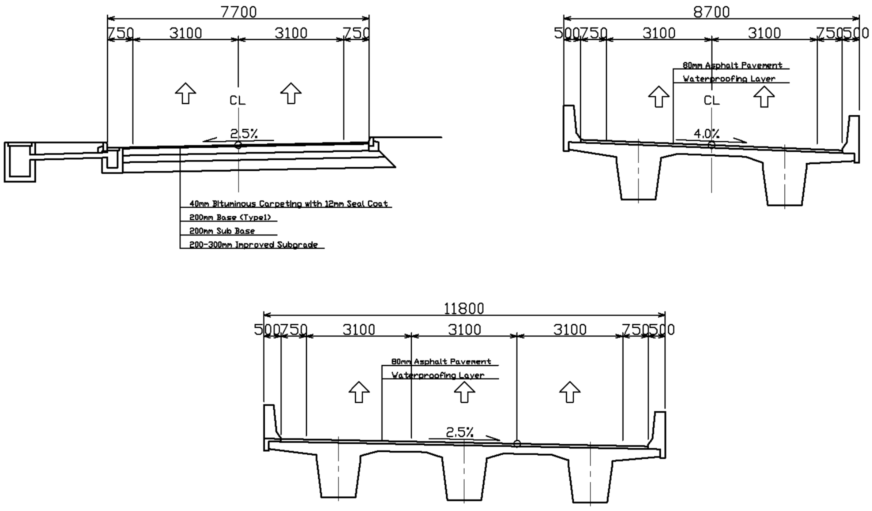
In the existing master plan, a trafic volume for pavement design of rapid exit taxiway and connecting taxiway is same as the runway pavement. It is possible to reduce the pavement thickness of connecting taxiway since the traffic volume of connecting taxiway may be reduced dependng on connecting location. In the detailed design stage of this project, it is necessary to recalculate the traffic volume and examine the pavement structure of the connecting taxiway taking into account the reviewed demand forecast results.

7.9 Internal Road and Bridge (Elevated Road)

(1) Cross Section

1) Access / Approach Road

The cross section of an access/approach road is shown below. In case of one-lane road, width of the carriageway including shoulder of more than 6 m should be provided for passing of an emergency vehicle.

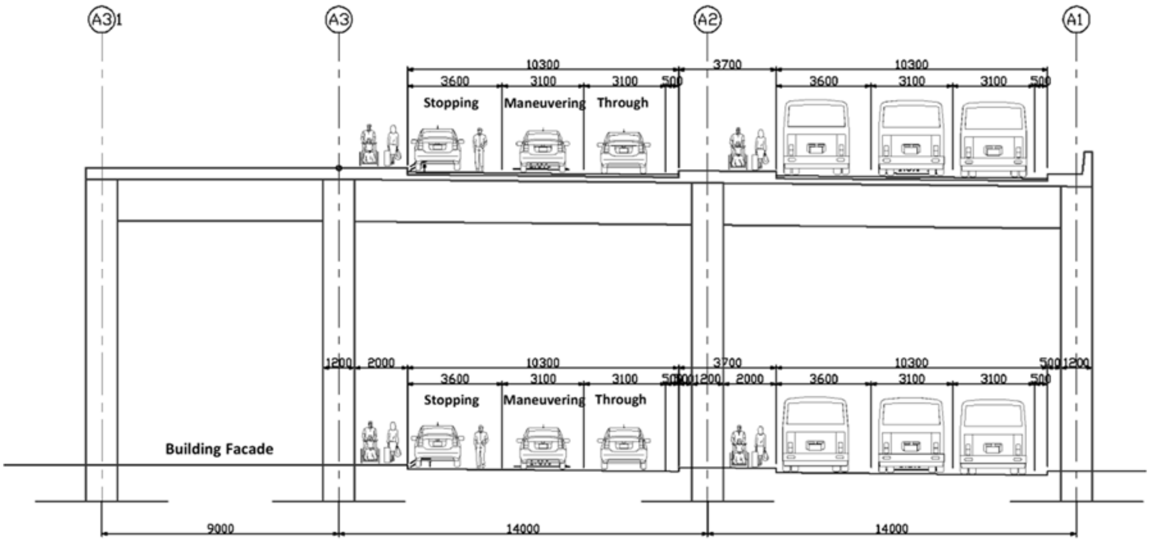


Source: JICA Study Team

Figure 7-10 Cross Section of Access / Approach Road

2) Curbside

Departure and arrival floors are each provided with two kerbsides for smooth traffic at peak hour. Each kerbside consists of three lanes for stopping, through traffic and maneuvering. In the stopping lane, wide width should be provided for stopping to let people get on and off and baggage handling. In a footway, width of more than 2 m should be provided in the resticted space around columns for passenger traffic and visibility.



Source: JICA Study Team

Figure 7-11 Cross Section of Curbside

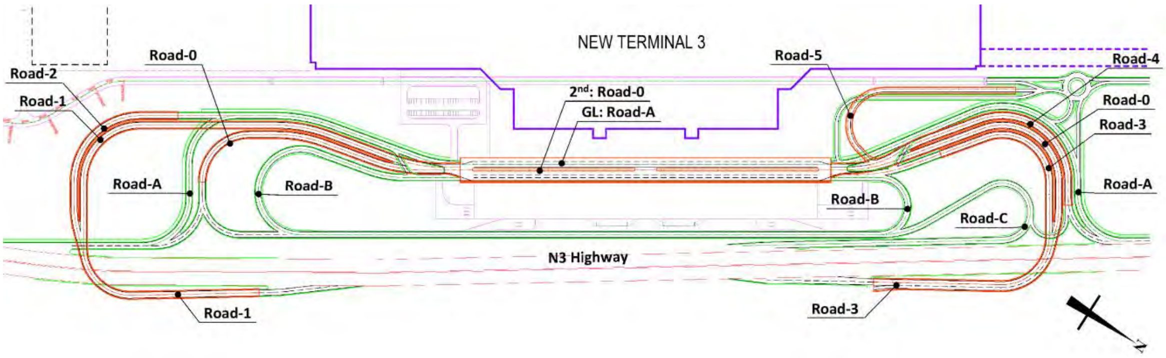
(2) Road Alignment Plannning

The access/approach road is constituted by nine roads from Road-0 to Road-5 and Road-A to Road-C.The road alignment should promote route continuity and harmony of horizontal and vertical alignment. It should be decided in consideration of smooth and safe traffic, facilities layout, and landscaping. Especially, since internal road has many diverging/merging sections, suitable visual guidance and diverging interval should be provided for drivers unfamiliar with layout. Each road and horizontal alignment are shown below.

Table 7-6 Access / Approach Road List

Road	Function	Summary
Road-0	Elevated Approach Way to Departure	Road-A > Departure >Road-3
Road-1	Entrance Access Way Elevated Approach Way to Departure	Entrance HW North > Cross HW> Departure
Road-2	Elevated Approach Way to Arrival	Road-1 >Road-A > Arrival
Road-3	ExitAccess way Elevated Approach Way from Arrival	Arrival> Cross HW> Exit HW South
Road-4	Elevated Approach Way from Departure	Departure >Road-0>Road-A
Road-5	Elevated Approach Way from Terminal 1 / Terminal 2	T1/T2 > Road-0
Road-A	Entrance / Exit Access Way Approach Way for Arrival	Entrance HW South > Arrival> Exit HW North
Road-B	Circulation Way	
Road-C	Entrance Access Way from DEE	Entrance DEE-Exit > Road-B

Source: JICA Study Team



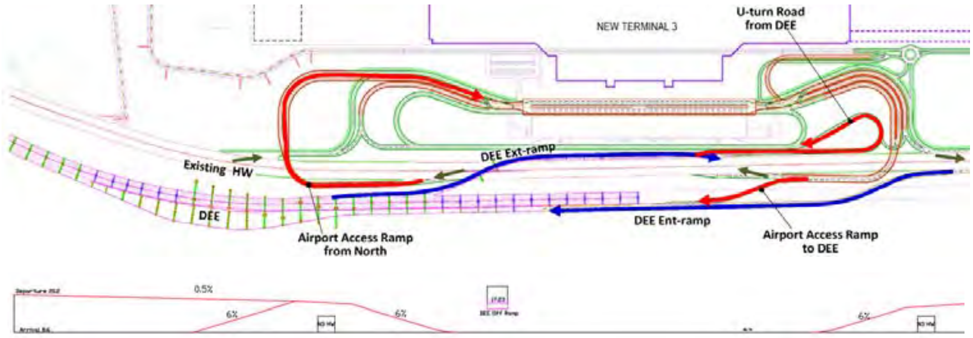
Source: JICA Study Team

Figure7-12 Access / Approach Road Layout

(3) Access with DEE

The entrance/exit ramp in Dhaka Elevated Expressway (DEE) is planned to be linked near to the existing airport. On the other hand, the entrance ramp from the north for Terminal 3 access interferes with the DEE exit ramp, and the exit ramp to the south interferes with the DEE entrance ramp. According to the master plan in 2015 and feasibility survey, a layout which shifts the DEE exit ramp to the south by 1 km and the entrance ramp to the north by 0.5 km is recommended. However, since the DEE project is already under construction, the replanning of the access method of Terminal 3 and DEE is required. Thus, examination of alternatives was carried out regarding the connection method with DEE.

As a result, the consultant proposed "Alt-2A:Shift Terminal 3 access ramp to the south and U-turn road" as for the connection method with DEE for traffic safety and economy.



Source: JICA Study Team

Figure7-13 Alt-2A (Connects by U-turn Road, Shift T3 Ent to South & Shift DEE Ent Ramp to North)

(4) Issues for the Detail Design

- Road alignment was planned based on new T3 terminal of the basic design 2015 in this survey. In a detail design, the benchmark coordinate and elevation should be adjusted with new T3 building, the existing road, and DEE.
- Horizontal alignment should be examined in the detail design to adjustment such as a transition curve and improvement of diverging / merging.
- Adjustment of vertical gradient to accommodate CAAB request for maximum 5% should be studied in the detail design.
- The layout of DEE entrance ramp should allow for maximum weaving length possible from the existing junction of T1 / T2.
- The northern section of DEE entrance ramp is not a DEE project but the DAEA (Dhaka Ashulia Elevated Expressway) project. In the detailed layout, adjustment with DAEA will be required.
- Bridge surface pavement should be studied including installation of the layer of leveling and waterproof in a detail design phase.

7.10 Water Treatment Plant

Water treatment plant does not calculate required supply water volume. The JICA Study Team arranged the following table and calculate the required supply water volume at the plant and plan facilities scale.

Table7-7 Required Supply Water Volume

Item	Qt	Water Use Ration	Water Volume(m^3)
Passenger	40,138	40ℓ/man	1,606
Pick up persons	21,822	40ℓ/man	873
Staff	3,738	100ℓ/man	374
No of resturant	4,385	40ℓ/meal	171
Other	2,191		1,682
Tptal	72,274		4,706

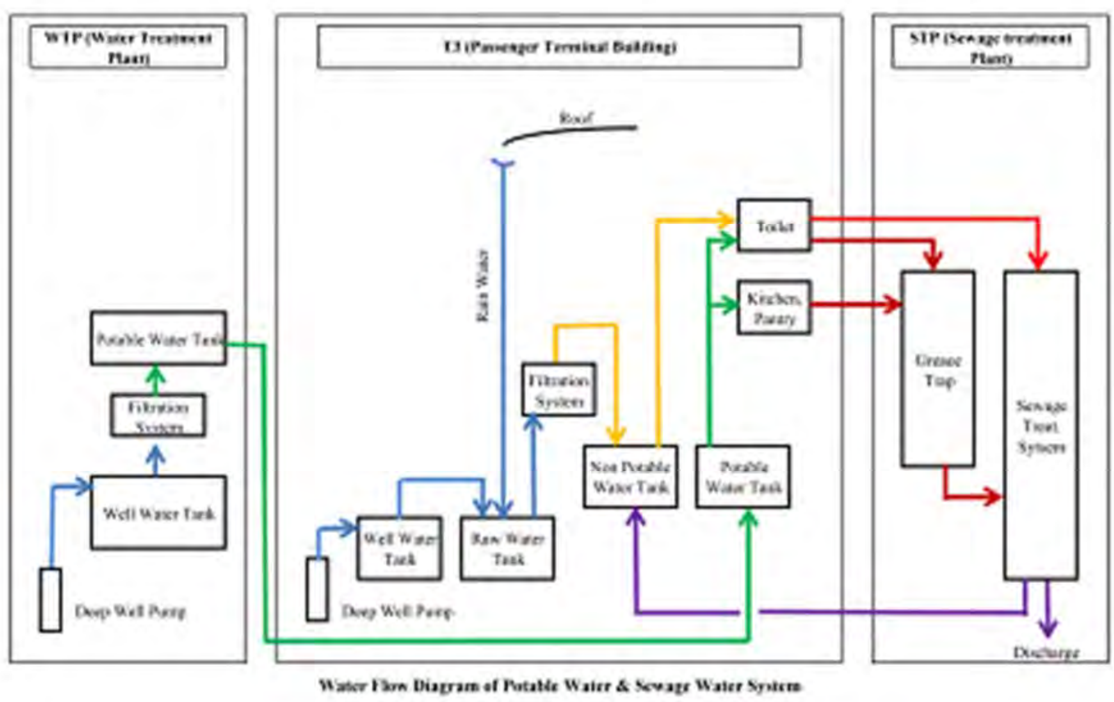
*Others include cooling tower make upwater, backwash water for filtration system in WTP, the make up water for the chemical feeder.
Source: JICA Study Team

Waterintake → Watertank → Waterpurification → Watersupply

Source: JICA Study Team

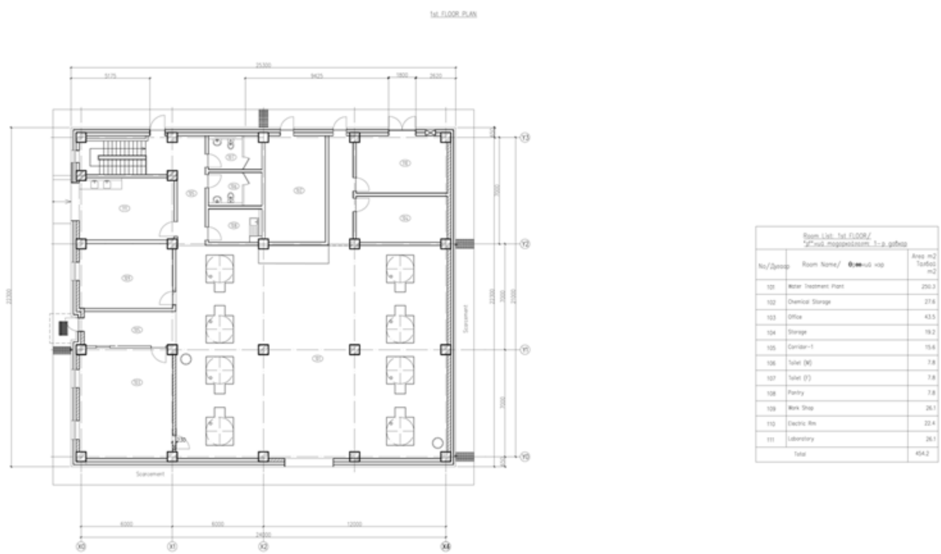
Figure7-14 WTP Flow Sheet

- Raw water is obtained from six deep well pumps as mentioned in the specifications of CPG.
- The storage water facilities are reserve deep well drawn water.
- The filtration facilities choose a filter device depending on raw water turbidity and do not install removal of iron and manganese device because there are few cases where iron content and manganese content is mixed with raw water.
- The filtered water undergoes chlorination to maintain a value of residual chlorine.
- The water supply facilities install water pump and piping system to the necessary building.



Source: JICA Study Team

Figure7-15 Water Flow Diagram



Source: JICA Study Team

Figure 7-16 Water Supply Equipment Layout

7.11 Sewage Treatment Plant

The sewage treatment plant is made based on the specifications in the basic design but considering the target processing material, there are many matters which need confirmation.

In the discussion with CAAB, the following matters are confirmed and assumed that the facilities will reflect these.

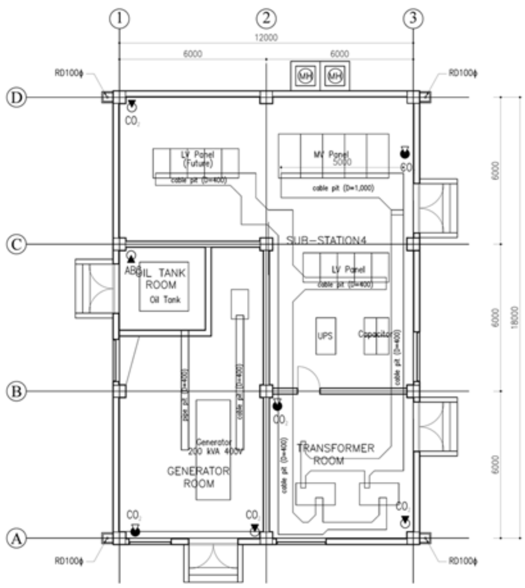
In addition, because the existing sewage treatment plant is reported to not operate smoothly, the sewage treatment plant for the whole airport was requested. However, it was decided to set the target facilities on the original scope because the request deviated from the conventional scope of JICA projects.

Since phosphorus and nitrogen are not prescribed as materials targeted under wastewater regulations, depending on the need, it is suggested to consider facilities which cope with these two materials in following recent trends in sewage treatment.

After confirming the existing sewage treatment plant from outside the facility, aeration processing space for the disposal of sludge was observed and a similar space will be secured for the new sewage treatment plant.

After the water supply capacity of the above was calculated, the necessary processing capacity was reduced for the make-up water or other water supply of the cooling tower for the air conditioning.

Based on the specifications of the CAAB, black water is the filthy water which is discharged from toilet, and grey water is wastage discharged from kitchen and canteen. Grey water shall be provided with oil and grease trap to remove oils and fats prior to connection to the septic tank facilities. The expansion will only handle grey water in the future.



Source: JICA Study Team

Figure7-17 STP Layout

Source: JICA Study Team

Figure7-18 Sewage Treatment Facilities Aeration Space (Existing Facilities)

7.12 Power Intake Station

(1) New power intake station

In this "Dhaka International Airport Expansion Project" plan, the expansion is planned with the new passenger terminal building, new cargo terminal building, and the VVIP building, so existing power receiving facilities and distribution lines do not have enough capacity.

Therefore, a new intake power station and HT distribution are to be installed.

The power station confirmed by CAAB to be planned to receive power supply from both ADA Power Station in the south side and CAAB Power Station in the north side, with an electric voltage of 11 kV.

In addition, in the meeting between CAAB and the Dhaka Power Supply Public Corporation, it wais confirmed that at least five years are required in the preparation of power station in the master plan of CAAB. This is a significant risk factor for planning of the construction schedule.

Therefore, reconfirmation by CAAB is requested, and it will be necessary to arrange countermeasures, such as temporary power supply, prior to commencement of construction if substation schedule does not meet the main construction schedule.

1) New Electric Equipment Capacity

Taking into consideration the plan of this "Dhaka International Airport Expansion Project" and future expansion plan, the total electric power capacity will be 57,520 kVA.Total power demand will be about 50,000 kVA (Intake power: minimum of 50,000 kVA required). Also, the generator is installed at each substation, and 100% backup excluding airconditioning, and refrigerator (chiller) demand is scheduled for power outage and accident. Total generator capacity is 64,000 kVA.

2) New Distribution System（HT Distribution Schematic Diagram）

The new power intake station assumes a two system retreat from an electric power company and plans four system pulls in the future so that it is possible for including it (future HT loop).

Confidential due to security reasons.

Source: JICA Study Team

Figure 7-19 HT Distribution Schematic Diagram

7.13 Fuel Supply Facilities

The fuel depot and hydrant facility are all in one system as a fuel supply system and it cannot be segregated individually. Therefore, the implementation of fuel supply system (Fuel depot and hydrant facility) for Terminal 3 must be done all in one system.

Further discussion for the work demarcation of fuel supply facility at Terminal 3 with Padma Oil Co., Ltd. will be required. However, we understand that fuel depot facilities will be provided by Padma Oil Co., Ltd and hydrant facility will be provided by CAAB.

Figure 7-20 shows the Outline of Fuel Supply Facilities for Terminal 3.

Confidential due to security reasons.

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Figure 7-20 Outline of Fuel Supply Facilities

7.14 Communication Facility

In the HSIA Expansion Project Phase-1, significant extension, including the new terminal building, new cargo terminal, and VVIP terminal is scheduled. Therefore, the existing communication network will be utilized and the new communication network for expansion area will be newly built. The new network will be connected to the existing network to complete the whole built out network.

7.15 Security Equipment

Confidential due to security reasons.

Confidential due to security reasons.

Figure7-21 HBS Inspection Flow

8. Study on Applicability of Japanese Technologies

The airports constructed by Japanese companies in the past 20 years and the Japanese technologies applied in these airports are listed.

There are various technical problems in each airport and a various Japanese advanced technologies are used to solve them. A condition considered to be a problem is listed in the column of "technical constrained conditions" and common problems in the Dhaka international Airport Expansion Project are airport construction under operation and soil improvement.

Confidential.

9 Construction Planning

9.1 Procurement Situation

The local procurement situation for the procurement of materials for civil engineering facilities works and building facilities works, which shall be the main works in the construction of HSIA Expansion Project, are summarized below.

However, based on the applicable standards and specifications, special equipment and plant, such as baggage handling system, passenger boarding bridge, aeronautical navigation radio facility, and lighting facilities, will have to be imported.

9.2 Planning Condition

The following are the important points in the construction planning of the HSIA Expansion Project:

- ✈ The construction planning has taken into consideration the schedule of piling work.
- ✈ The onsite construction work as well as related planning would take into consideration the bad nature of the site soil.
- ✈ The timing of infrastructure connection, such as mechanical, electrical and fuel should be coordinated.

9.3 Study on Construction Works Progress

Working ratio is determined at 75.7% (1.32), as shown in Table 9-1, omitting rainy days as disability period and holidays.

Table 9-1 Calculation of Operating Rate

Year (days)	Work Inability Date			Working Days	Operating Rate	
	Rainfall Date	Holidays	Total			
365	77.5	11	88.5	276.5	75.7%	1.32

Source: JICA Study Team

Main work volume and working days are shown below.

Table 9-2 Working Period

Engineering Work	Classification	Quantity	Working Days (days)	Working Months (months)	Remark
Earthwork	Removal of Topsoil	760,000 m^3	270	12	
	Sand Filling in pond	425,000 m^3			
	Soil Improvement Work	200,000 m^3			
	EarthCut	—			
Pavement work	Taxiway	108,000 m^2			
	Apron	498,500 m^2	500	22	
	Facilities Road	1 Lot	520	23	
Drainage work	Main Drainage	1 Lot	630	28	
	Reservoir	1 Lot	770	34	
Miscellaneous work	Security Fence	1 Lot	200	9	

Source: JICA Study Team

The critical work of the project is the terminal building work. The total work period of this project including preparation work, construction work, and trial run is 37 months.

10 Project Implementation Schedule

(1) Conditions

1) Precondition

Based on the intention of the Bangladeshi government of early completion, the procurement procedure shall be of a minimum period.

- Consulting service will start in April 2017.
- The period of detailed design is shortened to six months by utilizing existing drawings as much as possible.
- Construction will start in April 2018 based on the above condition.
- Construction period for international terminal (Terminal 3) is 37 months.
- Construction period for apron is 34 months.
- At the time of the soft opening planned in January 2019, the service of the new VVIP building shall start.

2) Project Implementation Schedule

Confidential.

Confidential.

Figure 10-1Step Drawing in December 2018 (9 months elapsed)

Confidential.

Figure 10-2 Step Drawing in December 2019 (21 months elapsed)

Confidential.

Figure 10-3 Step Drawing in December 2020 (33 months elapsed)

Confidential.

Figure 10-4Step Drawing in April 2021 (37 months elapsed)

Table 10.5 Project Implementation Schedule

Confidential

11 Environmental Consideration

Based on the JICA Guidelines for environmental and social considerations (Hearinafter called JICA Guidelines), this Project is classified under Category B. This Project is an expansion project involving construction of new buildings, among others, within the current airport area. There is no land acquisition involved. There is no new runway construction or extension. Thus, expected impacts are site specific, are reversible, and normal mitigation measures can be applied.

For this Project, as it is classified as Category B project, environmental and social consideration studies require the IEE level including examination of the potential positive and negative environmental impacts, mitigation measures to avoid, minimize, mitigate or compensate for adverse impacts, as well as measures to promote positive impacts, if any such measures are available.

11.1 Proposed Project Components Subject to the Environmental and Social Consideration (ESC)

Proper environmental and social protection against any adverse impact from a development project is the key to the project's sustainability. To ensure that, environmental and social analysis and assessment is to be carried out, and if required, proper mitigation plan is to be prepared. The environmental and social examination under this Survey is aimed at analysis of environmental and social considerations base on both JICA guidelines Bangladesh regulations, confirming the current status of environmental and social assessment, and formulating further tasks to be carried out before the Project can enter into the implementation stage.

The physical components of the proposed Project subject to environmental and social considerations are as follows:

Table11-1 Details of Scope of Works (Phase - 1)

Works	Division	Facilities
Building	New Passenger Terminal Building (Terminal 3)	3 story building with area of approximately 220,000 m^2 including supply of related equipment capacity of 12.0 mppa
	New Cargo Complex	Area of approximately 42,200 m^2
	VVIP Complex	Area of approximately 5,000 m^2
	Rescue and Fire Fighting Facilities	
	Multi-Level Car Parking with Tunnel	Area of approximately 62,000 m^2
Civil	Parking Apron (Terminal 3 Area)	Approximately 520,000 m^2
	Taxiways (two rapid exit and one connecting taxiway for the runway 14 threshold)	Approximately 60,000 m^2
	Taxiways Landside Service Road with Elevated Road	9 connecting taxiways connecting to the T3 apron: approximately 35,000 m^2
	Improvement of Drainage System	
Utility	Water Supply System	
	Sewage Treatment Plant	Area of approximately 3,000 m^2
	Intake Power Plant with Distribution System	Area of approximately 7,000 m^2
	Hydrant Fuel Supply System	

Works	Division	Facilities
	Communication System	
	Security and Terminal Equipment	

Source: JICA Study Team

The following are the scope of analysis under this Survey:

1. To confirm baseline of environmental and social conditions;
2. To confirm environmental and social system of Bangladesh;
3. To prepare item scoping of EIA study;
4. To predict future environmental and social situation with this project;
5. To assess effect of this project and to execute comparative consideration of altenative plans;
6. To consider mitigation measures;
7. To prepare draft environmental management plan and draft environmental monitoring plan;
8. To clarify budjet, financial resource and implementing organization of EMP and EMoP and
9. To support stakeholders' consultations.

As the Project does not need any land acquisition and as all the Project-related construction and operation activities are expected to be confined within the HSIA area, no adverse social impact is expected. However, there are some former leaseholders, who still have facilities within the proposed work site and still occupying the land. Details of the issue are explained in Section 13.3.

11.2 Present Conditions of the Project Area

A detailed description of the environmental setting of the project area has been elaborated in the project IEE Report (August, 2016). A brief summary is given in this report.

11.3 Investigation of Existing Structures/Facilities at the Proposed Work Site (Within Current Landside)

The proposed location of the Terminal 3 building, its entrance facility, and new apron will occupy some portion within the current airside area and some portion within the current landside area. The structures/ facilities within the current airside area are well defined and CAAB has definite plan for their relocation. The Study Team investigated the existing structures/facilities located within the current landside portion earmarked for the proposed T3 terminal.

Five structures/facilities are identified during the investigation as marked in Table 11-2. Brief descriptions of each structure/facility are given below.

Table11-2 Structures/Facilities at the Site

Number	Location	Facilities	Main Building
①	Location 1	CAAB’s Central Engineering, Maintenance and Stores Unit (CEMSU) compound	Administrative building, one workshop, one warehouse, two smaller stores
②	Location 2	Airport Armed Police Battalion	The Airport Police for their barrack and office
③	Location 3	Flying Club Complex	Proposed six-storey building. Construction is now suspended, and there is no business activities going on.
④	Location 4	Civil Aviation Training Center (CATC) of CAAB	Male hostel, female hostel, and diving area
⑤	Location 5	A subsidiary of Bengal Group	Five-storey building, a semi-pacca prayer area, a restaurant, a semi-pacca car garage, and some storage sheds

Source: JICA Study Team

For the implementation of the Project, all these facilities/ buildings/ structures mentioned above must be removed. Facilities at Location #1 are owned by CAAB; thus their relocation can be done with CAAB internal arrangements. Similarly, all the facilities at Location #4 are owned and operated by CAAB, thus their relocation can be managed easily by CAAB. Though the facilities at Location #2 are used by Police, the facilities are owned by CAAB. The policemen are staying there “at the request” of CAAB, and CAAB is "paying" for their duty and arranging accommodation. CAAB has already finished accommodation arrangement and request Police to move to new location. So there are no social issues.

On the one hand, facilities at Locations #3 and #5 are occupied by private entity. As lease tenures have been expired for both the cases, technically there is no bar on CAAB to re-possess the land. After the issue of the verdict, these area will be vacated in accordance with government law.

11.4 Legal and Administrative Framework

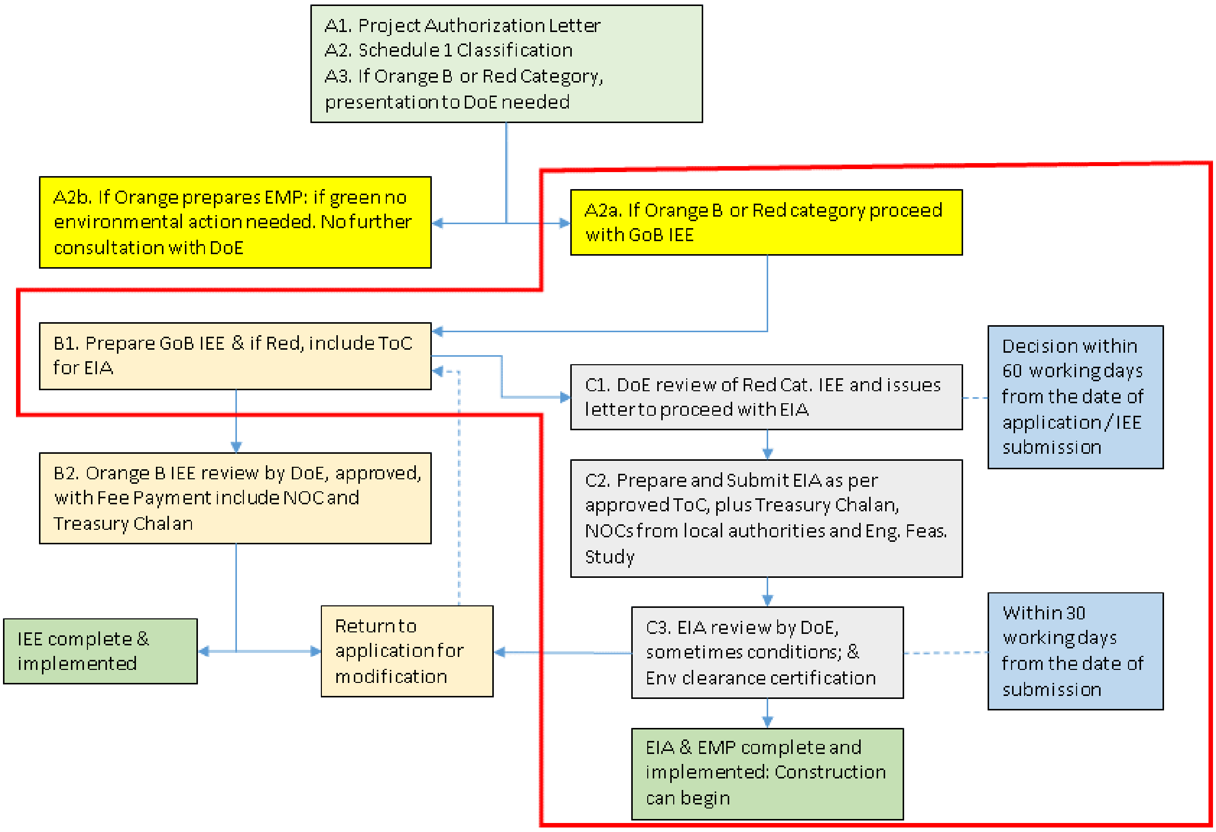
11.4.1 Environmental Policy and Regulation of GoB

For the protection, conservation, and management of the biophysical (natural) and social environment from damaging development pressures, if any, the Government of Bangladesh has developed a legal framework, including laws, regulations, decrees, and standards addressing environmental and social safeguards. These legislations also provide the principal mechanism for assessing and mitigating the environmental impacts of projects, both existing and proposed. The relevant national legislative, regulatory, and policy requirements are given in this report.

11.4.2 Application Procedure of Environmental Clearance

As explained above, any proposed project must obtain an ECC from the DOE before its implementation. The clearance process varies depending on the project classification.

Flow diagram for the environmental clearance procedure is shown below (as this airport expansion project falls under Red Category, only red colour marked steps need to be followed).



Source: Adopted from the Environmental Guidelines (DOE, 1997)

Figure 11-1 Diagram for DOE Environmental Assessment Process

11.4.3 Policy Gap between the Government and JICA

As explained in the previous sections, this Project is classified as Category B as per JICA guidelines requiring only IEE level environmental assessment. On the other hand, this Project is classified as Red Category as per ECR 1997 requiring EIA level of environmental assessment. For this particular Project, there is difference in categorization between GOB and JICA regulation. However, JICA guidelines also mentions that if an EIA procedure has been conducted to satisfy national requirement, JICA may refer to the EIA report, but this is not a mandatory requirement.

The Gap between the government law and JICA Guidelines are shown in this report.

11.4.4 International Civil Aviation Organization (ICAO) Recommended Practices

It may be noted that airport noise is exempted in the Bangladesh Noise regulation of 2006. Since this Project will be funded by JICA, proper noise management is required, and this Project should follow ICAO guidelines for noise.

International design code, manual, standards, and guidelines that are relevant to the proposed project include the following: International Civil Aviation Organization (ICAO), International Air Transport Association (IATA), and U.S. Federal Aviation Administration (FAA). The relevant documents and their relevance to the Project are given below:

Table 11-3 Outline of the international standard

Guidelines	Relevance to this Project
Annex 16 to the Convention on International Civil Aviation, Volume I: Aircraft Noise, Sixth Edition, July 2011	Gives the maximum allowable noise levels depending on aircraft types, at lateral point, approach point and flyby measurement point.
ICAO Doc. 9184 - Airport Planning Manual, Part 2: Land Use and Environmental Control, 2nd Edition, 2002	Airport and runway noise and its remedial measures
FAA Advisory Circular 150/5020-1-Noise Control and Compatibility Planning for Airports, 1983	Noise measurement methods, preparation of noise contour, prediction of noise exposure, and airport noise control planning

Source: The Study Team

11.5 Alternative Study

Since it is expected that the passenger of HSIA will be exceed the capacity of the existing facilities, the countermeasures of this issue had considered. The Plan-0 will obstruct the economic development for rising up from Least Development Countries. The Plan-1 is able to meet the expected demand after 2030, but the benefit per cost is low. And the negative effect to environment and social is large. Plan-2 is able to meet the expected demand until 2030, the benefit per cost is high and the negative impact to socio environmental aspect is small. Therefore, the Plan-2 is selected on this project. On the Plan-3, the cost is high and the negative impact to socio environmental aspect is significant and tne plan-2 will be acceptable until 2030.

11.6 Scoping

The project was reviewed in light of the JICA Guideline for environmental and social considerations. The scoping result is summarized in this report.

11.7 Result of Environmental and Social Consideration Survey

The result of survey and prediction for environmental and social consideration is shown in this report.

11.8 The assessment of project effect for environmental and social conditions

The assessment of project effect for environmental and social conditions is shown in this report. The negative impact of this project is considered small.

11.9 Mitigation Measures

It is needed to consider mitigation measures for avoiding or reducing environmental and social impact regardless the scale of the impact. The study on mitigation measures is conducted with consideration of technological feasibility and legislative system. The result of study is shown following table.

Table 11-4 Mitigation Measures

No.	Environmental Items	EMP	Implementing agency	Responsible Agency	Rough cost estimation (Million JPY)
Construction					
1.	Air pollution	• Water sprinkling for preventing resuspende soil • Cleaning activity of inside hauling road and entrance of the airport • Using of low air pollutant emission type machinery for construction	Contractor	CAAB	
2.	Water Pollution	• Using wastewater treatment such as sedimentation tank for discharge to the canals	Contractor	CAAB	
3.	Solid waste	• Segregation and sorting of the waste for appropriate reusing and recycling	Contractor	CAAB	
4.	Soil contamination	• Securing that contaminated soil will be isolated from clean soil.	Contractor	CAAB	
5.	Noise/Vibration	• Using of low noise type machinery for construction	Contractor	CAAB	
6.	Exisiting social infrastructuresand services	• Installation of inside hauling road for reducing imact to outside road.	Contractor	CAAB	
7.	Local conflicts of interest	• Nogotiating for relocatin	CAAB	CAAB	
8.	Landscape	• Cleanup activity in construction site for impact mitigation of scenery to the airport users and residents	Contractor		
9.	Infectious disease such as HIV/AIDS	• Complying with craus of HIV/AIDS prevention measures.	Contractor	CAAB	Confidenti al
10.	Working Environment (includes work safety)	• Installing Personal Protective Equipment (PPE), hearing protection for workers on demolition of concrete.	Contractor	CAAB	
11.	Accidents	• Preparing traffic management plan and road safety plan for prevebnting road accident around the airport.	Contractor	CAAB	
1.	Air pollution	• Installing multi storey car parking with adequate parking number for reduction of gas emission from waiting cars.	CAAB	CAAB	
2.	Water Pollution	• Installing wastewater treatment facility for complying with the standards mentioned in Schedule 10 of the ECR 1997 for inland water discharge	CAAB	CAAB	
3.	Solid waste	• Proper collection and disposing all internally generated solid waste	CAAB	CAAB	
4.	Soil contamination	• Installing Oil separator for drainage in oil farm	CAAB	CAAB	
5.	Noise/Vibration	• Establishing complaint section for issue of airport activity including aircraft noise	CAAB	CAAB	
6.	Exisiting social infrastructuresand services	• Installing road infrastructure for smooth traffic and human movement near airport.	CAAB	CAAB	

No.	Environmental Items	EMP	Implementing agency	Responsible Agency	Rough cost estimation (Million JPY)
7.	Accidents	• Installing road infrastructure for smooth traffic and human movement near airport.	CAAB	CAAB	Confidential
8.	Global Warming	• implementing energy reduction equipment for lighting or air conditioning.	CAAB	CAAB	

Source: JICA Study Team

11.10 Environmental Monitoring Plan

The environmental monitoring plan during construction and operation is shown in this report.

11.11 Next Activities Required for Obtaining ECC

As stated earlier, the DOE first step clearance (which is the site clearance) together with the approval of IEE and EIA TOR has been obtained. It may be noted here that as per JICA guidelines (2010), as this Project is of Category B, IEE approval by DOE can fulfil minimum JICA requirement. However, as this Project is classified as Red category as per Bangladesh law, EIA approval by DOE is required before the start of construction activities.

Based on the approved EIA TOR, the EIA document is to be prepared. The EIA document must include EMP, Environmental Monitoring Plan (EMoP), EMP implementation budget, and EMP implementation arrangement, in addition to expected impacts and their remedial measures. The EIA document should also include result of public consultant meetings/ information disclosure meetings should be conducted.

The Report is to be submitted to DOE for its approval leading to the issuance of ECC. It is rather difficult to estimate the time required for such approval process.,it can be assumed that two months will be required for EIA approval. A tentative timeline is given below.

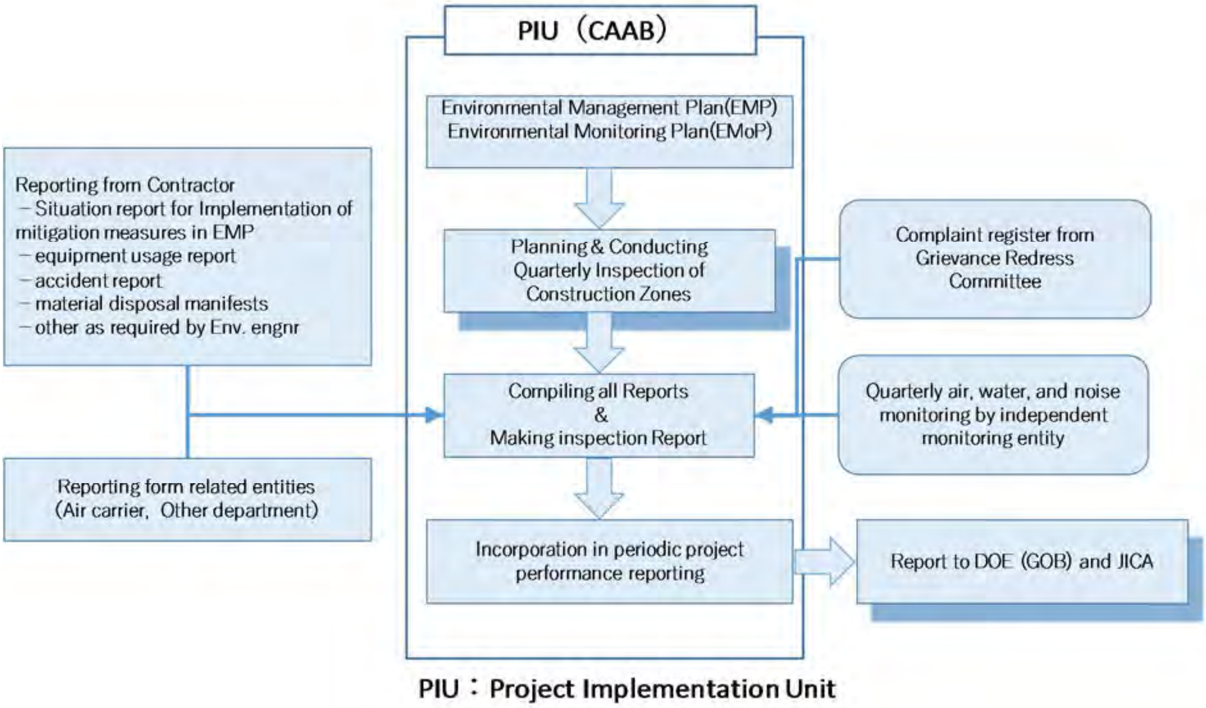
Table 11-5 Tentative Timeline

Activity	Q2, 16	Q3, 16	Q4, 16	Q1, 17	Q2, 17
IEE Approval / EIA TOR Approval by DOE					
EIA Preparation by CAAB					
EIA Approval/ ECC Issuance by DOE					

Source: JICA Study Team

11.12 JICA Environmental Checklist, Environmental Management Plan, Monitoring Plan

JICA Environmental Checklist, Environmantal management plan, Environmental monitoring plan and Environmental monitoring form are show in Annex. The frameworks of Environmental monitoring is shown below figure.



Source: JICA Study Team

Figure11-2 Tentative Environmental Monitoring Framework

11.13 Stakeholder's Meeting

During the IEE study, 6 stakeholder meetings were held. In the meeting, it was confirmaed that there is no opponents to this project and cooperation with this project during the construction. There were various constructive opinions concerning this project in the meeting.

12 Project Cost Estimate

(1) Total Project Cost

Confidential.

Table12.1 Financial Plan

Confidential.

Table12.2 Annual Financial Plan

Confidential.

Table12.3 Breakdown of Fund

Confidential.

(2) Construction Cost

Confidential.

Table12-4 Breakdown of the Construction Cost

Confidential.

13 Implementation Organization of the Project

13.1 Implementing Agency

The implementing agency for the terminal expansion project will be the Civil Aviation Authority, Bangladesh (CAAB), which will be responsible for the design, procurement, and construction of the project. CAAB shall establish the Project Implementation Unit (PIU) for this project, which will be an independent organization with delegated authority and specific functions.

13.2 Evaluation and Recommendations on the Implementing Agency (Required Staffing, Human Resource Development)

The staff required for PIU to carry out the implementation of the Japanese yen loan project will be selected from the CAAB staff with previous experience of airport development projects. In addition to DSIA, since CAAB is responsible for operation and management and development of international airports in Chittagong and Sylhet and five other domestic airports, experience of construction projects is abundant. There are no difficulties envisioned in the implementation of the project since the PIU will be appropriately established and manned mainly by experienced CAAB staff. However, the scale of the proposed Terminal 3 is extremely large and also the first passenger terminal with capacity of ten million passengers, which exceeds the annual handling capacity of the existing terminal building for CAAB. Moreover, the construction period is only three years from commencement of construction to commencment of operations requiring highly difficult construction management.

Furthermore, security management over the whole large construction site must also be firmly addressed following the terrorist attack of July 2016.

Therefore, it will be necessary to employ staff who have the capability to manage large projects in short construction schedules and are also capable of cooperation with the security management entity. At the same time, it will also be necessary to train CAAB staff in order to acquire capabilities to carry out similar difficult projects. Therefore, on-the-job training (OJT) programs must be implemented for CAAB staff as well as appropriate off-the-job training as required.

14 Maintenance and Operation Organization

14.1 Confirmation of Maintenance and Operation Organization

The operations, maintenance, and administration of airports in Bangladesh at present are under the jurisdiction of CAAB. The maintenance of runways, taxiways, aprons, landing strips, radio navigation facilities, and navigation aids are also their responsibility. The ground handling services are operated by Biman Bangladesh Airline and cargo handling is operated by Biman Cargo.

Table-14-1 Organization of Operations and Management at HSIA

Category of Operation	Responsible entity	notes
Operation of passenger terminal	CAAB	
Operation of cargo terminal	Biman Cargo	
Safety management	CAAB	
Fire fighting and emergency services	CAAB	
Disaster prevention	CAAB	
Security Services (security inspections, police)	CAAB, airlines, Bangladesh Police (Airport Armed Police), Bangladesh Ansar & VDP	

Facility Management & Maintenance	CAAB	
Ground Handling Services	Biman Bangladesh Airline	
Immigration/Emigration/Quanrantine	Bangladesh Police, Bnagladesh Customs, Department of Agricultural Extension	
Air Traffic Control Services	CAAB	

Source: JICA Study Team

This system is expected to remain during the construction period and after commencement of operations. The project encompasses not only the expansion of the airport facilities, but also includes the continued operations of the existing terminal during construction. Therefore, the existing maintenance operations must also be continued same as before.

14.2 Confirmation of Scope, Organization and Staffing of Maintenance and Operation Organization

Confidential due to security reasons.

Since CAAB has appropriately managed the operations of the passenger terminal up until now, it is expected that CAAB will continue its appropriate airport operations, maintenance, and administrations after commencement of services at Terminal 3.

15 Financialand Economic Evaluation, and Monitoring Indicators

15.1 Financial Analysis

The financial analysis of the proposed Dhaka International Airport Expansion Project was carried out by comparing the costs and revenues between the 'with project' and 'without project' cases. Based on the assumptions below, the cash flow of an 'incremental' case was prepared in order to measure the net financial impact of implementing the proposed project. The financial internal rate of return (FIRR) of the incremental case was calculated to evaluate the feasibility of the proposed project.

The FIRR was calculated at 6.2%, higher than the target of 1.983%. Therefore, the proposed project is financially feasible.

15.2 Economic Analysis

Economic analysis of the proposed project was carried out in this section by comparing the economic costs and benefits on the incremental case. The project's economic internal rate of return (EIRR) was calculated based on the cash flow of the incremental case to evaluate the net economic impact by the proposed project on the national economy.

The EIRR was determined at 22.5%, above the target of 12%. Therefore, the proposed project is economically feasible.

15.3 Sensitivity Analysis

Table 15-1 below summarizes the results of the sensitivity test of the project FIRR and EIRR to key variables, i.e., investment cost and passenger traffic.

Table 15-1 Sensitivity Test

	Project FIRR (%)	Project EIRR (%)
Target Rate	1.983	12.000
0. Base	6.225	22.511
1. Investment Costs (+30%)	3.924	19.121
2. International Passengers (-30%)	5.077	19.347
3. Domestic Passengers (-30%)	6.215	22.297
4. Total Passengers (-30%)	5.067	19.132
5. Investment Costs (+30%) and Total Passengers (-30%)	2.938	16.255

Source: JICA Study Team

The FIRR and EIRR are higher than the respective target rates of 1.983% and 12.000% under all cases.

15.4 Conclusion

The project FIRR and EIRR were calculated at 6.2%, and 22.5%, respectively, achieving the respective targets of 1.983%, and 12.000%. The sensitivity analysis also showed higher FIRR and EIRR than the targets even on the case of +30% investment costs and -30% total passengers.

From the above discussion, it was concluded that the proposed project would bring sufficient net benefits to both HSIA and the Bangladeshi economy.

15.5 Operation and Effect Indicators

Passenger traffic is generally considered as both operation and effect indicators for airport development projects. The quantitative indicators are follows. Target year of the quantitative indicators is 2023, two years after project completion.

- Traffic volume
- The annual revenue of HSIA

Qualitative effect indicators in 2023, two years after the completion of the Project, were considered in the following items:

- Upgrade of Service Levels
- Enhancement of capacity and function as a gateway airport

16 Points to Consider for Project Implementation

Following items are studied for Project implementation.

- Consultant services
- Measures for safety construction
- Safety measures in security such as terrorism
- Coordination with airport operator
- Measures against HIV
- Demolition and shifting of existing structure around Terminal 3 area
- Building permit
- Evasion of military use

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ABBREVIATIONS

ACM	Aircraft Movement
ADB	Asian Development Bank
AGL	Aeronautical Ground Lighting
AIP	Aeronautical Information Publication
ALS	Approach Lighting System
APTA	Asia Pacific Trade Agreement
ASDA	Accelerate Stop Distance Available
ASRS	Automatic Storage Rack System
ASYCUDA	Automated System for Customs Data
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
ATM	Air Traffic Management
ATS	Air Traffic Service
B/C	Benefit / Cost
BATMUP	Bangladesh Air Traffic Management Upgrade Project
BBA	Bangladesh Bridge Authority
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BDT	Bangladesh Taka
BHS	Baggage Handling System
BIFFL	Bangladesh Infrastructure Finance Fund Limited
BIMSTEC	Bengal Initiatives for Multi-sectoral Technical and Economic Cooperation
BNBC	Bangladesh National Building Code
BOT	Build Operate Transfer
BR	Bangladesh Railways
BRT	Bus Rapid Transit
BSMIA	Banglabandhu Sheikh Mujib International Airport
BUET	Bangladesh University of Engineering & Technology
BWDB	Bangladesh Water Development Board
CA	Concession Agreement
CAAB	Civil Aviation Authority, Bangladesh
CAT	Category
CATC	Civil Aviation Training Center
CCEA	Cabinet Committee on Economic Affairs
CCR	Constant Current Regulator
CEMSU	Central Engineering, Maintenance and Stores Unit
CNG	Compressed Natural Gas
CPG	CPG Corporation Pte. Ltd.
CPTU	Central Procurement Technical Unit
CRCCI	China Railway Construction Corporation International
DDC	Design Development Consultant
DEE	Dhaka Elevated Expressway
DESCO	Dhaka Electric Supply Company Limited
DFR	Draft Final Report
DOE	Department of Environment

DPP	Development Project Program
DSA	Debt Sustainability Analysis
DSF	Debt Sustainability Framework
DTCA	Dhaka Transport Coordination Agency
E/M	Electro Mechanical
ECA	Environment Conservation Act
ECC	Environmental Clearance Certificate
ECF	Extended Credit Facility
ECR	Environment Conservation Rules
EDS	Explosive Detection System
EIA	Environmental Impact Assessment
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
ERD	Economic Relations Division
F/S	Feasibility Study
FAA	Federal Aviation Administration
FDEE	First Dhaka Elevated Expressway Company Limited
FGD	Focus Group Discussion
FIR	Flight Information Region
FOD	Foreign Object Damage, or Foreign Object Debris
FY	Fiscal Year
GA	General Aviation
GDP	Gross Domestic Product
GDSUTP	Greater Dhaka Sustainable Urban Transport Project
GNSS	Global Navigation Satellite System
GoB	Government of Bangladesh
GRDP	Gross Regional Domestic Product
GSE	Ground Service Equipment
H. S. code	Harmonized Commodity Description and Coding System Code
HSIA	Hazrat Shahjalal International Airport
IAB	Institute of Architects Bangladesh
IEB	Institute of Engineers Bangladesh
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICB	International Competitive Bidding
IDCOL	Infrastructure Development Company Limited
IEE	Initial Environmental Examination
IFB	Invitation for Bid
IFC	International Finance Corporation
ILS	Instrumental Landing System
IMED	Implementation Monitoring and Evaluation Division
IMF	International Monetary Fund
IRR	Internal Rate of Return
ITD	Italian Thai Development Public Company Limited
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JPY	Japan Yen

LCC	Location Clearance Certificate
LDC	Least Developed Country
LGED	Local Government Engineering Department
M&E	Mechanical and Electrical
MHS	Material Handling System
MIST	Military Institute of Science and Technology
MoCAT	the Ministry of Civil Aviation and Tourism
MOEF	Ministry of Environment and Forest
mppa	Million Passenger Per Annum
MPEMR	Ministry of Power, Energy and Mineral Resources
MRT	Mass Rapid Transit
MYT-Plan	Myanmar National Transport Master Plan
NAPA	National Adaptation Programme of Action
NAVAID	Navigational Aids
NBSAP	National Biodiversity Strategy and Action Plan
NCS	National Conservation Strategy
NEMAP	National Environmental Management Action Plan
NOC	No Objection Certificate
NPV	Net Present Value
OD survey	Origin Destination survey
ODA	Official Development Assistance
OECF	Overseas Economic Cooperation Fund
PAX	Passenger
PCN	Pavement Classification Number
PCU	Passenger Car Unit
PDR	Peak Day Ratio
PHR	Peak Hour Ratio
PMBMA	Public Moneys and Budget Management Act
PMR	Peak Month Ratio
PPA	Public Procurement Act
PPP	Public-Private Partnership
PPR	Public Procurement Rules
PSR/SSR	Primary and Secondary Surveillance Radar
PTB	Passenger Terminal Building
PWD	Public Works Department
R/W	Runway
RCC	Reinforced Concrete Column
REHAB	Real Estate & Housing Association of Bangladesh
RFFS	Rescue and Fire Fighting Services
RFP	Request for Proposal
RFQ	Request for Quotation
RHD	Roads and Highways Department
RSP	RSP Architects Planners & Engineers
RSTP	the Revision and Updating of the Strategic Transport Plan
SAA	SAA Architect
SAFTA	South Asian Free Trade Area

SAIA	Shah Amanat International Airport
SATO	Station of Air Traffic Office
SBR	Sequencing Batch Reactor
SOB	Survey of Bangladesh
SPT	Standard Penetration Test
STD	Standard Tender Documents
STP	Strategic Transportation Plan
T/W	Taxi Way
T1	Terminal 1
T2	Terminal 2
T3	Terminal 3
TAF	Technical Assistance Financing
TODA	Take Off Distance Available
TOR	Terms of Reference
TORA	Takeoff Run Available
UNCTAD	United Nations Conference on Trade and Development
ULD	Unit Load Device
USAID	United States Agency for International Development
UTM	Universal Transverse Mercator
VAT	Value Added Tax
VGF	Viability Gap Financing
VOT	Value of Time
VVIP	Very Very Important Person
WASA	Water Supply and Sewerage Authority
WB	World Bank
WWTP	Waste Water Treatment Plant

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CHAPTER 1 INTRODUCTION

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Chapter 1 INTRODUCTION

1.1 Background of the Study

In recent years, Bangladesh's economy has experienced an average annual growth rate of more than 6%. Against this background, the aviation demand in Bangladesh has been increased rapidly at an average pace approaching 10%. The Dhaka International Airport or the Hazrat Shahjalal International Airport (HSIA) handles nearly 70% of all domestic and international flights in Bangladesh and plays an important role as infrastructure supporting the rapid growth of economic activity.

The HSIA was planned for a capacity of 8 million passengers annually. However, based on the data collection survey conducted in April 2016, the number of passengers for 2015 was approximately 6.5 million per annum (mppa) (international: 5.57 mppa, domestic: 0.91 mppa) and the passenger handling capacity of the passenger terminal building (PTB) is expected to be saturated by 2019. In order to respond to this situation, the Government of Bangladesh (hereinafter referred to as “GoB”) is considering the construction of a new international passenger terminal, the refurbishment of the cargo terminal and the construction of peripheral infrastructure including the approach road to the National Highway. The construction of the new international passenger terminal and the construction of peripheral infrastructure in particular are expected to be implementedas one of fast-track projects, having been prioritized as important projects in the Seventh Five-Year Development Plan by GoB. Furthermore, HSIA is located approximately 17 km north of central Dhaka and there are plans to make the approach to HSIA into a multimodal hub connected with urban railways and expressways planned for the future.

The Japan International Cooperation Agency (JICA) has been conducting a data collection survey for this project since April 2016. It has been confirmed that there is an immense amount of reference materials including the design drawings for civil and architectural works, which requires detailed review prior to the implementation of the project. The GoB has requested the early commencement of the project for completion by the end of 2019. In addition, the importance of the project was mutually confirmed in the Japan-Bangladesh Summit Meeting held on May 28, 2016.

The improvement of the navigation aid system and airport terminal security at HSIA has been implemented under the Japanese grant aid scheme project entitled “The Project for Improvement of Airport Safety and Security Systems” (2014), which is expected to secure safety of aircraft guidance to destination airports and landings and improve responses to aircraft accidents and acts of terrorism. In order to respond to the future increase in demand and to secure convenience and safety, it is urgently necessary to implement the mid-term expansion projects for HSIA. Acting on this background, GoB has requested JICA to implement the study on the expansion projects of HSIA with the intention to secure future yen loans.

1.2 Objective of the Project

The objective of the project is to meet future demand of air transportation and to ensure international standard of safety, security and facilitation by expanding airport terminal facilities and developing related infrastructure at the Hazrat Shahjalal International Airport in Dhaka, thereby contributing further economic growth in Bangladesh.

1.3 Objective of the Study

The objective of the present study is to conduct the necessary surveys to review the rationale of the project for implementation under Japanese government loan. It includes the objectives of the project, general composition, project finances, implementation schedule, implementation method (procurement and construction), organization for project implementation, organization for operation and maintenance, and environmental and social considerations based on the existing Master Plan (M/P) for expansion of HSIA

1.4 Location of the Project

The location of HSIA is shown in Figure 1.1.

Source: JICA Study Team

Figure 1-1 Location Map of HSIA

1.5 Components of the Project

- ✈ Construction of the following facilities at HSIA:
  - ✓ International PTB (Terminal 3),
  - ✓ New cargo terminal building (complex),
  - ✓ Expansion of apron,
  - ✓ Construction of new taxiways (including rapid exit taxiway),
  - ✓ Procurement of equipment for communication system, aeronautical light, airport security systems,
  - ✓ Internal roads in airport and parking facilities, and
  - ✓ Utility facilities.
- ✈ Assistance for improvement of operations at passenger/cargo terminal
- ✈ Strengthening of security organization for HSIA as a whole

1.6 Counterpart Agencies of the Recipient Country

The counterpart agencies are the Civil Aviation Authority, Bangladesh (CAAB) and the Ministry of Civil Aviation and Tourism (MoCAT).

1.6.1 Ministry of Civil Aviation and Tourism (MoCAT)

The main responsibilities of MoCAT are to provide highly reliable and organized aviation services for the smooth operation of air traffic in Bangladesh, and to contribute to the development of the economy of Bangladesh through development of tourism.

1.6.2 Civil Aviation Authority, Bangladesh (CAAB)

The CAAB is the sole regulatory organization for all aviation related matters in Bangladesh. In addition, it is responsible for providing air traffic control (ATC) services, securing fast and efficient flow of aviation traffic within the Bangladesh Flight Information Region (FIR), as well as the responsible agency for maintaining facilities including airports and navigation aid systems.

(1) Organization of CAAB and HSIA

The CAAB is in charge of operations and maintenance of all airports in Bangladesh, employing approximately 3,700 personnel. Within this organization, the section responsible for the operation and planning at HSIA is the Board Member in charge of operations and planning, one of the three under the Chairman, under whom the Director in Charge of HSIA is placed (refer to Figure 1.2).

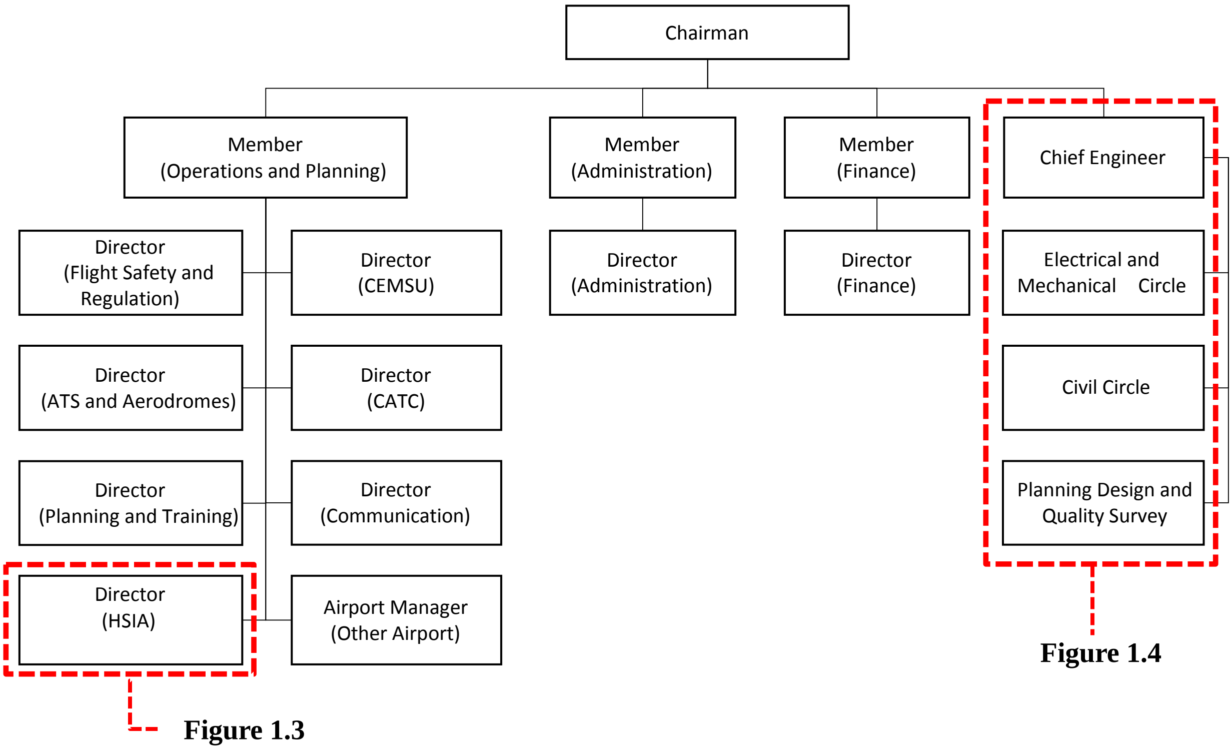
Planning and design of expansion at HSIA is carried out by individual Project Directors (Superintending Engineers) for each department under the Chief Engineer.

Furthermore, the present operational organization at HSIA belongs to the Operation and Planning Group and is composed of four departments for Deputy Airport Manager (Airport Operation), Station Air Traffic Officer, Station Communication Sector, and Security Section and Anti-Hijacking (refer to Figure 1.3).

Normal facility maintenance (cleaning, lighting, and mechanical building systems) is carried out by two teams: Civil Division 1 and Electrical and Mechanical Division 1 (refer to Figure 1.4).

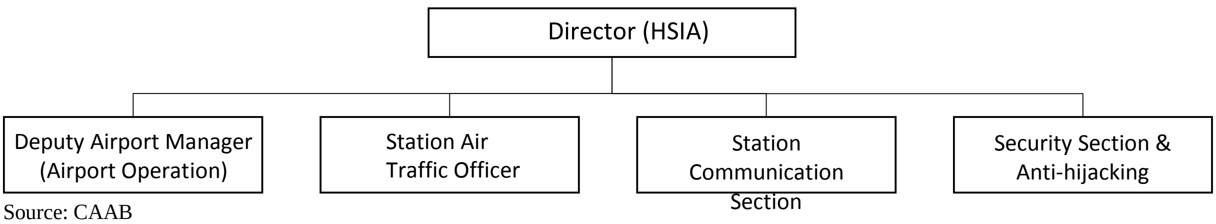
The Electrical and Mechanical Division 2 (Dhaka Area Excluding HSIA) is responsible for planning and maintenance of runways and airside facilities.

The operation of the commercial facilities is carried out by the Budget and Revenue Team in the Finance Group.



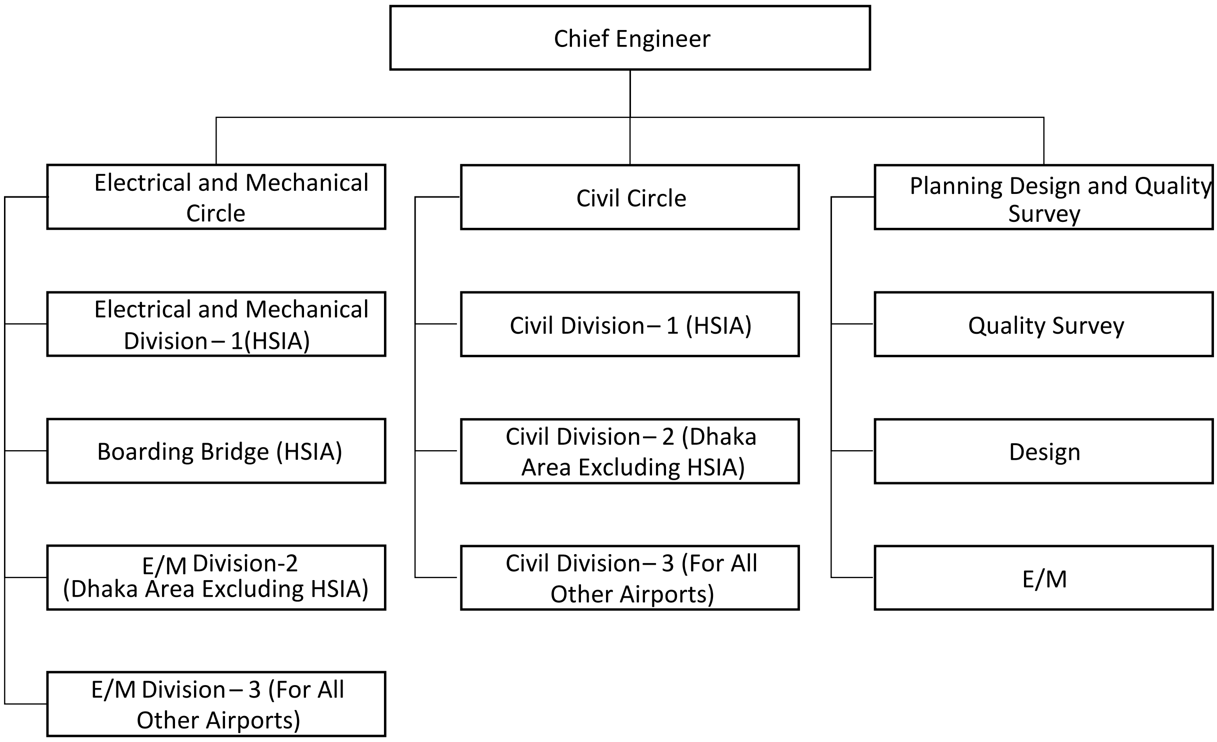
Source: CAAB

Figure 1-2 CAAB Organizational Structure



Source: CAAB

Figure 1-3 HSIA Organizational Structure



Source: CAAB

Figure 1-4 CAAB Engineering Organizational Structure

CHAPTER 2 SOCIAL AND ECONOMIC CONDITION

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Chapter 2 SOCIAL AND ECONOMIC CONDITION

This chapter discusses the social and economic conditions of the project area following the results of "Data Collection Survey of Expansion of International Airport in Dhaka, December 2016, JICA" (hereinafter referred to as "Data Collection Survey"), with some descriptions updated.

2.1 General Outline

Bangladesh is one of the poorest countries in Asia with a population of approximately 160 million people. According to the International Monetary Fund (IMF), Bangladesh's nominal gross domestic product (GDP) in 2013 was USD 161.3 billion, and the nominal GDP per capita was USD 1,030 (World Economic Outlook Database, April 2016). It is categorized as a least developed country (LDC) based on the standards of the United Nations.

Bangladesh has an eminently fertile land nurtured through the flooding of the Padoma River, the Jamuna River, and the Meghna River, and has been referred to as "the Golden Bengal". From the fact that the country has an enormous population and workforce, the economic potential is high; however, under the influence of natural disasters such as floods and cyclones, the development of its industries are delayed

Furthermore, even though Bangladesh has received technical and financial assistance over a long period, the country still faces challenges of economic and social development due to these natural disasters, excessive population, undeveloped infrastructure, and political confusion. However, they have shown a continuous steady economic growth after 2006 and are expected to achieve a nominal GDP per person of USD 1,900 in 2020 and to shift from LDC to middle-income country by 2021.

2.2 Basic Socioeconomic Indicator

Bangladesh's basic socioeconomic indicators are shown in Table 2-1.

Table 2-1 Basic Socioeconomic Indicators

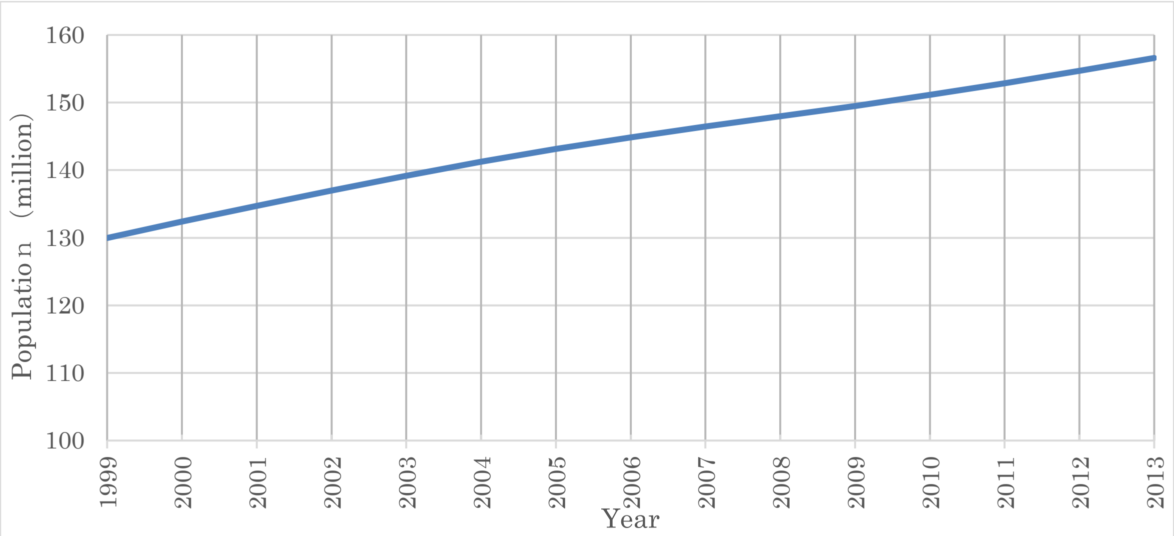
Indicator	2012	2013	2014
Real GDP Growth Rate	6.26%	6.04%	6.31% (Estimation)
Current GDP	USD 141.71 billion	USD 161.30 billion	USD 184.00 billion (Estimation)
Current GDP per Capita	USD 916.03	USD 1,030.03	USD 1,163 (Estimation)
Consumer Price Growth Rate	6.23%	7.54%	7.01%
Unemployment Rate	6.52%	6.01%	6.06%

Source: World Economic Outlook Database, April 2016
Source (Unemployment Rate): Institute of Developing Economies, Japan External Trade Organization

2.3 Indicators

2.3.1 Population

The population was 159,400,000 (Bangladeshi Statistics Bureau, October 2015), and the average annual growth rate of population was 1.37% (Bangladeshi Statistics Bureau, March 2011). The annual rate of population growth was 3.4% immediately after independence (1975) and population explosion became a social problem. However, the government has continuously and strongly promoted population control from 1992 to reduce the rate of population growth. Accordingly, the rate of population growth has shown decrease to 2.06% (2007 estimation) and 1.37% (2011 estimation) which is one of the lowest levels of population growth rate in Asia, in recent years.

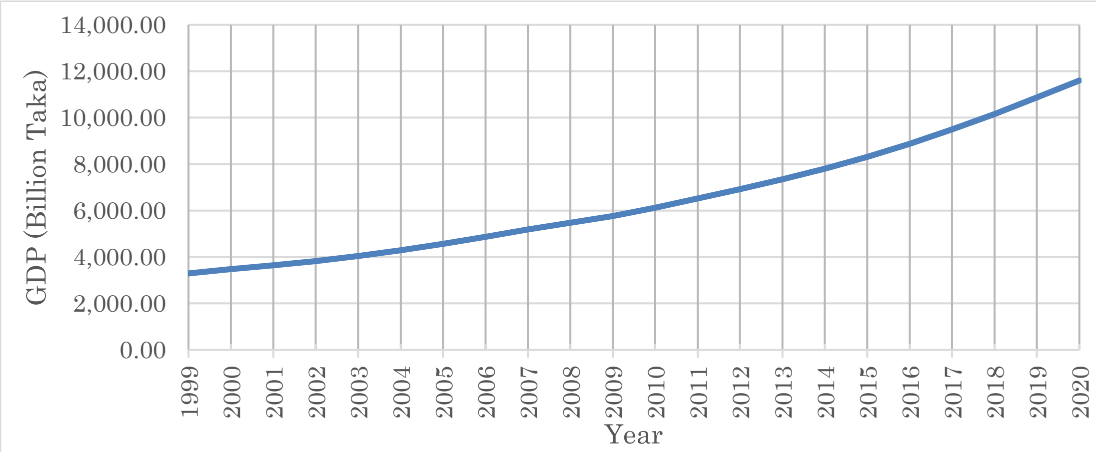


Source: IMF, World Economic Outlook Database, April 2016

Figure 2-1 Population

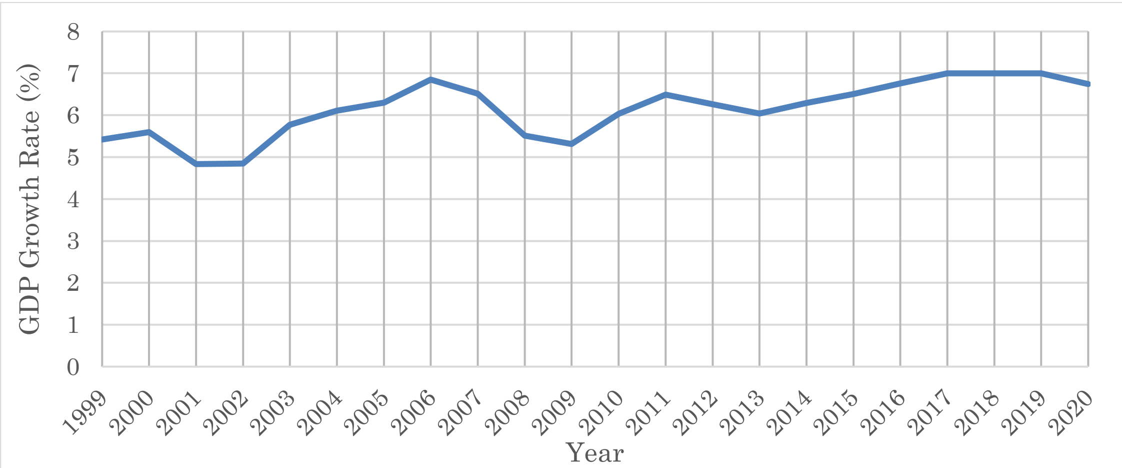
2.3.2 Gross Domestic Product

The economy of Bangladesh has been growing continuously for the past 20 years. According to the statistics of IMF, the growth rate of real GDP has been maintained at 5%-7% for the past 20 years. Its growth rate in the 2013 financial year (from July 2013 to June 2014) was 6.04%, and the total sum of real GDP reached BDT 7,342 billion. Continuous economic growth is supported by the stability of apparel products export and remittances from overseas workers, and the stable growth of agriculture.Meanwhile, diversification of industry and improvement of the energy industry including electric power supply and transportation facilities will be needed for sustainable development in the future.



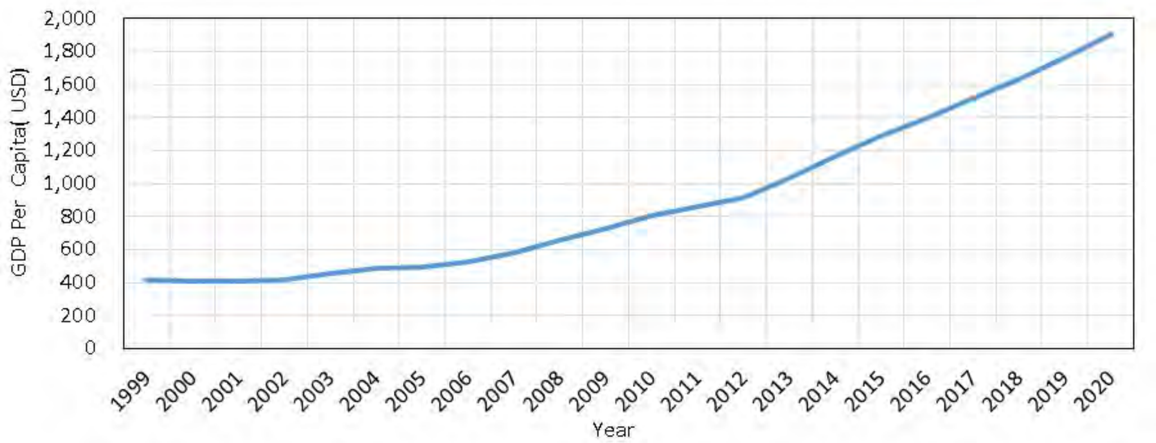
Source: IMF, World Economic Outlook Database, April 2016

Figure 2-2 Trend of Constant GDP



Source: IMF, World Economic Outlook Database, April 2016

Figure 2-3 Trend of Constant GDP Growth Rate



Source: IMF, World Economic Outlook Database, April 2016

Figure 2-4 Trend of Current GDP per Capita

2.3.3 Export and Import

The trade balance of Bangladesh shows a chronic payment deficit.

The main export items are textiles such as cotton, knit, jute, and home textile. On the other hand, the main import items are oil products, raw materials such as fibre, raw cotton, steel including machines, and transportation equipment.

Table 2-2 Trade Balance (USD in millions)

Year	Export	Import	Balance
2001	6,419	8,430	-2,011
2002	5,929	7,697	-1,768
2003	6,492	8,707	-2,215
2004	7,521	9,840	-2,319
2005	8,573	11,870	-3,297
2006	10,412	13,301	-2,889
2007	12,053	15,511	-3,458
2008	14,151	19,481	-5,330
2009	15,581	20,291	-4,710
2010	16,233	21,388	-5,155
2011	22,592	30,336	-7,744
2012	23,989	33,309	-9,320
2013	26,566	33,576	-7,010

Source：Annual Report 2012-2013, Bangladesh Bank

The development of the textile industry was triggered in the 1970's by investments from Korea and Hong Kong where textiles production had begun to slump. In recent years, with the rise of labour cost in China, the low labour cost in Bangladesh has attracted attention and textiles export have increased. 80% of the export of Bangladesh is accounted for by textiles, and major garment industries have moved into Bangladesh as a China+1manufacturing country. Items to support the export industry, such as raw fibre materials, oil, machinery and steel, account for the majority of imported goods.

Table 2-3 Main Export Items (2013 Provisional Value)

Main Export Item (Commodity)	Amount (USD in millions)
Fabric product	11,039
Knit product	10,475
Jute product	800
Home textile	791
Farm output product	535
Frozen food	543
Footwear	419
Leather, hides product	399
Industrial products	367
Straight jute	229
Others	1,337
Total	27,027

Source: Annual Report 2012-2013, Bangladesh Bank

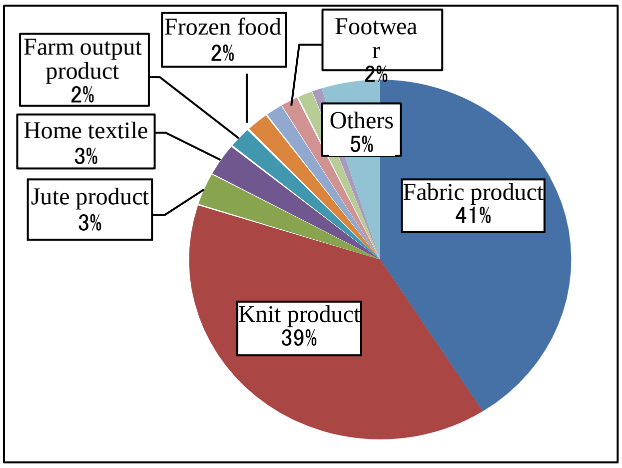


Figure 2-5 Main Export Items (2013 Provisional Value)

Table 2-4 Main Import Items (2013 Provisional Value)

Main Import Item (Commodity)	Amount (USD in millions)
Oil products	3,642
Fiber	3,273
Raw cotton	2,005
Steel	1,836
Capital goods such as machine and transportation equipment	1,835
Edible oil	1,402
Plastic rubber	1,366
Cotton yarn	1,356
Chemicals	1,302
Oil	1,102
Manure	1,188
Cereals	726
Others	12,543
Total (FOB)	33,576

Source: Annual Report 2012-2013, Bangladesh Bank

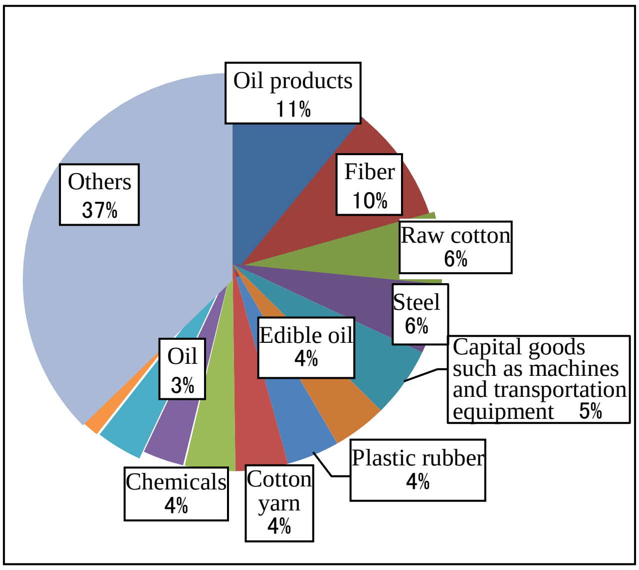


Figure 2-6 Main Import Items (2013 Provisional Value)

2.3.4 Inbound and Outbound Travelers

Bangladesh has some attractive tourist places including world heritage sites. However, integrated infrastructure such as transportation, accommodation, and advertisement for tourism has not yet been developed. According to the data of the Bangladesh Tourism Board, the annual number of foreign visitors after 2000 is approximately 250,000 people as shown in Table 2-5.

Table 2-5 Change of Foreign Visitors

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	199,211	207,199	207,246	244,509	271,270	207,662	200,311	289,110	467,332	267,107
% Change	15.3	4.01	0.02	17.98	10.94	-23.45	-3.54	44.33	61.65	-42.84

Source: Website of Bangladesh Tourism Board

The tourism and business visit accounted for 95% of all foreign visitors, followed by religion purpose in 2009. On the other hand, the departure for "service" which seems to be for overseas migrant workers, accounted for more than 45% of all departures followed by departure for tourism.

Table 2-6 Tourist by Purpose (2009)

Item	Tourism	Business	Office	Study	Religion	Service	Other	Total
Inbound Tourist	122,899	111,569	3,895	6,475	8,983	0	13,286	267,107
%	46.01%	41.77%	1.46%	2.42%	3.36%	0%	4.97%	100.00%
Outbound Tourist	483,074	102,144	1,951	29,850	23,606	1,059,300	554,653	2,254,578
%	21.43%	4.53%	0.09%	1.32%	1.05%	46.98%	24.60%	100.00%

Source: Website of Bangladesh Tourism Board

2.4 Airports in Bangladesh

As shown in Figure 2-7, there are three international airports in Bangladesh, namely, Dhaka (HSIA), Chittagong, and Sylhet. The target airport of this study is HSIA.

In addition, there are ten domestic airports in Bangladesh. In particular, five airports, namely, Jossore, Cox's-Bazar, Barisal, Rajshahi, and Saidpur, have regularly scheduled flights and the number of passengers are relatively high compared with other domestic airports. The number of passengers within the past seven years is shown in Table 2-7.

Source: JICA Study Team

Figure 2-7 Airports in Bangladesh

Table 2-7 Passengers in Major Domestic Airports

Airport		2009	2010	2011	2012	2013	2014	2015
Dhaka	International	3,657,449	4,194,385	4,561,771	4,984,315	5,231,581	5,398,945	5,568,934
	Domestic	596,617	523,133	527,950	589,108	648,019	685,198	912,644
	Total	4,254,066	4,717,518	5,089,721	5,573,423	5,879,600	6,084,143	6,481,578
Chittagong	International	370,917	447,393	542,052	596,630	572,275	666,986	718,265
	Domestic	185,345	242,893	321,486	307,389	356,725	397,014	NA
	Total	556,262	690,286	863,538	904,019	929,000	1,064,000	NA
Sylhet	International	NA	NA	136,293	138,530	140,880	168,421	NA
	Domestic	NA	NA	43,707	71,470	75,120	79,579	NA
	Total	160,000	191,000	180,000	210,000	216,000	248,000	207,701
Jossore	Domestic	52,489	50,005	83,379	81,255	104,536	108,001	114,200
Cox-Bazar	Domestic	25,000	35,000	57,998	63,837	66,424	87,001	136,051
Barisal	Domestic	0	0	0	0	3,269	2,926	13,872
Rajshahi	Domestic	0	0	734	3,105	3,754	4,162	16,459
Saidpur	Domestic	0	0	1,255	7,660	15,145	26,535	68,456

Source: CAAB

CHAPTER 3 PRESENT CONDITIONS AND ISSUES RELATED TO HSIA

Chapter 3 PRESENT CONDITIONS AND ISSUES OF HSIA

3.1 Airport Operation and Management

The existing HSIA landside facilities are shown in Figure 3-1.

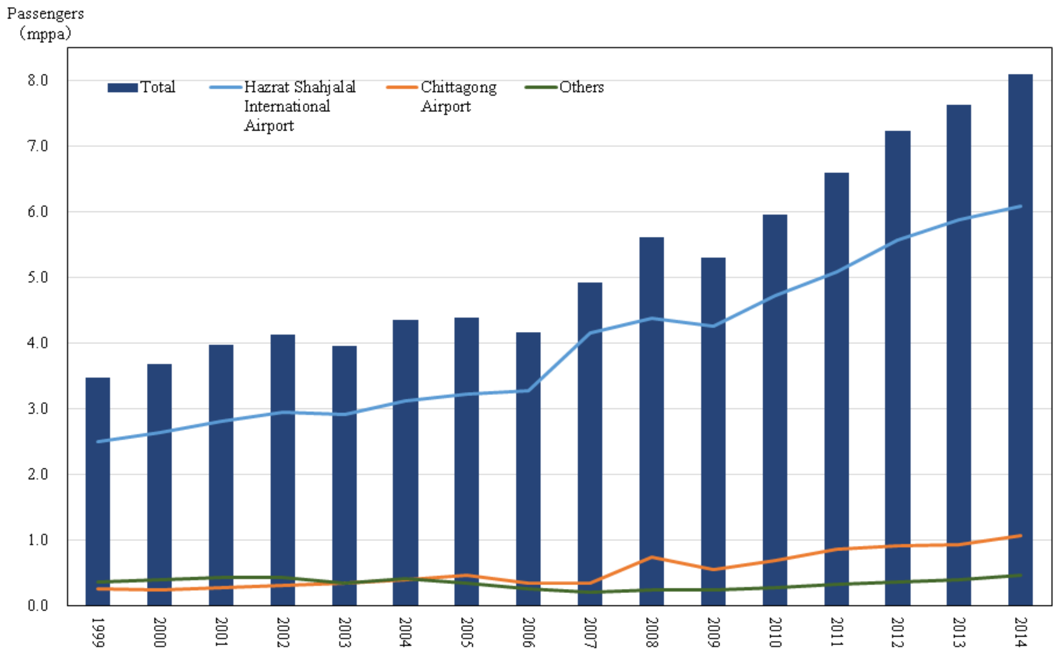
Source: CAAB Master Plan and Feasibility Study

Figure 3-1 Existing HSIA Landside Facilities

3.1.1 Number of Passengers

The number of passengers nationwide and at HSIA was increased in 2007 and 2008, but decreased by about 100,000 passengers in 2009 due to the “Lehman shock” as shown in Table 3-1 and Figure 3-3. After 2010, it continues to grow again by roughly 6% in line with economic growth.

Furthermore, the average annual growth rate of air passengers at HSIA from 1999 to 2015 was 6.17%. However, it rose to 7.88% after 2006 with increasing demand in recent years.



Source: JICA Study Team

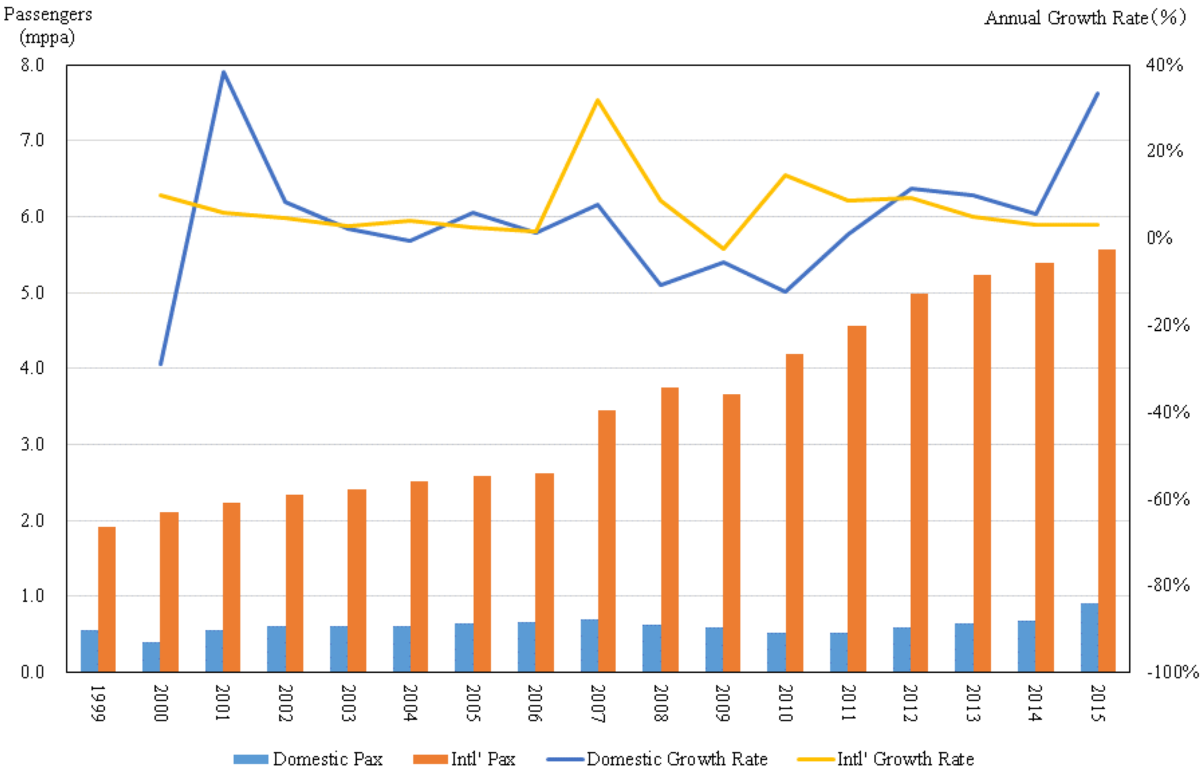
Figure 3-2 Demand of Passengers in Bangladesh

Although the ratio of passengers on international flights was 77.2% in 1999, it became around 90% after 2011. On the other hand, the number of domestic flights passengers has been stable between 1999 to 2009, recording around 700,000 passengers nationwide in 2007. It dropped to 520,000 passengers in 2010 after which a steady increase has been recorded, even though demand remains small. The average annual growth of the number of air passengers from 2010 to 2015 was 5.84%.

Table 3-1 Number of Passengers in HSIA (Unit: million passengers)

Year	Domestic Passenger	International Passenger	Total	International Passenger Ratio
1999	0.566	1.923	2.489	77.24%
2000	0.403	2.112	2.515	83.98%
2001	0.557	2.240	2.796	80.09%
2002	0.603	2.346	2.949	79.56%
2003	0.616	2.414	3.030	79.66%
2004	0.612	2.516	3.128	80.43%
2005	0.648	2.580	3.228	79.93%
2006	0.657	2.619	3.276	79.95%
2007	0.708	3.450	4.158	82.97%
2008	0.631	3.749	4.380	85.59%
2009	0.597	3.657	4.254	85.97%
2010	0.523	4.194	4.717	88.91%
2011	0.528	4.562	5.090	89.63%
2012	0.589	4.984	5.573	89.43%
2013	0.648	5.232	5.880	88.98%
2014	0.685	5.399	6.084	88.74%
2015	0.913	5.569	6.482	85.91%

Source: JICA Study Team



Source: JICA Study Team

Figure 3-3 Transition of HSIA Passengers

3.1.2 Cargo Volumes

The volume of import cargo at HSIA has been increased by 9% on average between 2011 and 2015, while export cargo has grown more rapidly by 14% during the same period. The volumes of export and import cargoes in 2015 were 200,560 tons and 84,379 ton, respectively.

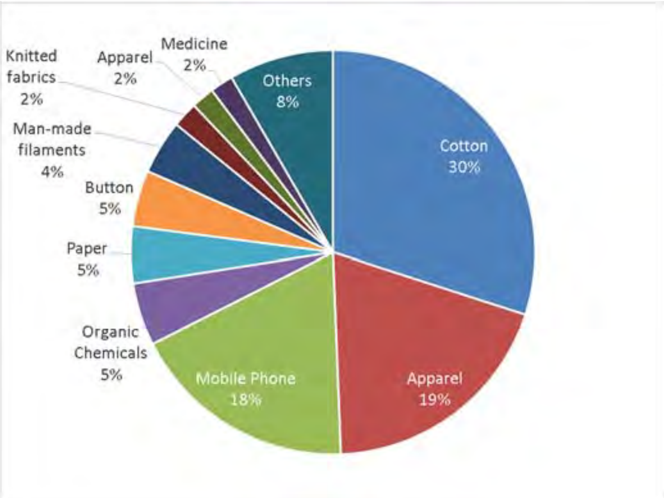
According to the data from the Custom House at HSIA[1], import for home consumption accounted for 10,385 tons between July 2015 and April 2016. Mobile phones recorded the largest volume with 5,816 tons, followed by chemical products (1,608 tons). Most of the import and re-export products (goods brought in bond) during the same period were mainly used for the apparel industry, which include clothing accessories (5,429 tons), cotton and denim (9,608 tons), and dyed woven fabrics (1,389 tons). Together with home consumption and goods for bond area, cotton, apparel, and mobile phones were the main imported goods in HSIA, which consist of around 67% of total imported goods (Figure 3-4).

In terms of export, apparel goods recorded 1,216,072 tons between July 2015 and April 2016, followed by fresh foods such as crabs and eels (34,120 tons) and vegetables (6,961 tons). Compared with the Biman Bangladesh Airlines' data for 2015, there was a huge increase of export of apparel goods at HSIA, while the volume of perishable exports remained at the same level. Currently, around 97% of export cargoes are apparel products, as shown in Figure 3-5.

The largest volume of imported cargo originated from Hong Kong and China, followed by India,

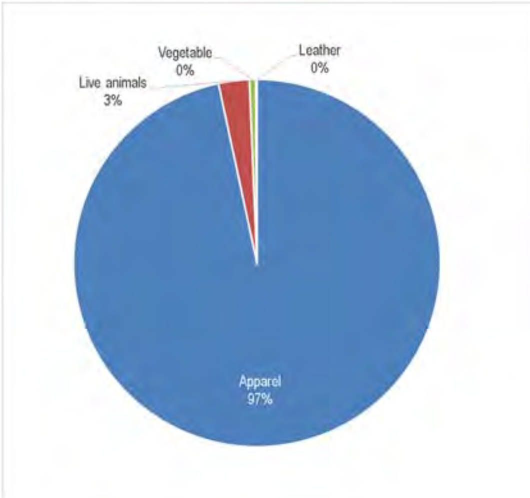
[1] The import data from the Custom House includes IM4 (for home consumption) and IM7 (goods for bond area), and does not include other categories such as IM5 (temporary import) that are very little in volume.

Pakistan, and Taiwan. Most of the imported goods from Hong Kong and China were primary materials for the garment industry. Mobile phones were largely imported from China and Korea, while chemical and pharmaceutical products were imported from Europe. Japan is ranked 14th in terms of imported cargo, accounting for 1,020 tons. In contrast to the imported cargo that were mainly from Asia, export cargo were mainly destined for Europe, in which Germany has the largest volume, standing at 648,825 tons, followed by the United Kingdom (444,654 tons), and Spain (81,729 tons). Most of the exported goods for Europe were apparel goods, followed by leather goods; while perishable goods were largely exported to the Middle East. Japan is the 9th export destination, accounting for 4,261 tons between July 2015 and April 2016.



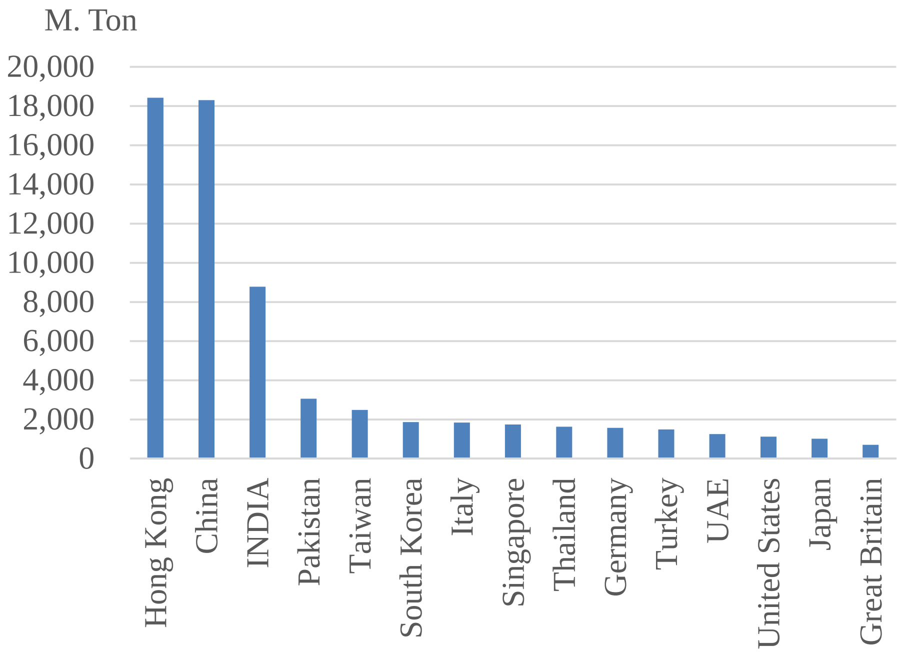
Source: Data from the Custom House

Figure 3-4 Composition of Import Commodities at HSIA Between July 2015 and April 2016



Source: Data from the Custom House

Figure 3-5 Export Commodities at HSIA Between July 2015 and April 2016



Source: Data from the Custom House

Figure 3-6 Imports by Country at HSIA between July 2015 and April 2016

3.2 Basic Facilities

3.2.1 Runway and Taxiway

The airport consists of a single runway (14/32), 46 m wide and 3,200 m long, with shoulders (8 m). About 90 m is secured for the runway end safety area (RESA) at both ends. The runway is equipped with CAT I instrument approaches. The declared distances are shown in Table 3-2.

Table 3-2 Runway Declared Distances of HSIA

Runway Designator	Take off Run Available (TORA) (m)	Take off Distance Available (TODA) (m)	Accelerate-Stop Distance Available (ASDA) (m)	Landing Distance Available (LDA) (m)
14	3,200	3,625	3,475	3,200
32	3,200	3,500	3,345	3,200

Source: AIP

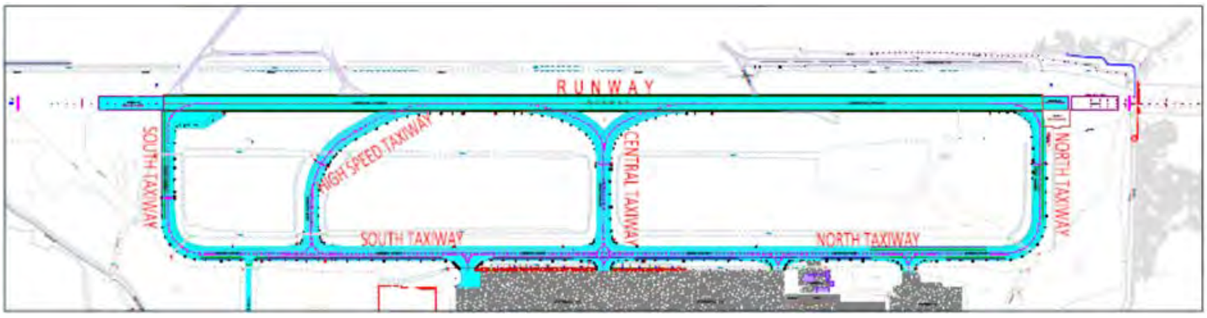
A part of the dual taxiway at the end of Runway 14 is being constructed. The runway will be extended to 3,290 m after completion of construction. A military airfield is located on the western side of the runway is connected by four taxiways to the runway. The runway and ATC are shared with the military. A taxiway is provided parallel to the runway, and a number of runway exits are available at the ends and in the middle of the runway. One rapid exit taxiway is provided for the landing direction of Runway 14. The entire runway was rehabilitated with an asphalt overlay of 180 mm in 2012 and the taxiway surface was rehabilitated by cut-out and repaving with 38 mm asphalt overlay for the taxing lanes of the main gear of large aircraft in 2015. These works raised the carrying capacities of the runway and taxiways to accommodate the heavy weight of large aircraft. The pavement classification number (PCN) of the runway and taxiways is now 116 as shown in Table 3-3.

Table 3-3 Runway and Taxiway Physical Characteristics

	Width	Surface	Strength (PCN)
Runway	46 m	Flexible pavement (asphalt)	PCN 116/F/C/W/T
Taxiway	23 m	Flexible pavement (asphalt)	PCN 116/F/C/W/T

Source: AIP

The layout and pavement of the HSIA runway and taxiway are shown in Figure 3-1 and Figure 3-4 respectively.



Source: CAAB

Figure 3-7 Runway and Taxiway Layout

Runway

North Taxiway

South Taxiway

Central Taxiway

Source: JICA Study Team

Figure 3-8 Runway and Taxiway Surface

3.2.2 Apron

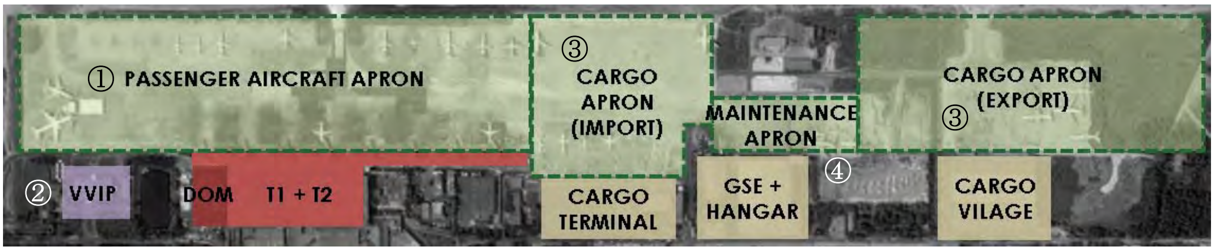
The existing apron areas are allocated as shown below:

① Passenger apron for scheduled service (nine stands, eight of which are boarding bridges),

② VVIP apron,

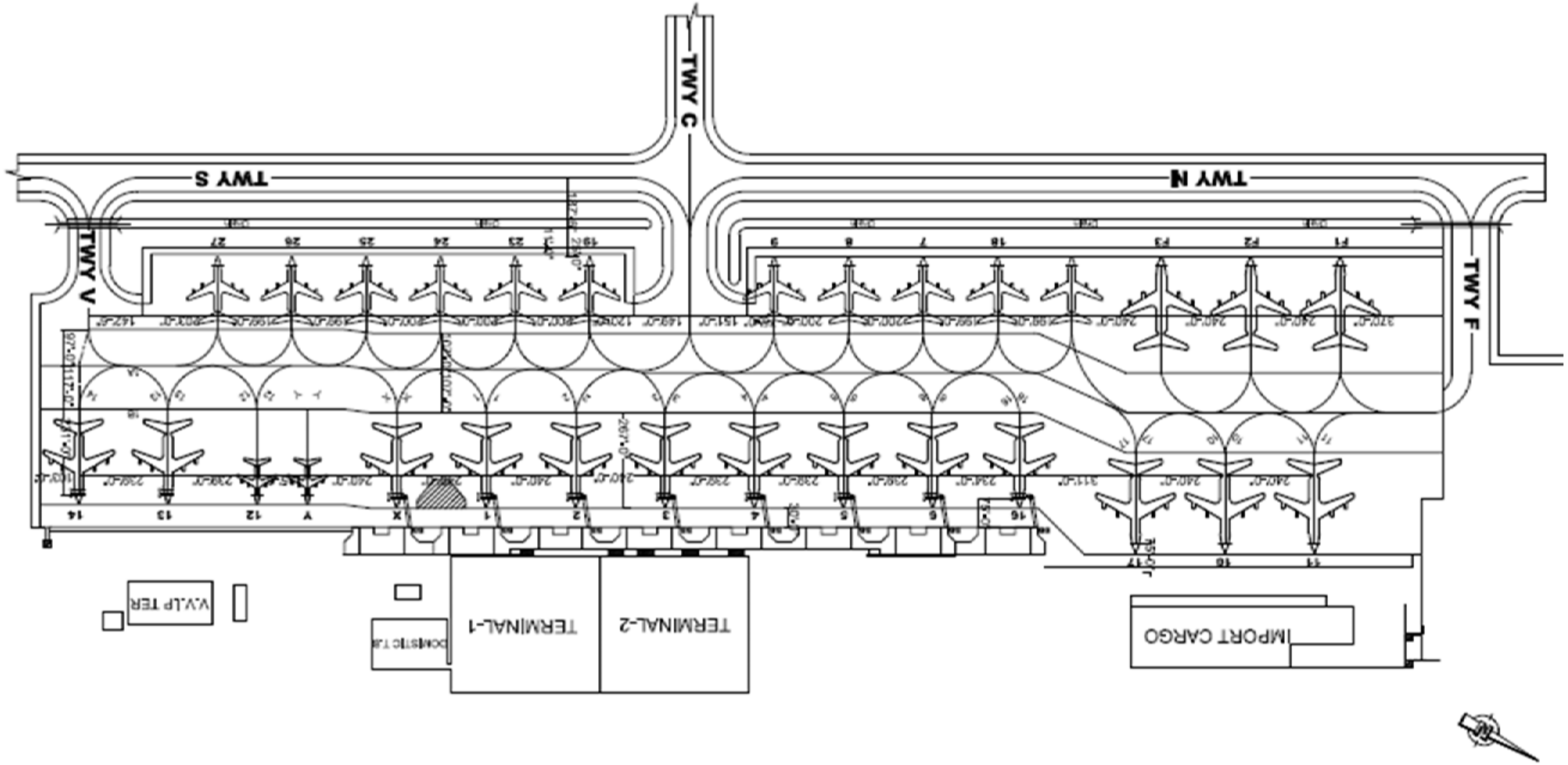
③ Cargo aprons (separate import and export aprons), and

④ Maintenance apron.



Source: CAAB

Figure 3-9 Apron Layout



Source: CAAB

Figure 3-10 Apron Stands and Marking Layout

Table 3-4 Existing Apron Stand Number

No.	Stand Number		Apron Type	Code	Remarks
	Present	Plan			
1	X	Bay 4	Passenger	E	Temporary Boarding Bridge
2	Y	Bay 3	Passenger	E	Combined with 12
3	1	Bay 5	Passenger	E	Boarding Bridge
4	2	Bay 6	Passenger	E	Boarding Bridge
5	3	Bay 7	Passenger	E	Boarding Bridge
6	4	Bay 8	Passenger	E	Boarding Bridge
7	5	Bay 9	Passenger	E	Boarding Bridge
8	6	Bay 10	Passenger	E	Boarding Bridge
9	7	Bay 20	Passenger	D	Boarding Bridge
10	8	Bay 21	Passenger	D	Non Scheduled
11	9	Bay 22	Passenger	D	“
12	10	Bay 13	Cargo	E	“
13	11	Bay 14	Cargo	E	
14	12	Bay 3	Passenger	E	Combined with Y
15	13	Bay 2	VVIP	E	
16	14	Bay 1	VVIP	E	
17	16	Bay 11	Passenger	E	
18	17	Bay 12	Cargo	E	Boarding Bridge
19	18	Bay 19	Passenger	D	
20	19	Bay 23	Passenger	D	Non Scheduled
21	23	Bay 24	Passenger	D	“
22	24	Bay 25	Passenger	D	“
23	25	Bay 26	Passenger	D	“
24	26	Bay 27	Passenger	D	“
25	27	Bay 28	Passenger	D	“
26	P1	Bay15	Passenger	E	“
27	P2	Bay 16	Passenger	E	“
28	P3	Bay 17	Passenger	E	“
29	Between 18 and P3	Bay 18	Passenger	D	“
30	Between 27 and T/W V	Bay 29	Passenger	D	“

Source: CAAB

The passenger apron pavement is showing many cracks and CAAB is planning improvement of the apron in the self-funded airport expansion plan currently under consideration. The characteristics of the apron pavement are shown in Table 3-5 and the condition of the passenger apron pavement is shown in Table 3-11.

Table 3-5 Apron Pavement Physical Characteristics

Surface	Strength (PCN)
Rigid pavement (concrete)	PCN 70/R/B/W/T

Source: AIP

Source: JICA Study Team

Figure 3-11 Passenger Apron Surface

3.2.3 Drainage System

The existing surface water drainage system in the airport is divided into two drainage zones, north and south. The drainage flow follows the lower areas, through retention ponds and drainage ditches in each zone and is discharged separately from the southeastern and northwestern corners of the airport area. Also, the airport area is an isolated zone avoiding entry of drainage from the outside. The existing drainage system is shown in Figure 3-12 and Table 3-13.

Confidential due to security reasons.

Figure 3-12 Existing Drainage System

Confidential due to security reasons.

Figure 3-13 Existing Drainage

3.3 Existing Landside Facilities

3.3.1 Current Condition of Passenger and Cargo Terminal

The existing terminal facilities of HSIA are the single storey domestic passenger terminal, two connected 3-storey international passenger terminals, two separate single-storey cargo terminal buildings for import and export, one VVIP passenger terminal, utilities and fuel supply facilities, and administration/management building. The auxillary facilities are located independently inside the airport area.

The floor areas of the HSIA passenger terminal and cargo terminal are shown in Table 3-6. The existing passenger terminal is shown as “T1and T2 Terminal”, but are actually a single connected terminal and have a combined floor area of about 73,400 m^2.

Table 3-6 Existing Facilities and Floor Area in HSIA

Facilities	Floor Area
T1 and T2 Terminal	73,400 m^2
Domestic	2,200 m^2
Cargo (export)	12,800 m^2
Cargo (import)	15,000 m^2 (160,000 ft^2)

Source: CAAB Master Plan and Feasibility Study

The arrival/departure area is a double deck system for international departures and arrivals. Access to the departure kerbside is open to both well-wishers and drop-off vehicles. However, in common with many airports in Asia, vehicular access to the arrival kerbside is limited by a security check. Therefore, the areas outside the security fence surrounding the controlled area, including the parking space, are all extremely crowded with both people and traffic.

Facility planning and passenger flow of the passenger terminals are described below.

3.3.2 International Passenger Terminal Facilities

(1) Existing International Passenger Terminal Departure and Arrival Flow

The departure and arrival flow for international passengers are shown in Figure 3-14. The points of note concerning the passenger flows are described as follows:

- ✈ Departure and arrival passengers share the same airside concourse space, which are a later extension to the terminal building;
- ✈ Due to the mixing of departure and arrival passengers in this space, departing passengers must undergo security check immediately before entering the boarding area;
- ✈ One X-ray scanner and customs officers are stationed for baggage check and scanning of arriving passengers; and
- ✈ VVIP facilities are available on the northwest side of the international passenger terminal with access road and independent parking lot.

Confidential due to security reasons.

Figure 3-14 Existing International Passenger Terminal Departure and Arrival Flows

(2) International Departure Passenger Facilities

Confidential due to security reasons.

Confidential due to security reasons.

Figure 3-15 Existing International Departure Passenger Facilities

(3) International Arrival Passenger Facilities

Confidential due to security reasons.

Confidential due to security reasons.

Figure 3-16 Existing International Arrival Passenger Facilities

(4) International Passenger Terminal (T1 and T2)

Confidential due to security reasons.

Source: JICA Study Team

Confidential due to security reasons.

Figure 3-17 Existing International Terminal

3.3.3 Domestic Passenger Terminal Facilities

(1) Present Situation

Confidential due to security reasons.

Confidential due to security reasons.

Figure 3-18 Existing Domestic Passenger Terminal Facilities

(2) Issues

1) Issues in Domestic Passenger Terminal

Confidential due to security reasons.

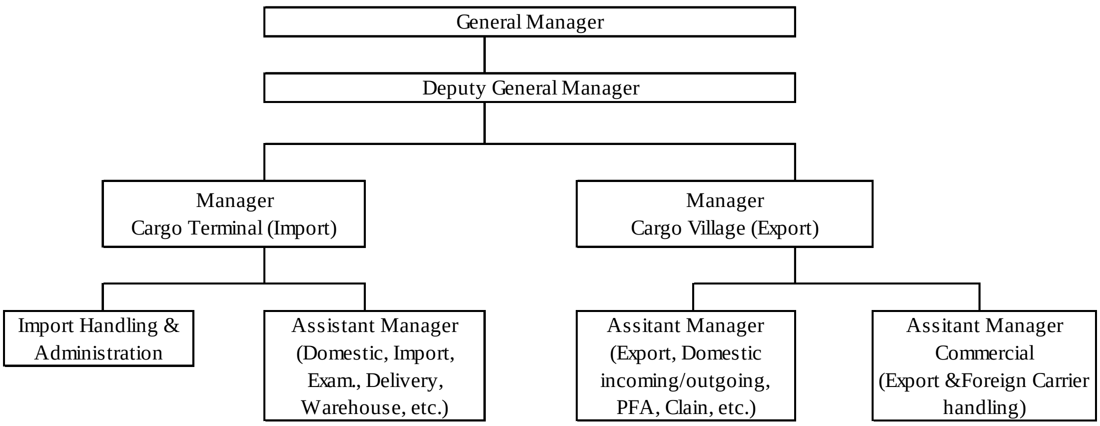
Confidential due to security reasons.

Figure 3-19 Existing Domestic Terminal

3.3.4 Cargo Terminal Facilities

(1) Management

The cargo terminal of HSIA has been operated by Biman Cargo since 1972 when CAAB approved Biman Cargo as the sole ground handler to handle cargo services in Bangladesh. Figure 3-20 shows the organizational chart of the cargo terminal. The cargo terminal is headed by a general manager, who is assisted by a deputy general manager. There are two managers in-charge of export and import, who are assisted by assistant managers as shown in Figure 3-20. Currently, Biman Cargo has 110 employees but it plans to increase staffing to 355.



Source: Biman Cargo

Figure 3-20 Current Organizational Structure of Cargo Terminal at HSIA

The Civil Aviation Rules 1984 provides the rules related to airport transport services and safe transportation of dangerous goods. A license to operate air transport services shall be authorized by the chairman of CAAB and air transport fares are regulated by CAAB. Biman Cargo prepared the Cargo Operation Manual in 2013, which provides the information necessary for cargo handling, documentation, automation, loading and storing, and import procedures. The automated system for cargo handling and documentation was once introduced at the cargo terminal, but it was not functioning as expected. Currently, the documents are handled manually in the import cargo building and cargo are identified and processed on the basis of airway bill. The cargo are not classified by Harmonized System (HS) Code, but by two categories of 1) perishable cargo and 2) dry cargo. There is no separation between import for home consumption and import for bond area.

The Custom House under the National Board of Revenue is responsible for collecting import duties at HSIA. Recently, the Custom House introduced an automated system for custom data, called the Automated System for Customs Data (ASYCUDA) World, which was introduced in December 2013 for export goods and in May 2014 for import goods. The automated system has been supported by the United Nations Conference on Trade and Development (UNCTAD). UNCTAD provided training courses for operating the automated system in Malaysia. There are two payment methods for clearing customs, namely: 1) pre-paid system and 2) e-payment through bank. The Custom House handles around 4,000 imported goods per day, which include courier services. The import section for home consumption consists of six sections, and is very congested with clearance agents as shown in Figure 3-21. More than 90% of imported goods for home consumption were cleared within four days, 50% of which were cleared within one day. Around 75% of imported goods for bonded area (import + re-export), were cleared on the same day. The number of courier traffic has been increasing rapidly, and there are currently 33 courier agents at HSIA.

Confidential due to security reasons.

Figure 3-21 Existing Custom House

(2) Present Situation

Even though institutional framework such as the cargo management manual mentioned above are in place, the airside of the import cargo terminal is very crowded. The photographs in Figure 3-22 show that many parcels of import cargo are not carried into the cargo terminal building.

One cause of this problem is that the service hours for handling of imported cargo are limited to 9:00 – 17:00. Therefore, many irregular inspections take place outside. Since the cargo left outside are not properly supervised, some imported items are taken out inappropriately; leading to even more confusion.

The imported cargo which are fortunately carried into the cargo terminal is delivered to the shipper if the ledger sheet and cargo are matched; however, a process which is reported to take at least four days. There is almost no signage inside the terminal to direct the proper movement of the imported cargo, resulting in a confused circulation of handling staff and cargo. The floor is also littered with collapsed freight leaving only space sufficient for a wheelbarrow to pass when the passage lanes for dollys are excluded.

Some cargo racks have been installed in a part of the warehouse, but the work was suspended during installation and it has not been used yet. Forklifts are also in short supply and there is no space for vehicles to freely approach the racks to load/unload and move cargo on pallets.

There appears to have been some previous attempts to rectify the situation, but the handling staff cannot be stabilized (it has been reported that they are mostly day workers), making it difficult to train the staff. This in turn requires reliance on verbal instructions and makes operations far from efficient. It has also been reported that many of the handlers cannot correctly read and understand the labels attached to the cargo. It is considered essential to address the issue of improving the capability of the handlers and to train the staff to a sufficiently high level for the handling procedures and volumes expected after installation of the new equipment/facilities while developing an appropriate organization for cargo operation and management in time for the commencement of operations at the new cargo terminal.

Since in general, the number and letter combinations used to identify freight are not familiar to the cargo handlers, introduction of easily recognizable pictures and colours are believed to be required, as well as a means to reward by volume worked (increase in wages).

The education and training of staff members and management of handlers that reflects the reality in Bangladesh, coordinated with the introduction of appropriate equipment will be required to raise the efficiency of cargo handling to a level equal to that of ordinary airports in neighbouring countries

What is immediately apparent, both inside and outside the terminal building, is that orderly maintenance and cleaning are not being carried out and unnecessary goods, garbage, and damaged equipment are left abandoned. This condition is apparent throughout the airport, but this situation presents a candidate area where application of Japanese technical guidance and training would be appropriate.

The requirement for x-ray scanning of all items, requiring even small parcels to be individually passed through the large x-ray machine, is considered to be a bottleneck in export procedures. Continuing the same procedure in the future will require doubling the number of scanning equipment.

Export is serviced on a 24-hour basis and the procedures themselves are simple, so that the situation is better than imports, but it will be essential to eliminate excessive procedures and to improve working conditions similar to that for imports.

At present, trucks are overflowing the parking area. One reason is due to the traffic regulations that restrict daytime movement of large trucks causing the daytime movement of export cargo to be restricted to small trucks.

Both terminal buildings suffer from insufficient interior lighting and must be improved. A well-lit working environment will help to reduce mistakes and accidents.

The inability of handling capacity to keep up with the increased import volumes is another cause for the unkempt mess of import cargo. Other causes are the lack of an automated handling system and lack of efficient categorization. According to records, cargo whose owners could not be identified due to lack of efficient categorization was recorded to be 1,000 tons for the month of January 2016 alone. Already, airside space is saturated with insufficient space for storage of cargo. Interior spaces are also crowded with insufficient passage space (see Figure 3.22). The multilevel shelf space is also insufficient and is inaccessible to forklifts.

CAAB is aware that the current organization is also problematic for the export and import of air cargo to and from the United States and EU. CAAB is considering separating these operations from the Asian and Middle Eastern cargo to enable stricter management. However, compliance with Western standards is a fundamental requirement for international cargo, which is quite inferior under present circumstances. It is extremely important to introduce necessary facilities and focus on operation management.

Confidential due to security reasons.

Figure 3-22 Existing Cargo Building

(3) Issues at the Import Cargo Terminal

The import cargo terminal is quite small. There is a canopy area in front of the terminal building for temporary storage of imported cargo, but the space is not properly managed. Conditions do not allow for cargo to be properly handled and stored, frequently resulting in damage or disfigurement. The cargo terminal is operated solely by Biman Cargo. Although the terminal suffers from very limited space and debilitated facilities, the deterioration of the management and operations of the cargo terminal is also quite serious. Some cargo take almost one week to pass through customs which normally should take only one or two days, creating a major issue for air cargo with its need for speed. The present conditions at the import cargo terminal are shown in Figure 3-23.

Confidential due to security reasons.

Figure 3-23 Existing Import Cargo Terminal

(4) Issues at the Export Cargo Terminal

The export cargo terminal is more spacious than the import cargo terminal.

The handling cargo exported from Bangladesh was prohibited by countries such as UK, Australia, and Germany due to the weak security scanning process. To improve the situation, new security screening equipment has been setup based on research by an UK airport security consultant, but waiting for inspections can be long and is considered a bottleneck at present.

Roller conveyors are available after the security scanning process and cargo are placed on dollys and lined up for uploading into the aircraft. The installation of cargo racks is also progressing to optimize space utilization inside the terminal area.

All cargo are moved inside the terminal from the gable side of the terminal where the security scanning facilities are placed due to the restrictions on the landside area. Cargo passing the security process are divided into categories and temporarily placed inside the terminal. Most operations are completed by workers by hand and the handling is rough and chaotic, mainly due to the lack of modern equipment. The export procedures follow a cargo handling manual prepared by Biman Cargo. Current conditions of the export cargo terminal are shown in Figure 3-24.

Confidential due to security reasons.

Figure 3-24 Existing Export Cargo Terminal

3.3.5 VVIP Facilities

The VVIP passenger terminal is located at the southeast side of the airport area. There is an independent access for the VVIP terminal, which is connected directly to the main road outside the airport area. The VVIP terminal is fenced in and has a large garden.

Confidential due to security reasons.

Figure 3-25 Existing VVIP Facilities

Confidential due to security reasons.

Confidential due to security reasons.

Figure 3-26 Layout of the Existing Ground Floor, Flow Chart

Confidential due to security reasons.

Figure 3-27 VVIP Facilities (1)

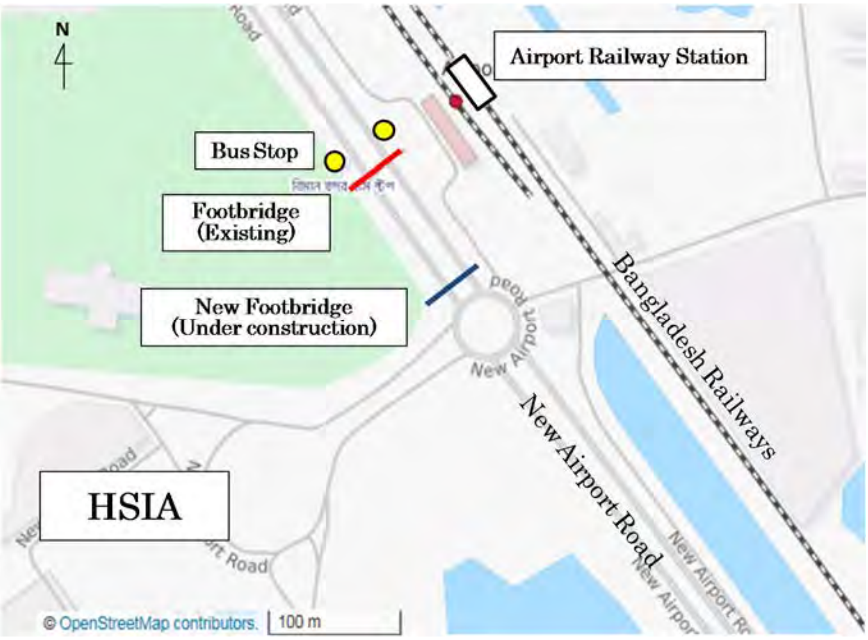
Confidential due to security reasons.

Figure 3-28 VVIP Facilities (2)

3.3.6 Landside Access Road

(1) Current Condition of the Airport Access Road

The existing New Airport Road is the main access road to HSIA with four lanes on each side. The airport roundabout is located in front of HSIA and there are no traffic signals at the intersection. All traffic passes through the airport roundabout to enter HSIA. There is a median strip and pavement on the New Airport Road is well maintained. Physical devices such as speed bumps are not installed on the New Airport Road around the airport roundabout. Flyover and underpass to access HSIA are not developed at present.



Source: JICA Study Team

Figure 3-29 Current Location Map of the Airport Access Road and Surrounding Facilities

A bus stop is located 160 m north of the roundabout and many passengers board and disembark there. The pedestrian sidewalk is reduced to provide bus bays; however, passengers are sometimes forced to board or get off in the road mainly because of the following reasons: a) avoiding puddles especially during the rainy season, b) using the space for queuing, and c) the area is occupied by other vehicles (Figure 3-30). These behaviours obstruct the traffic flow and cause traffic congestion at the airport roundabout.

Source: JICA Study Team

Figure 3-30 Current Traffic Condition around the Bus Stop (Northbound)

Southbound bus passengers alight opposite to HSIA since traffic drives on the left in Bangladesh. The footbridge installed 130 m north of the airport roundabout (Figure 3-31), should be used to access HSIA. However, few pedestrians use the footbridge due to the distance, preferring to cross the road directly in front of HSIA, a zone without traffic signals. This behaviour is also another cause of traffic congestion in this area. A new footbridge is under construction near the roundabout (Figure 3-32).

Source: JICA Study Team

Figure 3-31 Existing Footbridge (in the North)

Source: JICA Study Team

Figure 3-32 New Footbridge Under Construction (South of the Existing Footbridge)

The Bangladesh Railways (BR) operates alongside the New Airport Road. The Airport Railway Station is located on the side opposite to HSIA. According to the interview with BR staff, the user numbers for Airport Railway Station is the largest among all stations in Dhaka City, and major users are the residents of Uttara and Mirpur. Railway users also use the footbridge or cross the road in the zone without traffic signals similar to the bus users. Users of the station often take buses, compressed natural gas (CNG) vehicles, or pick up their private cars to leave the railway station. Furthermore, the New Airport Road, which connects downtown Dhaka with north and northwest parts of the city, is a major artery with heavy traffic by private cars and buses unrelated to HSIA, causing heavy congestion in the vicinity.

(2) Issues of Airport Access Road

Traffic congestion on the New Airport Road is aggravated by the excessive dependence on road traffic throughout the whole area of Dhaka. Significant problems of the airport access road are: (i) reduced road capacity (ii) disorderly crossing by pedestrians no traffic signal zone and (iii) convergence of airport users and non-airport users. The causes and issues are summarized in Table 3-7.

Table 3-7 Summary of Causes and Issues

Problems	Causes	Issues
(i) Reduction of the road capacity	・Location of the bus stop ・Flooding of the road especially during the rainy season ・On-street parking	・Consideration of proper bus stop location ・Maintenance of drainage systerm ・Control of on-street parking
(ii) Disorderly crossing by pedestrians in no traffic signal zone	・Location and inconvenience of the footbridge ・Shortcut preferred due to big and heavy luggage to carry	・Installation of new footbridge nearby (under construction) ・Direct connection to HSIA from bus stop (footpath) and BR station
(iii) Convergence of airport users and non-airport users	・Proximity to residential areas ・Location and number of bus stops and BR station	・Development of dedicated bus stop and railway station for airport users. ・Development of new public transport

Problems	Causes	Issues
		system

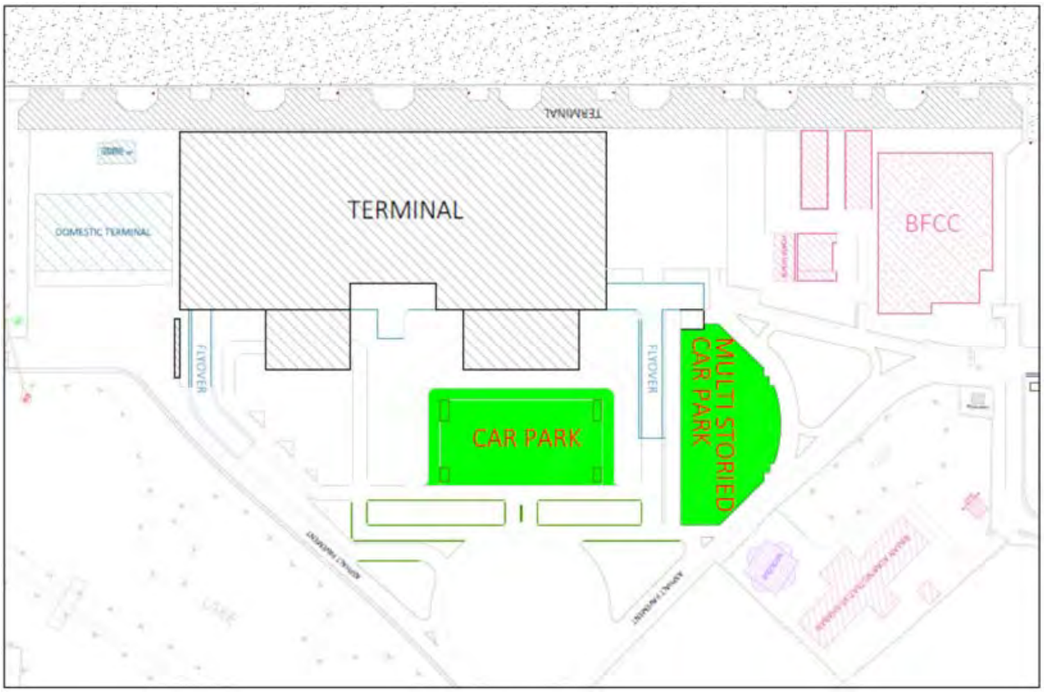
Source: JICA Study Team

The new T3 terminal at HSIA will be constructed 750 m south of the existing terminal. There are no railway stations nearby the new terminal location.

3.3.7 Car Parking

(1) Current Condition of Car Park

There is a car park in front of the passenger terminal, and a the multi-storied car park on the north side. The total number of parked cars is 1,000.



Source: JICA Study Team

Figure 3-33 Existing Car Park

(a) Car Park

(b) Multi-storied Car Park

Source: JICA Study Team

Figure 3-34 Existing Car Park

(2) Issues of Car Park

The space for car parking and for staging of taxis will also be facing severe shortage in the near future due to the increase in passenger volumes that will entail a corresponding increase in the numbers of taxis or cars using the airport. Also, more airport employees will be commuting by car and requiring staff car parking areas.

3.4 Aeronautical Ground Lighting

Runways 14/32 at HSIA are operated in CAT-I (precision approach runway category I). Aeronautical ground lighting (AGL) system is located based on the International Civil Aviation Organization (ICAO) Annex14. The runway lights, approach lighting system (ALS), and an improved AGL system for taxiways are being implemented. The format of the ALS for Runway 14 is ‘distance coded centreline’ type. The ALS for Runway 14 from Station No. 11 to No. 30 has been installed outside the airport. The existing AGL system is shown in Table 3-8.

Table 3-8 Existing AGL System

DESCRIPTION	QUANTITY	
CAT-I Precision Approach Lighting System for 14R Approach	1 lot	30 m x 30 stations
Simple Approach Lighting System for 32L Approach	1 lot	30 m x 14 stations
Runway Threshold and End Lights for 32L-14R Runway	50	
Precision Approach Path Indicator for 32L-14R Runway	8 units	14L-32R
Runway Centerline Lights	116	15 m interval
Runway Touch Down Lights for 14L Approach	240	4 units x 60 barrete
Runway Edge Lights	106	
Taxiway Centerline Lights	1 lot	
Rapid Exit Taxiway Indicator Lights	1 lot	
Taxiway Edge Lights	1 lot	
Taxiway Guidance Signs	1 lot	
Intermediate Holding Position Lights	1 lot	
Illuminated Wind Direction Indicators	2	
Aerodrome Beacon	1	
Apron Floodlighting	1 lot	
Obstacle Lights	1 lot	

Source: JICA Study Team

The AGL cable used is 6.6 A, medium voltage, 6 mm^2 single core and direct buried cable. Its power source is supplied from the improved new cargo control room (CCR). The electric power for the inset type AGL in the pavement is supplied through the underground wire which is installed by ‘saw cutting method’. Existing counterpoise wire for AGL system was installed on top of the AGL cable using a 16 mm^2 wire.

3.5 Utility Facilities

3.5.1 Power System

The power demand of HSIA is estimated at 8 MVA. It is supported by two intake power substations, called the CAAB DESCO Service Station in the north and ADA DESCO Service Station in the south.

From these DESCO service stations, CAAB’s main power plant service substation in the north and Euro Tech Bangladesh (ETB) service substation in the south are connected by the 11-kV power cables. From CAAB’s main power plant service substation and ETB service substation power supplied to other service substations via the 11-kV cable infrastructure.

The 11-kV cable is designed to connect emergency power generator of either CAAD DESCO Service Station or ADA DESCO Service Station. CAAB has placed a high priority on the reliability of their power infrastructure and has placed similar emphasis on the future power supply infrastructure (Figure 3.35).

Confidential due to security reasons.

Figure 3-35 Inside of the Existing Power House

3.5.2 Water Supply

Water in HSIA is supplied from three filtration plants operated by the Dhaka Water Supply and Sewerage Authority (WASA). The filtration plants draw water from 240 to 300 A tube wells 70 to 100 meters deep, which are all used within the airport. The present condition of the water supply system is shown in Figure 3-36.


Source: JICA Study Team

Figure 3-36 Existing Water Supply

3.5.3 Wastewater Treatment

The wastewater treatment plant (WWTP) is located north of the airport. It uses traditional activated sludge process to treat wastewater, but the WWTP is not working at present. CAAB is planning to construct a new WWTP to cater to the future wastewater treatment demand under the HSIA development project**.** The technology for the new WWTP will be based on a patented non-decanter WF-SBR (Figure 3-37). WF-SBF is an improvement of the traditional sequencing batch reactor (SBR) method that increases the efficiency of the wastewater treatment process.


Source: JICA Study Team

Figure 3-37 Existing Wastewater Treatment

3.6 Support Facilities

3.6.1 Maintenance Hangar

The maintenance hanger at HSIA is located between the two cargo terminal buildings. Although this land is part of the airport area, the hanger is maintained and operated by Biman Bangladesh Airlines. The capabilities of Biman Bangladesh Airlines have not yet been confirmed and a detailed study will be carried in the future, if necessary.

The Biman Bangladesh Airline's maintenance hanger is shown in Figure 3-38Figure 3-38.

Source: JICA Study Team

Figure 3-38 Existing Biman Bangladesh Airline's Maintenance Hangar

3.6.2 General Aviation

The general aviation area is located in the southeastern corner of the airport and comprises some small hangars and aircraft parking. However, the area is within the new third passenger terminal site and should be considered for relocation (Figure 3-39).

Source: JICA Study Team

Figure 3-39 Existing General Aviation Hangar

3.6.3 Firefighting Facilities

The fire station is ideally located close to the centre of the runway with the shortest possible distance to both runway ends.

Table 3-9 and Figure 3-40 show the characteristics and conditions of the existing vehicles and equipment, respectively.

Table 3-9 Facilities in Existing Fire Station

Confidential due to security reasons.

Confidential due to security reasons.

Figure 3-40 Existing Fire Station

Two Japanese firefighting vehicles (FFVs) are to be introduced in February 2017 under the grant aid project initiated two years ago and will improve the ranking from the current category VII to IX. Some current vehicles are not operational, but the new vehicles combined with the present 4x4 vehicles will satisfy the required capacity at present. In the Aeronautical Information Publication (AIP), the fire and rescue service is categorized as CAT IX under the ICAO (Annex 14) classification for response and equipment in case of emergency situations, which satisfies the requirements for the Code E aircraft like the Boeing 747-400.

In future planning for relocation of the fire station, introducing new high-speed vehicles should be considered in order to shorten the arrival time from the current station location in central runway to the end of the runway. Also, in order to avoid temporary deterioration of firefighting capability due to vehicle maintenance and breakdown, it is necessary to add one more vehicle. It is also desirable to enhance the firefighting system to deal with emergency situations by introducing crushing cars and water supply cars.

3.6.4 Fuel Supply Facilities

The existing fuel supply facilities are located in the southeast of the airport; and operated by Padma Oil Co., Ltd. The Padma Oil Co., Ltd. is supplying fuel to existing passenger terminal by hydrant system.

Source：JICA Study Team

Figure 3-41 Current Exterior View of Fuel Depot

(1) Capacity and Current Issues of Existing Facilities

Outline of existing fuel supply facilities under operation is as follows;

- Owner : Bangladesh Petroleum Corporation（BPC）
- Facility Operator : Padma Oil Co., Ltd.
  Date of construction : Unknown (Since T1 was completed in 1980, the fuel supply facilities may have been constructed at the same time.)
- Annual fuel supply : 356,000 kl (Data for 2015 provided by Padma Oil Co., Ltd.)
- Daily average fuel supply : Approx. 1,000kl/day (Calculated from annual fuel supply)
- Transport to the airport depot : Fuel is transported by 9kl tank lorry
- Storage Tanks : 320kl/tank x 9 tanks (above ground) = Total 2,880 kl
- Capacity of hydrant pumps : Unknown
- Hydrant Pipelines : 14 inch. (Outer diameter 35cm) and 8 inch. (Outer diameter 20cm) 1 line each. The fuel supply capacity considering the pipelines (2 lines) diameter would be maximum 2,400 gpm (545kl/h).

1) Problems of the existing facilities

The facilities are antiquated and supply capacity is very small. The fuel supply for Terminal 1 and Terminal 2 appear to have already reached their maximum upper limit.

The total storage capacity is very small with only 2,880kl, equivalent to only a little over 2 days reserve, presenting issues with stable fuel supply. Presently, three storage tanks with 2,500kl capacity are under construction, which combined with present capacity would satisfy 7 days stock required by international standards for fuel supply for 2015 aircraft demand. However, this will still not be enough against storage capacity required for phase-1 volumes.

The hydrant pumps are also over-aged and delivery capacity is very limited. Even at present, current pumps seem insufficient to meet peak time demand.

Considering the above, additional tanks are required for fuel supply to the aircraft parked in T3 apron.

Confidential due to security reasons.

Figure 3-42 Photos of Current Condition of Existing Facilities

3.6.5 Air Traffic Control Tower

The ATC tower satisfies its functional requirements at the present location. However, after the planned expansion and modification of the airport, some qualifications are anticipated for control operations, such as visibility of the south side of Terminal 3 will be obstructed. CAAB plans to construct a new ATC tower nearby Terminal 3 under the Bangladesh Air Traffic Management Upgrade Project (BATMUP), a public-private partnership (PPP) project. At present, the date for commencement of operation at the new ATC tower has not been clarified. However, the operation is expected to start before Terminal 3 opens. The current ATC Tower is shown in Figure 3-43

Confidential due to security reasons.

Figure 3-43 Existing ATC Tower

3.6.6 Catering Facilities

The present Biman Bangladesh Airlines catering facility is located between the technical building and the import cargo area. The flight catering services are provided to Biman Bangladesh Airlines flights and some other airline companies. Existing catering facilities are shown in Figure 3-44.

Source: JICA Study Team

Figure 3-44 Existing Catering Facilities

3.7 CNS/ATM

Confidential due to security reasons.

Confidential due to security reasons.

Figure 3-45 Location of CNS/ATM Systems

3.7.1 Communication

Confidential due to security reasons.

Table 3-10 ATS Communication Systems

Confidential due to security reasons.

3.7.2 Navigation

(1) VOR/DME

The status of the VHF omnidirectional range (VOR)/ distance measuring equipment (DME) for instrument approach and departure in the HSIA terminal control area (TMA) is shown in Table 3-11.

Table 3-11 Status of VOR/DME

Item	No.	Description	Specification
VOR	1	Equipment Type	Doppler VOR
	2	Equipment System	Dual
	3	Frequency Range	108 to 118 MHz
	4	Output Power	100 w
	5	Antenna Type	-
	6	Manufacture	SELEX
	7	Install Year	2008
DME	1	Equipment System	Dual
	2	Frequency Range	960 to 1215 MHz
	3	Peak Power	1000 W
	4	Antenna Type	-
	5	Collocation	DVOR System
	6	Manufacture	SELEX Sistemi Integrati
	7	Install Year	2008

Source: JICA Study Team

(2) Instrument Landing System (ILS)

The status of the ILS for precision approach and departure to/from HSIA is shown in Table 3-12.

Table 3-12 Status of ILS

Item	No.	Description	Specification
Instrument landing system localizer (LLZ) (RWY 14)	1	Equipment Type	Two Frequency
	2	Equipment System	Dual
	3	Frequency Range	108 to 112 MHz
	4	Output Power	25 W
	5	Antenna Type	Capture effect method (M Type)
	6	Manufacture	THALES ATM
	7	Install Year	2012
Glide Path (GP) (RWY 14)	1	Equipment Type	Two Frequency
	2	Equipment System	Dual
	3	Frequency Range	328 to 336 MHz
	4	Output Power	5 W
	5	GP Angle	2 to 4 degrees
	6	Antenna Type	Two Frequency
	7	Manufacture	THALES ATM
	8	Install Year	2012
DME (RWY 14)	1	Equipment System	Dual
	2	Frequency Range	960 to 1215 MHz
	3	Peak Power	10 kW
	4	Antenna Type	FAN-88, directional antenna
	5	GP Angle	
	6	Manufacture	THALES ATM
	7	Install Year	2012
Middle Marker (MM) (RWY 14)	1	Peak Power	Replaced by L-DME
	2	Frequency Range	
	3	Antenna Type	
	4	Manufacture	
	5	Install Year	
Inner Marker (IM) (RWY 14)	1	Peak Power	Replaced by L-DME
	2	Frequency Range	
	3	Antenna Type	
	4	Manufacture	
	5	Install Year	
LLZ (RWY 32)	1	Equipment Type	Two Frequency
	2	Equipment System	Dual
	3	Frequency Range	108 to 112 MHz
	4	Output Power	25 W
	5	Antenna Type	Capture effect method (M Type)
	6	Manufacture	THALES ATM
	7	Install Year	2014
GP (RWY 32)	1	Equipment Type	Two Frequency
	2	Equipment System	Dual
	3	Frequency Range	328.6 to 335.4 MHz
	4	Output Power	5 W
	5	GP Angle	2 to 4 degrees
	6	Antenna Type	Capture effect method (M Type)
	7	Manufacture	THALES ATM
	8	Install Year	2014
DME (RWY 32)	1	Equipment System	Dual
	2	Frequency Range	960 to 1215 MHz
	3	Peak Power	100 W
	4	Antenna Type	FAN-88, directional antenna
	5	Collocation	With GP
	6	Manufacture	THALES ATM
	7	Install Year	2014

Source: JICA Study Team

3.7.3 Surveillance

The primary surveillance radar (PSR)/secondary surveillance radar (SSR) was installed at HSIA for radar surveillance for ATC services such as departure and approach control at the Dhaka Terminal Control area. The radar data are transmitted to the visual flight rules (VFR) room and instrumental flight rules (IFR) room in the control tower. The status of PSR/SSR is shown in Table 3-13.

Table 3-13 Status of PSR/SSR

Confidential due to security reasons.

3.7.4 Meteorological Observation System

The following weather conditions are observed, recorded, and reported at the observation field:

- Wind speed and direction,
- Temperature,
- Dew point temperature,
- Humidity,
- Atmospheric pressure,
- Height of cloud, and
- Visibility.

The automatic weather observation system (AWOS) manufactured by VAISALA was installed in 2008. This system consists of weather data collecting equipment, runway field sensors such as wind speed and wind direction, temperature, pressure, runway visual range (RVR), ceilometer, and relevant indicators.

The status of the Meteorological Observation System is shown in Table 3-14.

Table 3-14 Status of Meteorological Observation System

Item	No.		Description	Specification
AWOS	1		Wind Vane	
		1	Range	0 to 75 m/s
		2	Distance Constant	2 m
		3	Threshold	0.1 m/s
		4	Resolution	.01 degree
		5	Time Averaging	Max. 3,600 s average
	2		Anemometer	
		1	Range	0 to 360 degrees
		2	Resolution	.01 degrees
		3	Time Averaging	
		4	Update	
	3		Ceilometer	
		1	Measurement Range	0 to 7.6 km
		2	Reporting Resolution	5 m/10 ft
		3	Reporting Cycle	programmable, 2...120 s
	4		Temperature	
		1	Display Range	
		2	Minimum Scale Space	
	5		Humidity	
		1	Recording Range	0 to 100%
		2	Minimum Scale Space	1%
	6		Pressure	
		1	Display Range	500-1100 hpa
		2	Recording Range	
		3	Minimum Scale Space	0.1 hpa
	7		Visibility Sensor	
		1	Measurement Range	5 ... 75 000 m with 1, 3, and 10-minute averaging +10% range 5 ... 10 000 m
		2	Accuracy	±20% range 10 000 ... 75 000 m
	8		Manufacture	VAISALA
	9		Installation Year	2008

Source: JICA Study Team

3.7.5 Airspace and Flight Route

(1) Airspace

Dhaka FIR is surrounded by Kolkata FIR, Gauhati FIR, and Yangon FIR. Air traffic service (ATS) for the southern part of Dhaka FIR from FL280 to FL460 has been delegated to Kolkata area control center (ACC)/flight information center (FIC).

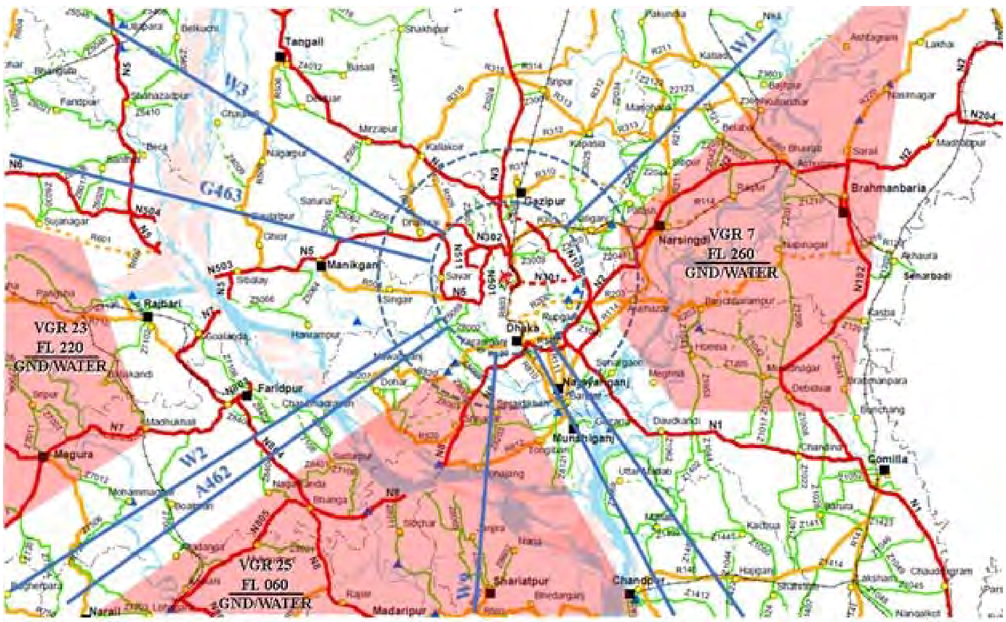
Other types of airspaces are shown in Table Table 3-15

Table 3-15 Characteristics of Airspace around HSIA

Type of Airspace	Description
Terminal Control Area (TMA)	Dhaka TMA is the airspace within the circle of 50 NM radius centered on Dhaka VOR excluding the area which falls within Indian territory and north of the straight line joining points 241145N 0910930E and 241145N 0893530E. The lower limit altitude is FL055 and the higher limit altitude is FL460.
Dhaka Approach Control Area (ACA)	To extend jurisdiction of approach control service within ACA has been established at and around HSIA. The area of lateral limits is same with Dhaka TMA. The lower limit is FL055 and the higher limit is FL155.
Aerodrome Traffic Zone (ATZ)	At HSIA, ATZ is established to handle the traffic in the vicinity of the airport. The lower limit of the airspace is ground, while the higher limit is FL040. The lateral limits are oval shaped area joining outer tangents of 5NM radius circles centered at the runway center and both ends of the runway.

Source: JICA Study Team

The HSIA is surrounded by five restricted areas and one prohibited area. Almost all international ATS routes are located in corridors that are formed by numerous large restricted areas as shown in Figure 3-46, while many domestic ATS routes move across the restricted areas. According to current AIP, civil aircraft can fly in restricted area located in TMA and controlled traffic region (CTR), if they have coordinated with the military.



Source: JICA Study Team

Figure 3-46 Prohibited and Restricted Areas Around HSIA

(2) Flight Route

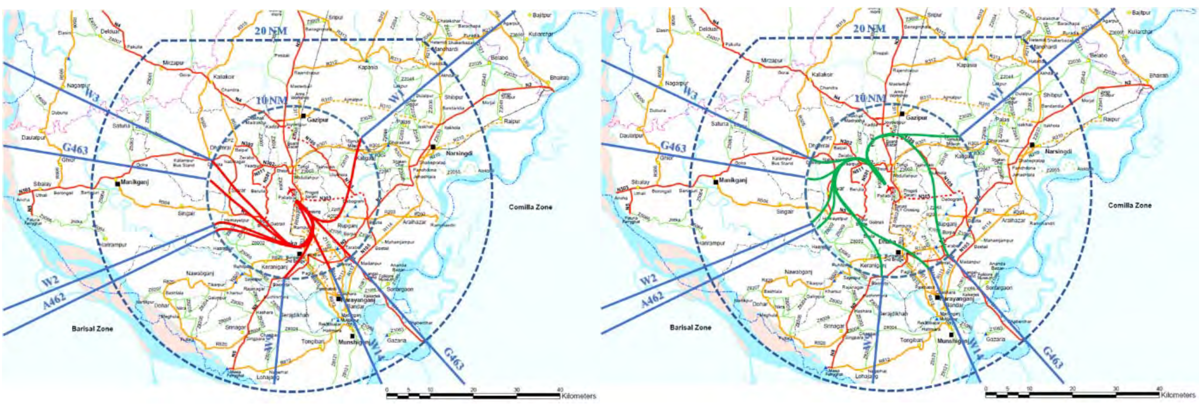
The currently established and published instrument approach procedures are listed in Table 3-16Table 3-16.

Table 3-16 Instrument Approach Procedures in HSIA

Runway	Navigational Aids	Procedure Name
14	NDB	NDB RWY 14
14	NDB/ILS	NDB/ILS RWY 14
14	VOR	VOR RWY 14
14	VOR/DME	VOR/DME RWY 14
14	VOR/DME, ILS	VOR DME ILS RWY 14
14	DA Locator	DA Locator RWY 14
14	DA/ILS	DA/ILS RWY 14
14	VOR/DME, ILS	VOR DME-ARC ILS RWY 14
14	-	RNAV (GNSS) RWY 14
32	VOR	VOR RWY 32
32	VOR/DME	VOR/DME RWY (1) 32
32	VOR/DME	VOR/DME RWY (2) 32
32	VOR/DME	VOR/DME-ARC RWY 32
32	VOR/DME, ILS	VOR/DME/ILS (1) RWY 32
32	VOR/DME, ILS	VOR/DME/ILS (2) RWY 32
32	VOR/DME, ILS	VOR/DME-ARC/ILS RWY 32

Source: JICA Study Team

There are 23 flight routes of the standard instrument departures (SIDs) which consist of 15 SIDs for RWY 14 and eight SIDs for RWY 32 in HSIA. All departure flights are directed by ATC to individual ATS routes according to submitted flight plan after passing 1,000 ft, 1,500 ft ,or 2,000ft as shown in Figure 3-47



Source: JICA Study Team

Figure 3-47 SIDs wPattern of RWY 14 and RWY 32

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CHAPTER 4　STUDY OF NATURAL CONDITIONS

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Chapter 4 STUDY OF NATURAL CONDITIONS

4.1 Summary of Natural Conditions (Wind, Rainfall, and Temperature)

4.1.1 Geography

About 90% of Bangladesh lies on low flat alluvial plains reaching to the Bay of Bengal built up by silt from floods originating in the Himalayas. The area is a delta formed by the three great rivers of Ganges, Jamuna, and Mehguna. The delta is affected by recurring floods and approximately one-thirds of the country is flooded by over one meter of water during the rainy season.

4.2 Climate

Bangladesh belongs to the tropical monsoon climate zone. The seasons are divided into the minor rainy season from the end of March to May, the major rainy season from June to the beginning of October and the dry season from mid October to the end of March. Seventy percent of rain is concentrated in the rainy season. There is a large difference in rainfall between regions, with western areas receiving 1,500 mm per annum while South Chittagong and Sylhet to the southeast receive 3,000 mm. In general, rainfall increases when moving further east and closer to the Bay of Bengal. During the minor rainy season, strong north-westerly winds cause squalls accompanied by tornados and thunderstorms. At the change between the dry and rainy seasons in April-May and October-November, cyclones occur which assault the coastal regions once every two years on average causing heavy damage.

The average monthly high and low temperatures, rainfall and wind speed for the past five years in the Dhaka Region, where HSIA is located is shown in Table 4-1.

Table 4-1 Climate Data for Dhaka Region

Year	Average for the Years 2011-2015											
Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Highest Temperature (℃)	22.4	25.6	30.0	31.7	32.1	32.1	31.3	31.0	31.3	30.5	27.0	23.6
Lowest Temperature (℃)	13.1	18.3	23.2	24.0	25.0	26.3	26.5	26.6	26.6	24.6	21.5	14.7
Rainfall (mm)	3	8	19	134	216	306	344	338	186	76	14	2
Wind Speed (km/hr)	3.8	4.3	4.6	4.6	4.9	4.6	4.4	3.9	3.5	3.1	2.8	2.8

Source: JICA Study Team

4.3 Natural Condition Survey Conducted by CAAB

4.3.1 Review of Past Natural Condition Survey

The CAAB has already carried out much of the planning, study, and design regarding the HSIA expansion project, and the topographic survey for the airport site and the surrounding area were also performed under these works. The topographic survey was performed by the joint venture (JV) among Yooshin, CPG, and DDC, who were the consultants for CAAB for the past works on the HSIA expansion project. Especially, Yooshin was in-charge of the topographic survey among the JV members according to the information acquired by the JICA Study Team. The report of the topographic survey was submitted to CAAB in June 2015.

The outline of the topographic survey conducted by CAAB is shown in Table 4-2. The conditions of the benchmarks installed at the site are shown in Figure 4-1.

Table 4-2 Outline of the Past Topographic Survey (June 2015)

Survey	Quantity	Outline
Control Point Survey	40 points	✈ Establishment of temporary benchmark using reinforced concrete column (RCC) pillars at around 1 km interval. ✈ Coordinates were referred to four control points provided by the Survey of Bangladesh (SOB). ✈ Coordinates of temporary benchmarks were controlled by the global navigation satellite system (GNSS) static method and the differential leveling method.
Topographic Survey	Around 800 ha	✈ Coordinates measurement at 10 m grid. ✈ Cross sections were taken at 20 m interval, centered on the centerline of the proposed new runway. ✈ Existing physical features were shown in the topographic map based on the survey of existing facilities and structures

Source: JICA Study Team

Control Point administrated by SOB

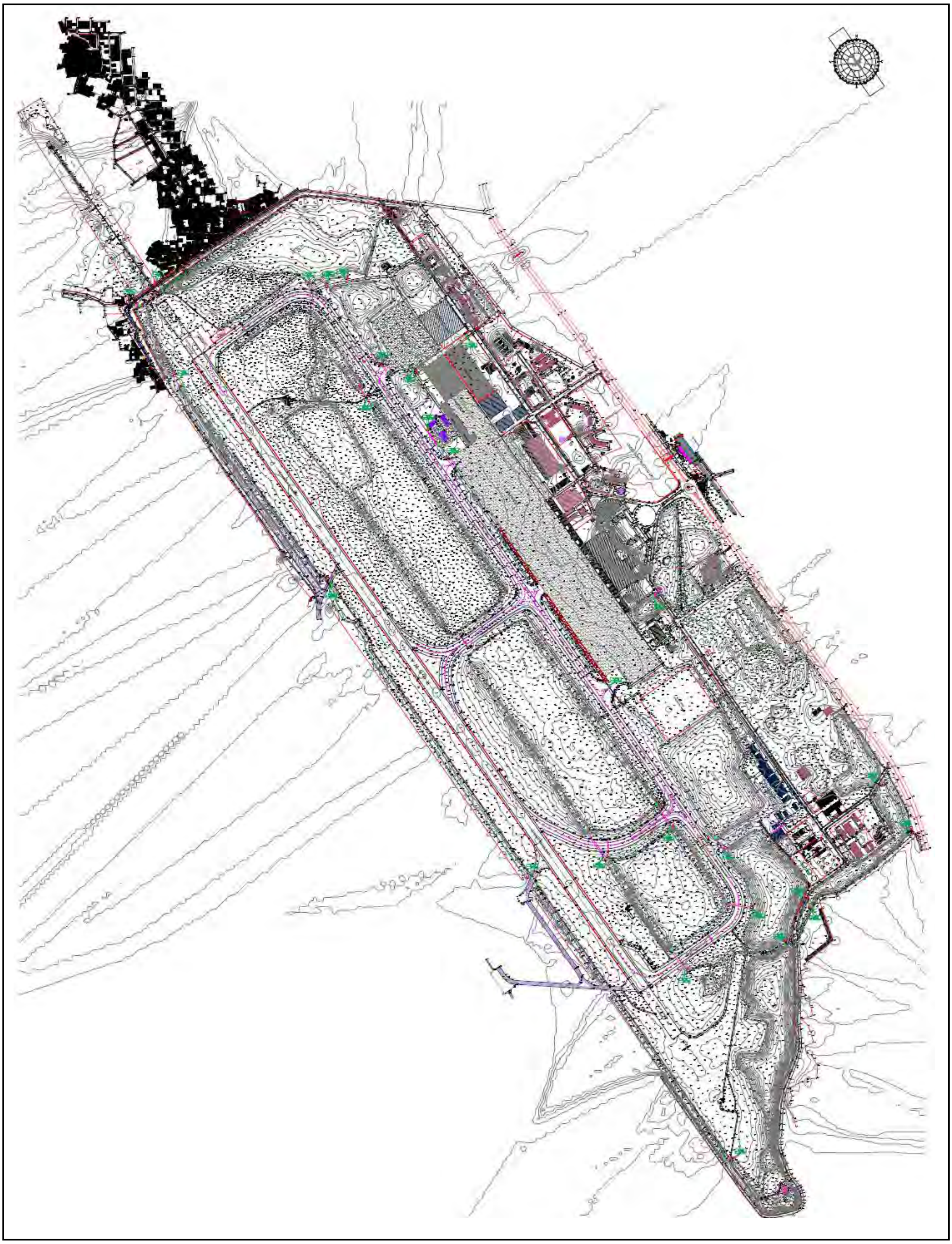
Temporary Benchmark (Damaged)

Source: JICA Study Team

Figure 4-1 Condition of Benchmark at the Site

Based on the result of the confirmation of this CAAB's report, the topographic map shown in Figure 4.2 was prepared. The map is sufficient in providing the necessary data for the future works for the HSIA expansion project. However, the topographic data used the Universal Transverse Mercator

(UTM) coordinate system; The airport coordinate system, which is normally used for the development and management of airport facilities, has never been established for HSIA.

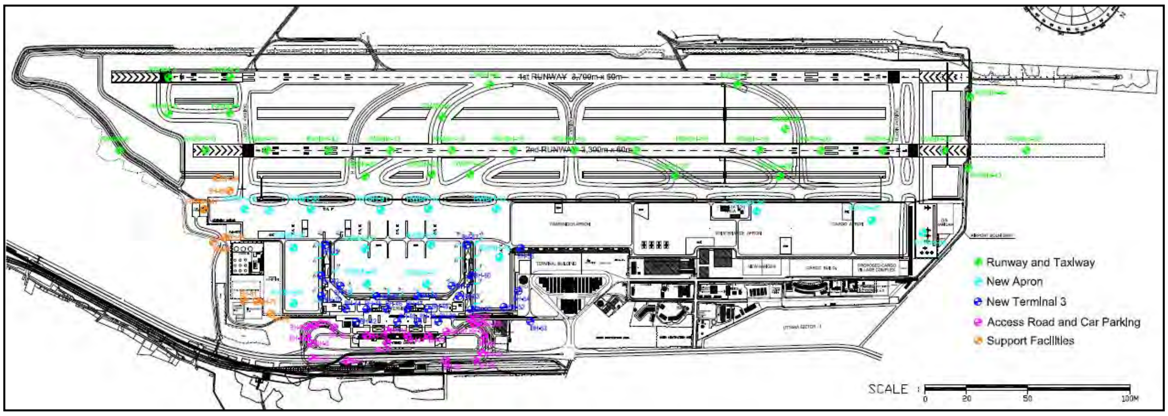


Source: CAAB

Figure 4-2 Topographic Map

4.3.2 Geotechnical Survey

Many geotechnical surveys, as shown in Table 4-3 and Figure 4-3, were carried out in the previous investigations for the existing runway, new runway, taxiway, new apron, multi-storied car park, and Terminal 3 areas.



Source: CAAB

Figure 4-3 Locations of the Past Geotechnical Survey

Table 4-3 Previous Geotechnical Investigations

		Existing, R/W, New R/W and T/W	New Apron	Multi-storied Car Park	New T-3
Borehole		30 Points	16 Points	20 Points	23 Points
Site Works	Boring	√	√	√	√
	Standard Penetration Test（SPT）	√	√	√	√
	Undisturbed Sampling	√	√	√	√
	Test Pit Sampling	√	√		
Laboratory Tests	Particle Size Analysis by Sieve and Hydrometer	√	√	√	
	Atterberg Limits	√	√	√	√
	Specific Gravity	√	√	√	√
	Natural Water Content	√	√	√	√
	Unit Weight Test	√	√	√	√
	Direct Shear Test	√	√	√	√
	Unconfined Compression Test	√	√	√	√
	Consolidation Test	√	√	√	√
	Compaction Test	√	√		
	Soaked CBR Test	√	√		

Source: JICA Study Team

However, the soil data analysis for the design has not been conducted satisfactorily so far. Many problems or insufficiencies were found in the previous geotechnical investigation reports.

In order to resolve the above insufficiencies and perform a more accurate design, the review of previous geotechnical investigation reports was conducted and additional geotechnical investigations were carried out during the Data Collection Survey of JICA in Phase-1 areas for Terminal 3, multi-storied car park, new apron, and connecting taxiway for Runway 14 threshold.

4.4 Implementation of Natural Condition Survey

4.4.1 Topographic Survey

(1) Control Survey

A control survey on four points was carried out in order to determine the conversion formula for the preparation of the airport coordinate system from the original coordinate data. Two points are on the runway centreline at each end of the runway, whose coordinates are shown in AIP Bangladesh. The other two points are set on a line parallel to the runway centreline on the parallel taxiway centreline. However, since the existing parallel taxiway is not exactly parallel with the runway, this line does not correspond exactly with the taxiway centreline. The locations of the points for the control survey are shown in Figure 4-4.

Source: Google Earth modified by the JICA Study Team

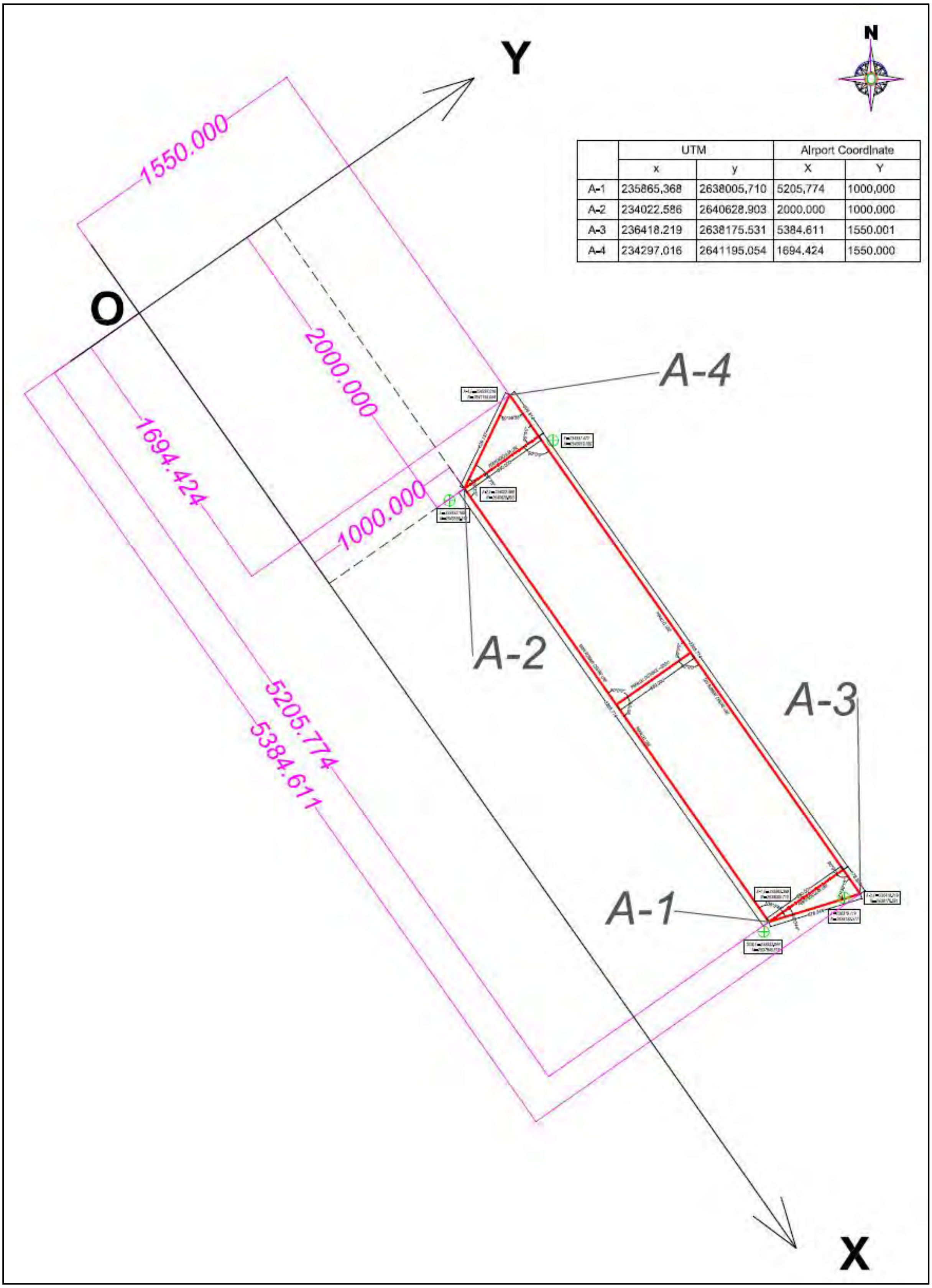
Figure 4-4 Location of Four Points for Control Survey

Based on the UTM coordinates acquired by the control survey, coordinates of each point are determined at the HSIA airport from geometrical relationship as shown in Table 4-4. The new coordinate system formulated from the results of the control survey is shown in Figure 4-5.

Table 4-4 Airport Coordinate of Control Survey Points

	UTM Coordinates		HSIA Airport Coordinates	
ID	**x**	**y**	**X**	**Y**
A-1	235865.368	2638005.710	5205.774	1000.000
A-2	234022.586	2640628.903	2000.000	1000.000
A-3	236418.219	2638175.531	5384.611	1550.001
A-4	234297.016	2641195.054	1694.424	1550.000

Source: JICA Study Team



	UTM		Airport Coordinate	
	x	y	X	Y
A-1	235865.368	2638005.710	5205.774	1000.000
A-2	234022.586	2640628.903	2000.000	1000.000
A-3	236418.219	2638175.531	5384.611	1550.001
A-4	234297.016	2641195.054	1694.424	1550.000

Source: JICA Study Team

Figure 4-5 New Airport Coordinate System Based on the Result of the Control Survey

(2) Conversion Formula

Based on the result of the control survey, the relationship between the UTM coordinates and the airport coordinates was clarified, and the conversion formula using Helmert Transformation was created. The general formula for Helmert Transformation is shown as:

$$\begin{pmatrix} X \\ Y \end{pmatrix} = \begin{pmatrix} a & b \\ -b & a \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} c \\ d \end{pmatrix} \quad \ldots (1)$$

In this formula, (X, Y) are the coordinates after transformation, (x, y) are the coordinates before transformation, and a, b, c, and d are transformation parameters. In this study (X, Y) are the HSIA airport coordinates, and (x, y) are the UTM coordinates.

The transformation parameters for the airport coordinates can be determined by the least squares method when more than three samples of the UTM coordinates are available. In this study, the transformation parameters are determined from the coordinates shown in Table 4-4.

$$\left.\begin{aligned} a &= 0.574836 \\ b &= 0.818280 \\ c &= 2028248.968 \\ d &= -1708425.771 \end{aligned}\right\} \ldots(2)$$

Therefore, the conversion formula from the UTM coordinates to the airport coordinates in this study is as follows:

$$\begin{pmatrix} X \\ Y \end{pmatrix} = \begin{pmatrix} 0.574836 & 0.818280 \\ -0.818280 & 0.574836 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} 2028248.968 \\ -1708425.771 \end{pmatrix} \quad \ldots (3)$$

Furthermore, the scale factor “s” and rotation degree “κ” in this study are shown as follows:

$$\left.\begin{aligned} s &= \sqrt{a^2 + b^2} = 1.000 \\ \kappa &= \tan^{-1}\frac{-b}{a} = 0.95840\ [rad] \\ &= 54.912\ [\mathrm{deg}] \end{aligned}\right\} \ldots(4)$$

(3) Topographic Map Based on Airport Coordinate System

Based on the conversion formula mentioned in the (2) above, the existing UTM coordinates of the topographic map were converted. The topographic map based on the new airport coordinate system is shown in Annex 1-1 and Annex 1-2.

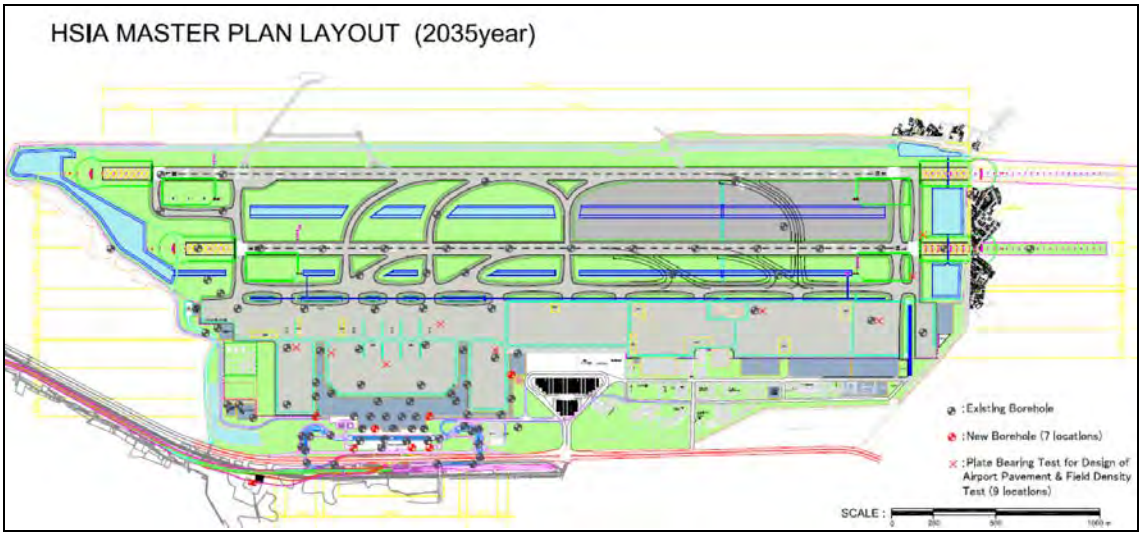
4.4.2 Geotechnical Investigation

(1) Outline of the Geotechnical Investigation

As mentioned in Section 4.2.2, the compilation and analysis of the past geotechnical investigation data were insufficient. Therefore, further data analysis was conducted in this study based on the classification of soil stratification. The data has been analysed for each location within the scope of phase-1 development, including the Terminal 3 area, the access road and car parking area, the new apron area, and the new taxiway area (the new southern rapid exit taxiway, the new northern rapid exit taxiway, and the new connection taxiway).

In addition, the results of the geotechnical investigation for points newly conducted in this study were also compiled in the same way.

The locations of the existing and new geotechnical surveys are shown in Figure 4-6.



Source: JICA Study Team

Figure 4-6 Location of Existing Survey and New Survey

(2) Soil Stratification

Soil stratification was reviewed and classified into eight layers, namely, clayey soil layer (C-1, C-2, C-3, and C-4) and sandy soil layer (S-1, S-2, S-3, and S-4), based on soil type and N-values as shown in Table 4-5.

Table 4-5 Soil Stratification

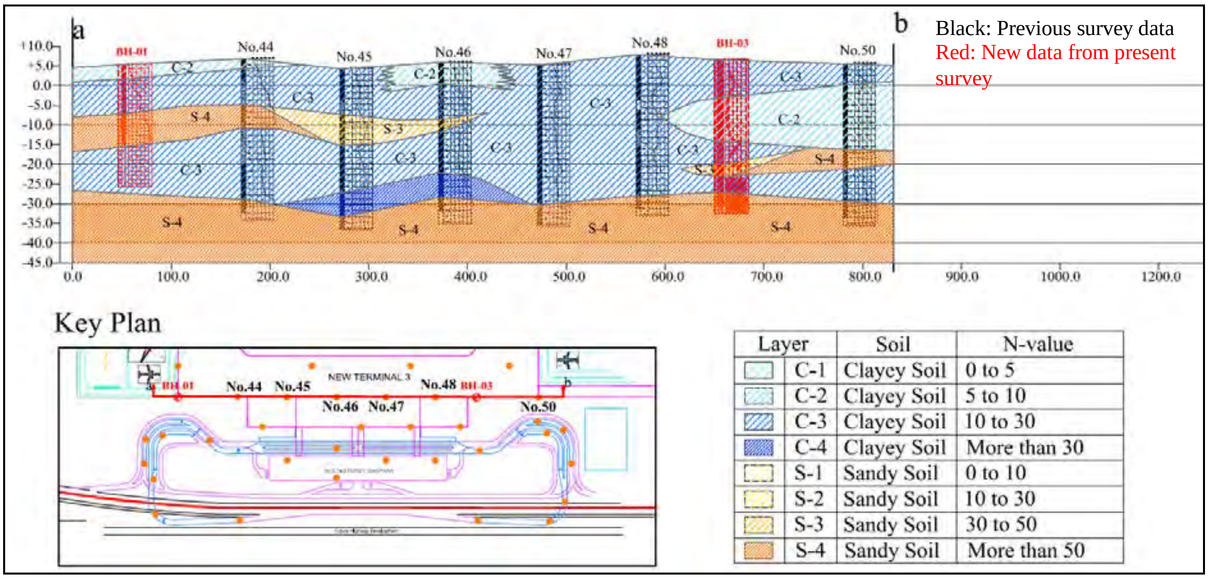
Layer	Soil	N-value	Relative Density or Consistency	Distribution
C-1	Clayey Soil	0～5	Very Soft to Soft	Very soft to soft clayey soil layer of the project area. C-1 layers are found in only a few locations in the project area. C-1 layer appears only near the ground surface level.
C-2		5～10	Medium Stiff	Medium stiff clayey soil layer distributed mainly at the shallow levels. C-2 layers are found mainly in airside boreholes rather than landside.
C-3		10～30	Stiff to Very Stiff	Stiff to very stiff clayey soil layer distributed widely from the surface to deeper levels. The soils in the present project area are mainly composed of C-3 layers.
C-4		Over 30	Hard	Hard clayey soil layer distributed mainly at deep levels around C-3 and S-4 layers.
S-1	Sandy Soil	0～10	Very Loose to Loose	Very loose to loose sandy soil layer. S-1 layers are found in only a few locations in the project area. S-1 layers appear only near the ground surface level.
S-2		10～30	Medium Dense	Medium dense sandy soil layer. S-2 layers are found in only a few locations in the project area. S-2 layer is not found at deeper levels.
S-3		30～50	Dense	Dense sandy soil layer distributed mainly at a depth of 0 ~ -30 m from the ground level.
S-4		Over 50	Very Dense	Very dense soil layer. S-4 is widely distributed at deeper levels with depth of around -30 m.

Source: JICA Study Team

(3) New Terminal 3

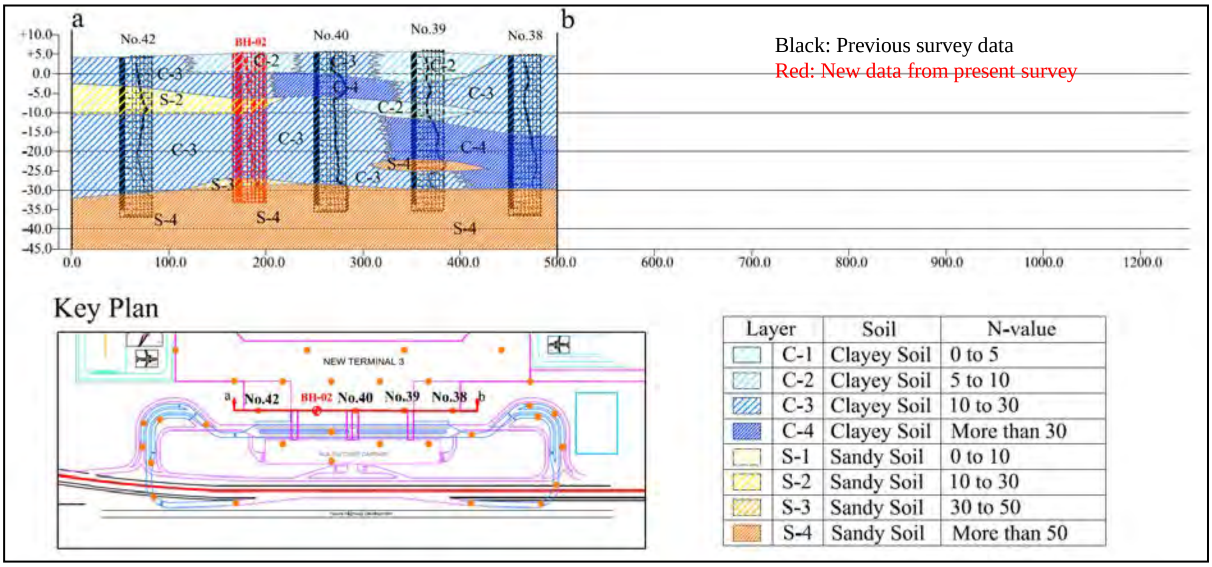
1) Soil Profile

The soil profile of Terminal 3 is shown in Figure 4-7 and Figure 4-8.



Source: JICA Study Team

Figure 4-7 Soil Profile (New Terminal 3) (1)



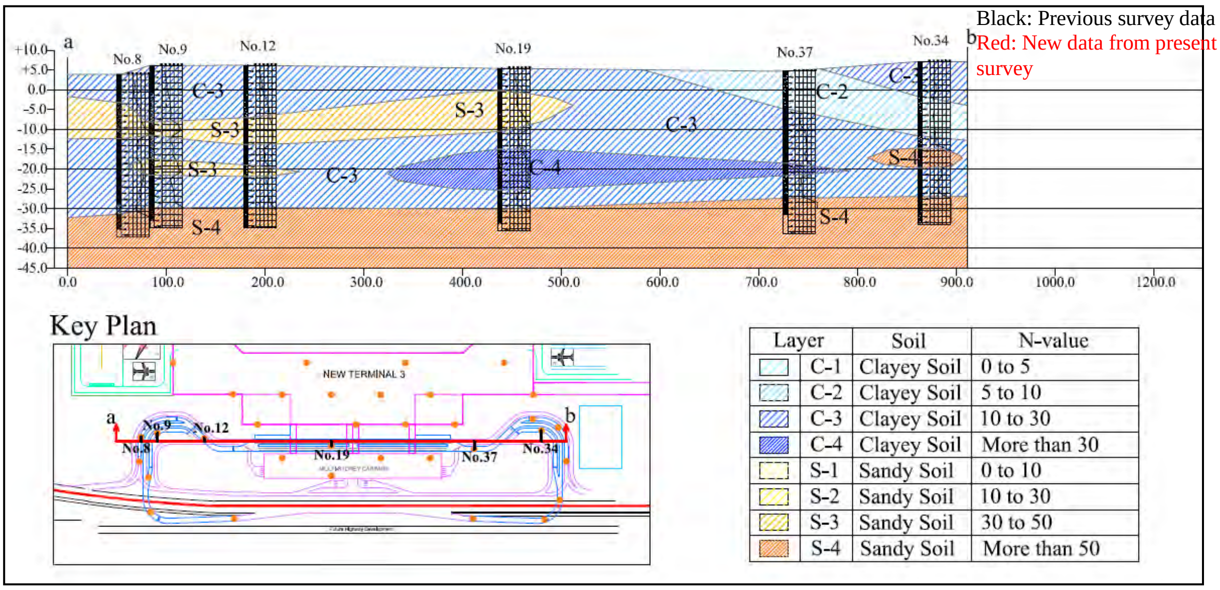
Source: JICA Study Team

Figure 4-8 Soil Profile (New Terminal 3) (2)

Terminal 3 is planned with pile foundations. In the pile foundations for this building, the support layer can be either the clayey soil layer with N-value over 30 or the sandy soil layer with N-value over 50. Therefore, either Layer C-4 or Layer S-4 is appropriate for the support layer. C-4 is intermittent under Terminal 3 while S-4 is uniformly distributed at a depth of approximately 30 m below ground level. In general, S-4 should be selected as the support layer for the pile foundations.

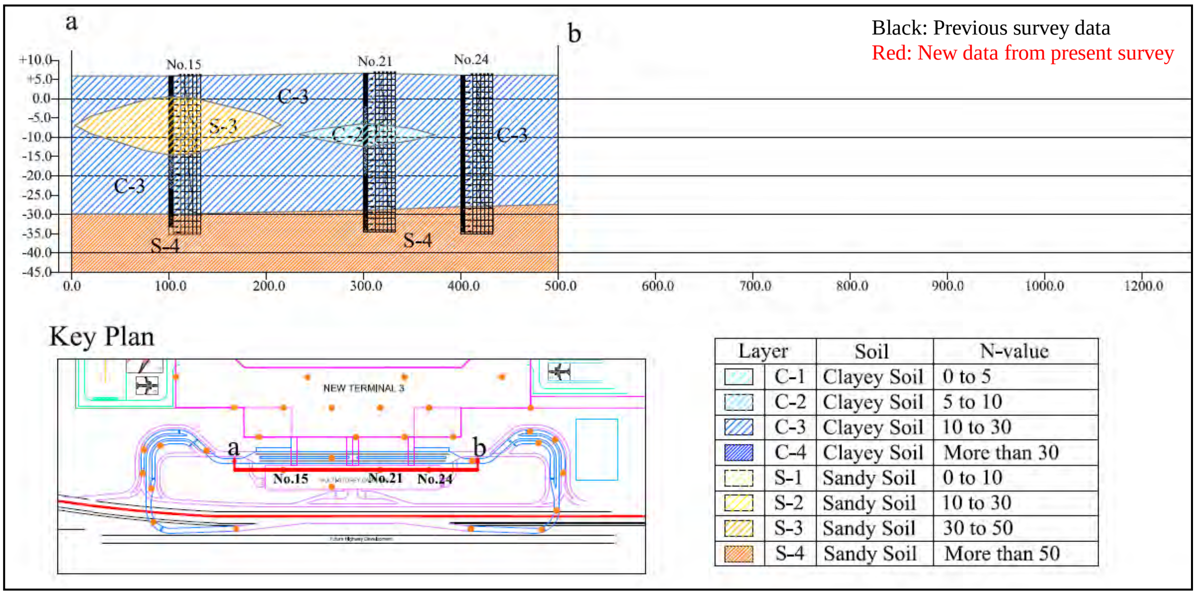
(4) Access Road and Car Parking Area

The soil profiles under the elevated access road and multi-storied car park are shown in Figure 4-9, Figure 4-10 and Figure 4-11, respectively.



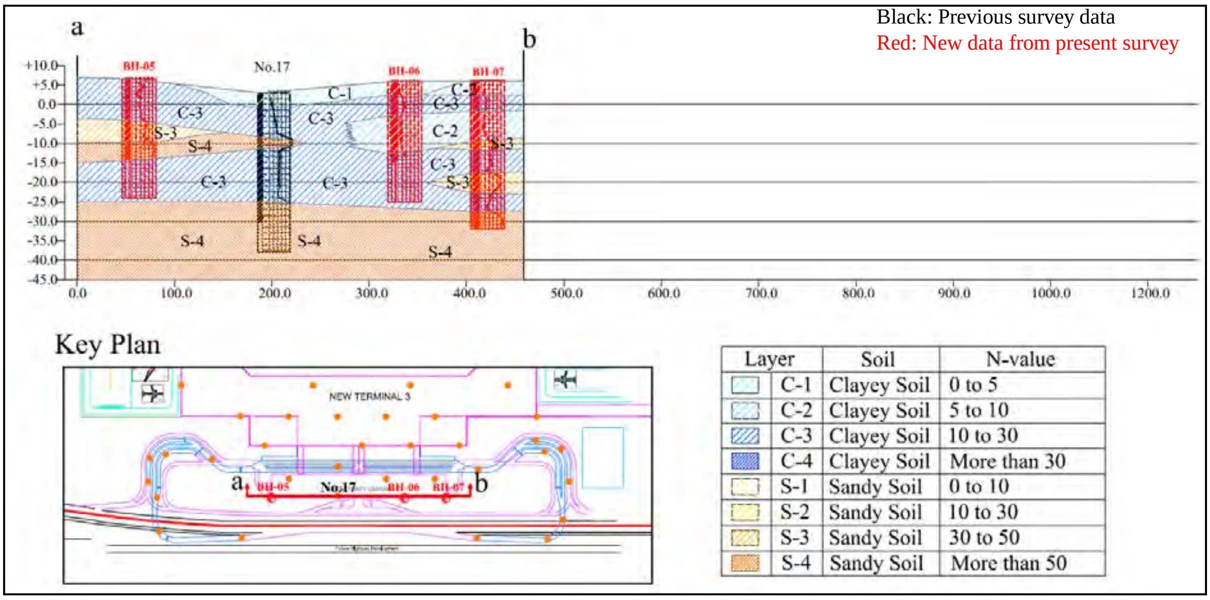
Source: JICA Study Team

Figure 4-9 Soil Profile (Elevated Access Road)



Source: JICA Study Team

Figure 4-10 Soil Profile (Multi-storied Car Park) (1)



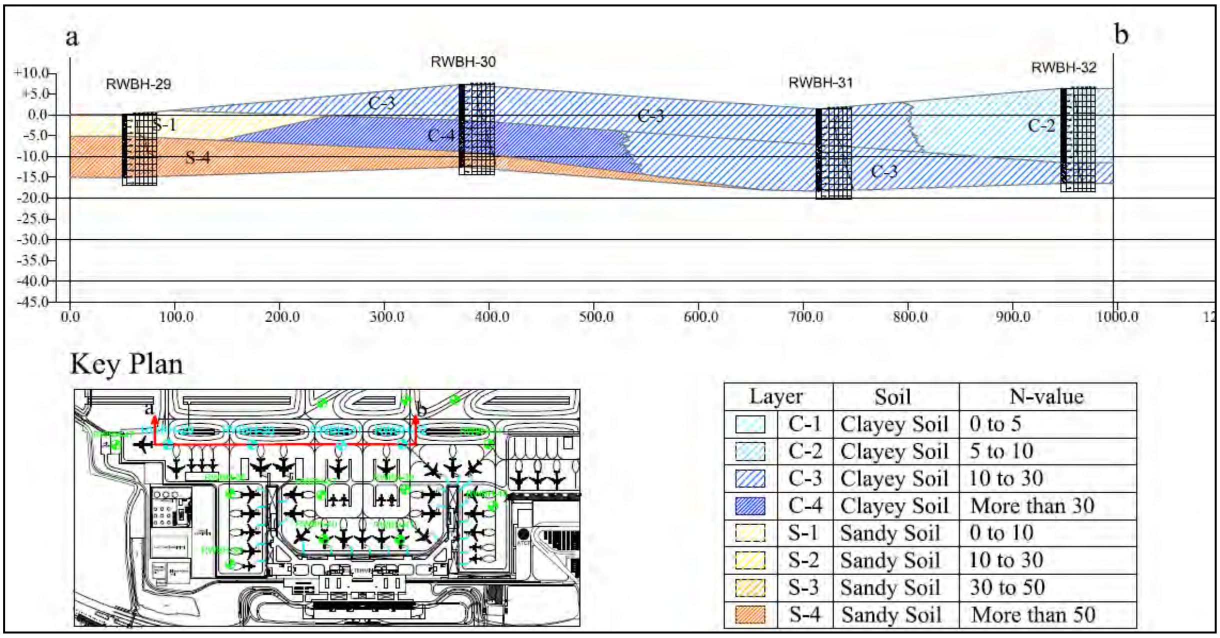
Source: JICA Study Team

Figure 4-11 Soil Profile (Multi-storied Car Park) (2)

Pile foundations are also planned for the elevated access road and multi-storied car park in this area. As with Terminal 3 area, C-4 and S-4 layers are appropriate as the support layer for the piles. Based on the distribution under each structure, S-4 layer should be selected as the support layer for the pile foundations.

(5) New Apron Area

The soil profile of the new apron is shown in Figure 4-12.



Layer	Soil	N-value
C-1	Clayey Soil	0 to 5
C-2	Clayey Soil	5 to 10
C-3	Clayey Soil	10 to 30
C-4	Clayey Soil	More than 30
S-1	Sandy Soil	0 to 10
S-2	Sandy Soil	10 to 30
S-3	Sandy Soil	30 to 50
S-4	Sandy Soil	More than 50

Source: JICA Study Team

Figure 4-12 Soil Profile (New Apron)

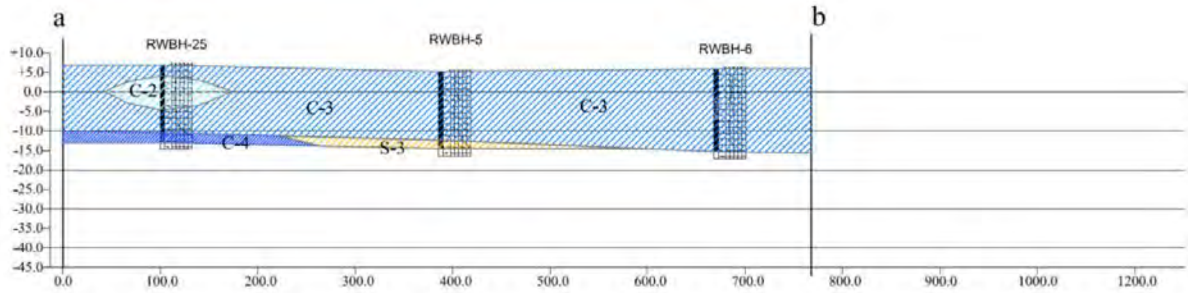
There are relatively large-scale C-2 layers at some locations of the new apron area. The analysis of settlement regarding the apron pavement structure is needed at these locations.

In the new apron area, S-1 layer is found (RWBH-29). Since loose sand layer may cause liquefaction during earthquakes, the analysis for liquefaction is needed at this area.

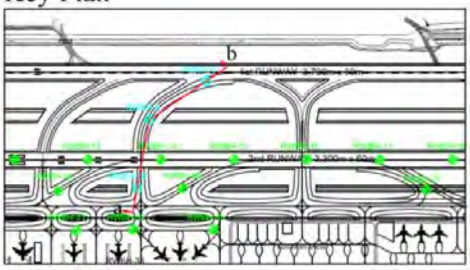
The results for K75 value in the plate bearing tests show large variations at each location. This is mainly caused by ground conditions such as current usage of land and construction methods in the past, which are different in each location because the tested locations have been used for some purpose for the current operation of the airport.

(6) New Southern Rapid Exit Taxiway

The soil profile for the new southern rapid exit taxiway is shown in Figure 4.13.



Key Plan



	Layer	Soil	N-value
	C-1	Clayey Soil	0 to 5
	C-2	Clayey Soil	5 to 10
	C-3	Clayey Soil	10 to 30
	C-4	Clayey Soil	More than 30
	S-1	Sandy Soil	0 to 10
	S-2	Sandy Soil	10 to 30
	S-3	Sandy Soil	30 to 50
	S-4	Sandy Soil	More than 50

Source: JICA Study Team

Figure 4-13 Soil Profile (Southern New Rapid Exit Taxiway)

The C-2 layers are found at some locations of the taxiway area like the new apron area. The analysis for settlement regarding pavement structure is needed at these locations.

As for connection taxiway, the detailed data of the geotechnical investigation done by BUET should be acquired and utilized for the pavement design, considering how to utilize these data for the design.

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Chapter 5 Aviation Traffic Forecast

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Chapter 5 AVIATION TRAFFIC FORECAST

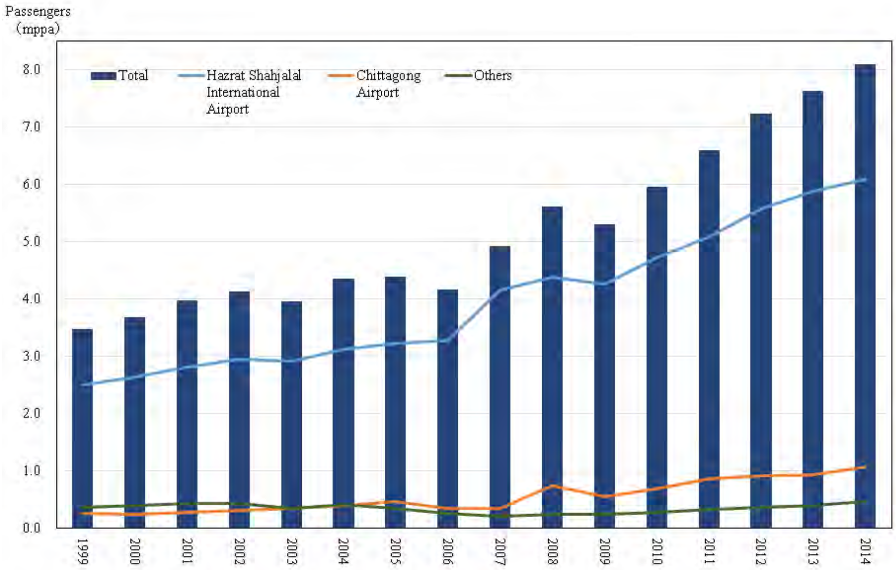
5.1 Aviation Demand in Bangladesh

HSIA handles approximately 75% of the total passenger demand and 90% of the total cargo demand in Bangladesh. Local airports such as Chittagong, Cox's Bazar, Jessore, and Sylhet handle the remaining demand. The passenger handling volume in 2014 at HSIA was approximately 6 million passengers per annum (mppa) and Chittagong Airport was second with approximately 1 mppa. The other airports handle much fewer passengers with annual passenger handling of less than 0.2 mppa each.

The annual average growth rate of the real GDP of Bangladesh has shown steady growth of 6% after 2004, achieving 6.85% in 2006. The rate in 2007-2008 decreased slightly and dropped to 5.3% in 2009 due to the financial crisis starting in September 2008. However, it recovered after 2010 and has maintained a growth rate of 6% or more.

The number of air passengers for Bangladesh as a whole and HSIA both increased in 2007 and 2008, but declined by approximately 300,000 passengers and 100,000 passengers, respectively, in 2009 due to the financial crisis. However, it has continued to grow by 6% after 2010 in step with economic growth.

Furthermore, although the annual average growth rate of passengers from 1999 to 2015 at HSIA was 6.17%, the growth rate after 2006 has increased to 7.88%, showing a prominent increase in demand in recent years.



Source: Statistical Year Book of Bangladesh 2014 and CAAB and JICA Study Team

Figure 5-1 Growth of Air Traffic Passenger Traffic in Bangladesh

In HSIA, the international passenger ratio was 77.2% in 1999, but the ratio has increased in recent years and international passenger has come to occupy approximately 90% of all passengers after 2011.

Domestic passenger numbers at HSIA have not seen major change from 1999 to 2009; while 0.7 mppa nationwide was recorded in 2007, it maintained approximately 0.6 mppa during this period, reducing to 0.52 mppa at its lowest in 2010. However, demand is now recovering after 2010 and the annual average growth rate from 2010 to 2015 was 5.84%.

5.2 Passenger Demand

The results of the passenger traffic forecast conducted by this study compared with the CAAB Master Plan forecast are shown in Table 5-1. The passenger numbers for high /low cases are derived by adjusting the GDP growth rate for base case by ±1.24% and forecasting the passenger demand numbers for each growth rate.

- The actual international passenger numbers for 2015 were approximately 5.6 mppa, but the CAAB Master Plan has assumed 6 million. Therefore, the CAAB forecast starts from a slightly inflated figure.
- The domestic passenger demand has previously trended from 10% to 15% of the international passengers, but the ratio has increased after 2010 and the domestic passenger numbers are expected to show further increase in the future. Based on the results of the forecast, the domestic passengers are expected to reach almost 5.2 mppa in 2035, approximately 20% of international passengers. This is a large revision of the CAAB Master Plan forecast.
- The combined demand for international and domestic passengers does show a large difference between the JICA Study Team and CAAB forecasts, but the differences can be explained by the following reasons:
- CAAB's forecast is based on aviation traffic demand data up to 2013, but the JICA Study Team was able to utilize data up to 2015.
- CAAB's forecast assumes GDP growth, which has a strong influence on aviation traffic demand, of 7% for 2015-2025, 6% for 2025-2030 and 5% for 2030-2035. In contrast, the JICA Study Team has assumed slightly lower GDP growth of 6.67% for 2013-2021, 6% for 2021-2025, 5.5% for 2025-2030, and 5% for 2030-2035, based on the latest data/forecast by IMF published in April 2016.

Table 5-1 Comparison of Passenger Demand Forecast (Million Passengers)

Category	Year	JICA Study Team			CAAB Master Plan		
		High Case	Base Case	Low Case	High Case	Base Case	Low Case
International Passenger	2015	5.569	5.569	5.569	6.120	5.997	5.875
	2020	9.252	8.669	8.112	9.312	8.671	8.069
	2025	13.662	12.042	10.583	14.206	12.564	11.100
	2030	19.366	16.082	13.295	20.623	17.313	14.513
	2035	26.611	20.835	16.214	28.451	22.659	18.012
	CAGR (2015-2035)		6.82%			6.87%	
Domestic Passenger	2015	0.913	0.913	0.913	0.691	0.685	0.679
	2020	1,493	1.379	1.270	0.820	0.796	0.773
	2025	2.410	2.086	1.793	0.974	0.926	0.881
	2030	3.632	2.959	2.388	1.134	1.056	0.983
	2035	5.226	4.017	3.050	1.294	1.179	1.073
	CAGR (2015-2035)		7.69%			2.75%	
Total	2015	6.482	6.482	6.482	6.811	6.682	6.554
	2020	10.745	10.047	9.382	10.132	9.467	8.842
	2025	16.072	14.127	12.376	15.180	13.490	11.981
	2030	22.997	19.041	15.683	21.746	23.838	19.085
	2035	31.837	24.852	19.264	29.746	23.838	19.085
	CAGR (2015-2035)		6.95%			6.57%	

Source: JICA Study Team

Note: CAGR: Compound Average Growth Rate; the mathematical average for the indicated period

5.3 Cargo Demand

Based on the actual numbers for international cargo, the cargo demand has shown a steady increase and a stable demand for cargo services can be assumed. However, the domestic cargo demand is very small and unstable compared with international cargo demand, having less than 1% of the volume and exhibiting violent fluctuations in demand. The combined cargo volume of international and domestic cargo for 2015 was approximately 260 thousand tons.

The following observations are made based on the comparison with the CAAB forecast:

- As shown in Table 5-2, the volumes for international cargo for 2015 in the JICA Study Team's and CAAB's forecasts are almost the same, but the growth rate afterwards is greater in the JICA Study Team forecast.
- The actual domestic cargo volume for 2015 is recorded at 1,900 tons, substantially larger than the 760 tons forecast by the CAAB Master Plan.
- The difference between the JICA Study Team and CAAB's forecasts for cargo volumes is due to the following reasons:
- The CAAB Master Plan is based on cargo demand data up to 2013, but the JICA Study Team was able to utilize data up to 2015.
- The growth in cargo volumes after 2010 is large and since the JICA Survey Team utilized the available data up to 2015 to build its forecasting model, the regression formula with the growth rate higher than that of CAAB model was derived.

Table 5-2 Comparison of Cargo Demand Forecast (tons)

Category	Year	JICA Study Team			CAAB Master Plan		
		High Case	Base Case	Low Case	High Case	Base Case	Low Case
International Cargo	2015	258,010	258,010	258,010	261,000	257,000	254,000
	2020	449,790	418,152	387,953	350,000	333,000	317,000
	2025	689,105	601,172	522,012	472,000	433,000	396,000
	2030	998,588	820,411	669,181	615.000	543,000	479,000
	2035	1,391,731	1,078,310	827,570	773,000	662,000	479,000
	CAGR (2015-2035)		7.41%			4.84%	
Domestic Cargo	2015	1,888	1,888	1,888	770	760	750
	2020	3,732	3,447	3,174	950	900	860
	2025	7,231	6,257	5,380	1,170	1,070	980
	2030	12,710	10,357	8,359	1,380	1,220	1,070
	2035	20,902	16,068	12,201	1,550	1,360	1,120
	CAGR (2015-2035)		11.3%			2.95%	
Total	2015	259,898	259,898	259,898	261,770	257,760	254,750
	2020	453,523	421,599	391,127	350,950	333,900	317,860
	2025	696,336	607,429	527,392	473,170	434,070	396,980
	2030	1,011,299	830,768	677,539	616,380	544,220	480,070
	2035	1,412,633	1,094,378	839,771	774,550	663,360	559,120
	CAGR (2015-2035)		7.45%			4.84%	

Source: JICA Study Team

5.4 Aircraft Movement

The number of aircraft movement between 2011 and 2015 showed a marked increase from 56,000 to 57,000 movements annually in 2010 and 2011 to 73,000 movements annually for 2015.

The general aviation (GA) (sightseeing flights and training flights, aircraft owned by private companies and individuals) and military aircraft accounted for 5,000 to 7,000 movements annually with little variation. The records separately obtained from ATC for 2015 showing monthly movements of aircraft by category showed that GA and military aircraft movements are stable at around 200 and 430 movements per month, respectively.

The forecast for aircraft movements is calculated based on the passenger numbers forecast by the JICA Study Team and formulating an aircraft mix and the average numbers of passengers on each craft (load factor).

Based on this analysis, when the aircraft movements are determined using the aircraft mix and passenger forecast, movements reached approximately 17.1 million in 2030. The JICA Study Team forecast exceeds the CAAB forecast by approximately 10%. This was caused by assuming a lower number of passengers on each flight due to the small upsizing of the aircraft compared with the CAAB Master Plan.

Table 5-3 Comparison of Aircraft Movement Forecast (Including GA and Military Craft)

Year	JICA Study Team			CAAB Master Plan		
	High	Base	Low	High	Base	Low
2015	73,235	73,235	73,235	70,400	69,400	68,500
2020	118,556	110,830	103,455	94,400	89,600	85,300
2025	165,430	145,460	127,483	129,100	117,700	101,400
2030	206,196	171,130	141,367	172,000	150,000	131,300
2035	264,178	206,900	161,077	222,100	185,000	154,900

Source: JICA Study Team

In addition, the JICA Study Team conducted a forecast for freighter aircraft movements. Freighter aircrafts are not used for domestic cargo in Bangladesh and are carried as belly cargo on passenger flights (permissible cargo on passenger flights). Domestic cargo volume will continue to be extremely low compared with international cargo even in 2035, accounting for only 1.5% of total volume. Since domestic cargo will continue to be carried as belly cargo in the future, the aircraft movement forecast for cargo was based on international cargo volume using freighter. The forecast for the base case is shown in Table 5-4.

Table 5-4 Freighter Aircraft Movement Forecast

	2015	2020	2025	2030	2035
Freighter	1,248	2,023	2,908	3,969	5,216

Source: JICA Study Team

5.5 Peak Hour Traffic

Based on the statistical data of HSIA, the numbers of passengers and aircraft movements during peak hour in the traffic demand base case were calculated. The aircraft movement numbers are exclusive of GA and military aircraft.

Table 5-5 Passengers and Aircraft Movements during Peak Hour and Peak Day (Base Case)

			2015		2020		2025		2030		2035	
			Inter-national	Domestic	Inter-national	Domestic	Inter-national	Domestic	Inter-national	Domestic	Inter-national	Domestic
Passenger (mppa)		International/Domestic	5.569	0.913	8.669	1.379	12.042	2.086	16.082	2.959	20.835	4.017
		Total	6.482		10.047		14.127		19.041		24.852	
A/C Movement		International/Domestic	37,192	32,212	56,289	47,540	75,260	63,200	96,880	67,250	121,133	78,767
		Total	69,404		103,830		138,460		164,130		199,900	
Average Daily Flight			102	89	155	131	207	174	266	185	332	216
Passengers	Peak Day Ratio (Terminal Building)		1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300
	PAX at Peak Day	International/Domestic	18,563	3,043	28,895	4,596	40,138	6,952	53,607	9,863	69,450	13,390
		Total	21,607		33,491		47,091		63,470		82,840	
	Peak Hour Ratio		0.1225	0.138	0.1196	0.1145	0.1182	0.102	0.1173	0.0997	0.1166	0.0946
	PAX at Peak Hour	International/Domestic	2,273	402	3,456	526	4,744	709	6,285	984	8,098	1,267
		Total	2,694		3,982		5,453		7,269		9,365	
A/C Movement	Peak Day Ratio (Apron and Utilities)		1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330
	Peak Day Flight	International/Domestic	113	98	171	144	228	192	294	204	367	239
		Total	210		315		420		497		606	
	Peak Hour Ratio		0.1233	0.1305	0.1202	0.1099	0.1186	0.0985	0.1176	0.0964	0.1169	0.0917
	Peak Hour Flight	International/Domestic	14	13	21	16	28	19	35	20	43	22
		Total	27		37		47		55		65	
A/C Movement (Freighter)			1,248		2,023		2,908		3,969		5,216	
Peak Day Flight (Freighter)			4		6		9		12		16	

Source: JICA Study Team

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CHAPTER 6 REVIEW OF THE HSIA EXPANSION PROJECT IN CAAB MASTERPLAN

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Chapter 6 REVIEW OF THE HSIA EXPANSION PROJECT IN CAAB MASTERPLAN

6.1 General

In this chapter, information of the study, planning, and design works done by CAAB is organized. The results of the review of each item are described in Table 6-1.

Table 6-1 HSIA Expansion Project Made by CAAB

No	Title	Table of Contents	Date	Format	Remarks
1	MASTER PLAN AND FEASIBILITY STUDY	Executive Summary 1. Introduction 2. Overview of the Existing Airport 3. Aviation Demand Forecast 4. Conceptual Design 5. Land Use Plan 6. Environmental Screening 7. Economic Analysis	February 2015	PPT	“5. Phased Development Plan” and “9. Financial Analysis” are not in this version.
2	MASTER PLAN REPORT	Executive Summary 1. Introduction 2. Overview of the Existing Airport 3. Aviation Demand Forecast 4. Conceptual Design 5. Phased Development Plan 6. Land Use Plan 7. Environmental Screening 8. Economic Analysis 9. Financial Analysis	June 2015	PPT	The latest version of the Master Plan Report
3	FEASIBILITY STUDY REPORT	1. Economic Analysis 2. Financial Analysis	June, 2015	PPT	Chapter 8 and 9 of No. 2
4	BASIC DESIGN REPORT (TERMINAL and LANDSIDE)	01 Project Background and Brief Description 02 Chapter: I Terminal Planning and Design 03 Chapter: II Structural: Terminal Buildings 04 Chapter: III Structural: Elevated Drive Way (EDW) 05 Chapter: IV Plumbing 06 Chapter: V Heating and Ventilation and Air Conditioning System	No information	PDF Report	The design report of Terminal 3, EDW, new VVIP, new domestic terminal and other infrastructures.
5	BASIC DESIGN REPORT VOL. 1 Airside	Chapter I. Introduction Chapter II. Executive Summary of Master Plan and Feasibility Study Chapter III. Design of Civil Works Chapter IV. Design of NavAids and AGL System	June 2015	PPT	The civil works, navigational aids, and AGL system
6	TENDER DOCUMENT	Section - 1 Instruction to Tenderers (ITT) Section - 2 Tender Data Sheet (TDS) Section - 3 General Condition of Contract (GCC) Section - 4 Particular Conditions of Contract (PCC) Section - 5 Tender and Contract Forms Section - 6 Bill of Quantities Section - 7 1 General Items 2 Preliminaries 3 Earth and Pavement Works 4 Concrete and Reinforcement 5 Sealing 6 Marking 7 Airfield Ground Lighting System and Navigation Aid 8 Drainage and Protective Works 9 Civil Works 10 Plumbing and Sanitary Works 11 Electrical Works 12 Substation Equipment 13 Diesel Generator 14 Installation of Passenger Lifts 15 Fire Protection Works. 16 Air Conditioning System 17 Installation of Deep Tube Well 18 Gas Connection System 19 Communication and CCTV 20 Steel Truss 21 Wastewater Treatment Plant 22 Siphonic Drainage System 23 Cargo Terminal 24 Intake Power Station 25 Pump House and Out Station 26 Landscaping / Particular 26 Specification / Drawings	June 2015	Word PDF CAD	

Source: JICA Study Team

6.2 Master Plan and Feasibility Study

The CAAB conducted the "Master Plan and Feasibility Study, Construction of Second Runway and Other Infrastructure Development Works at Hazrat Shahjalal International Airport" for the Dhaka International Airport Expansion Project in February 2015. Thereafter, the study was updated in June 2015. In the updated study report, the phased development plan has been proposed. According to the phased development plan, the second runway will not be constructed under the phase-1 development (completion in 2019), but will be constructed under the phase-2 development. The completion year of phase-2 is not mentioned in the report.

The consultant who executed this study was the JV of Yooshin (Korea), CPG (Singapore), and DDC (Bangladesh).

6.2.1 Summary of Master Plan and Feasibility Study

The indexes of the reports for the master plan and feasibility study (February 2015 version and June 2015 version) are shown in Table 6-2 and Table 6-3, respectively.

Table 6-2 Contents of the Report (February 2015 Version)

Chapter	Contents
Master Plan and Feasibility Study	
1.	Introduction
2.	Overview of the Existing Airport
3.	Aviation Demand Forecast
4.	Conceptual Design
5.	Land Use Plan
6.	Environmental Screening
7.	Economic Analysis
Feasibility Study (Separate Volume)	
1.	Economic Analysis
2.	Financial Analysis

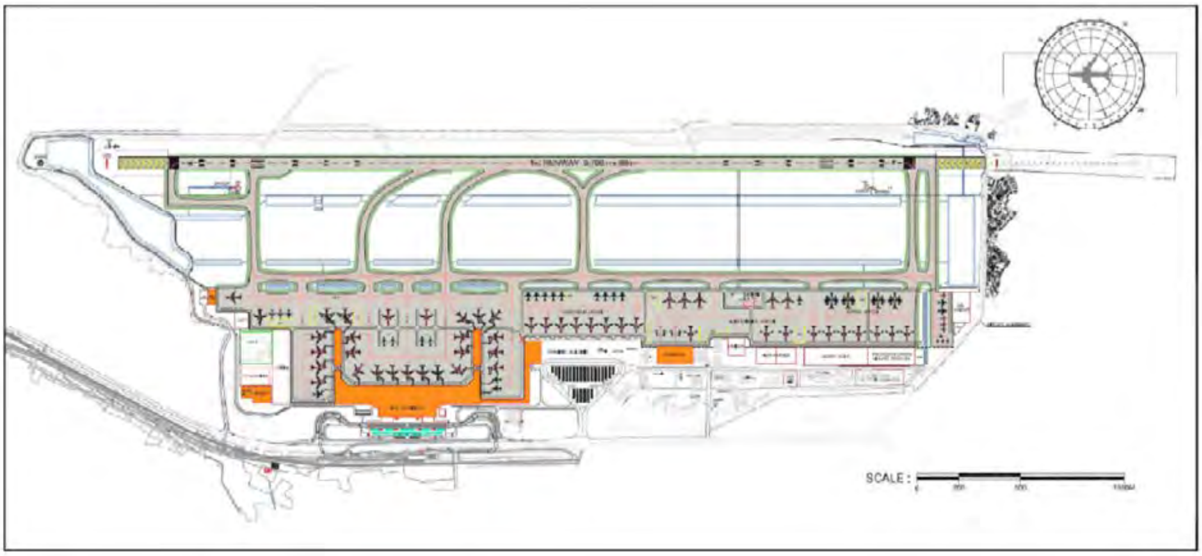
Source: CAAB

Table 6-3 Contents of the Report (June 2015 Version)

Chapter	Contents
1.	Introduction
2.	Overview of the Existing Airport
3.	Aviation Demand Forecast
4.	Conceptual Design
5.	Phased Development Plan
6.	Land Use Plan
7.	Environmental Screening
8.	Economic Analysis
9.	Financial Analysis

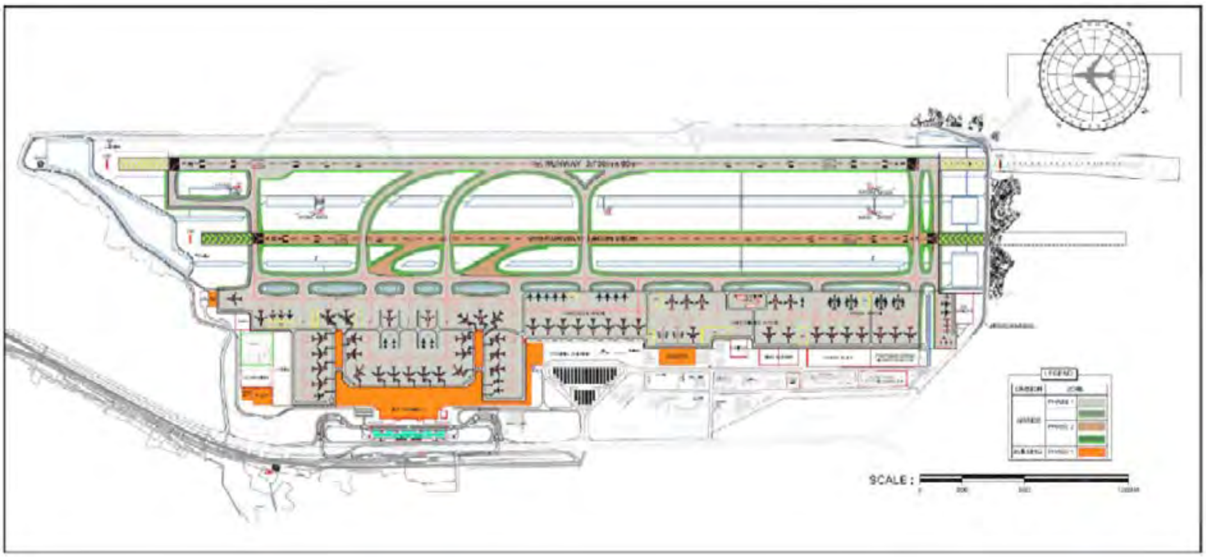
Source: CAAB

The scope of the expansion project based on the report (June 2015 version) is shown in Table 6-3, and the layout plans are shown in Figure 6-1 and Figure 6-2.



Source: CAAB

Figure 6-1 Master Plan Layout (Phase-1, Completion in 2019)



Source: CAAB

Figure 6-2 Master Plan Layout (Phase-2)

Table 6-4 Scope of the HSIA Expansion Project by CAAB

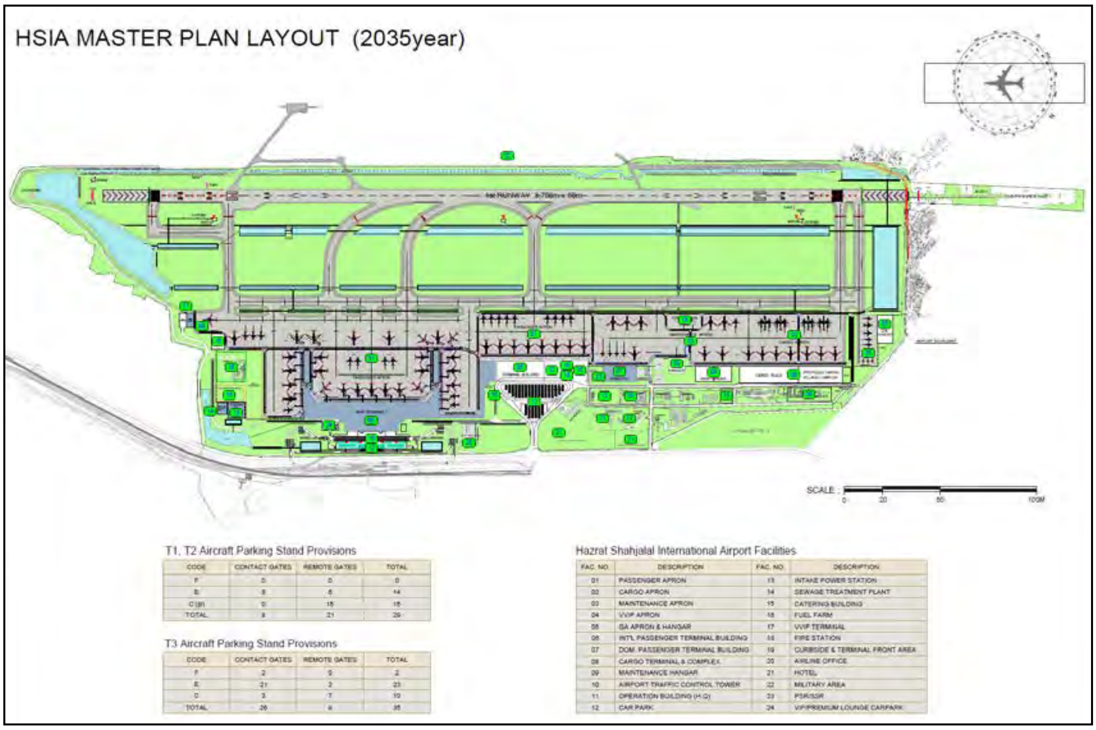
Facilities	Contents	Remarks
Existing Runway	Extension and Widening 3,200 x 46 m → 3,692 x 60 m	
New Runway	3,292 x 60 m	For dependent operation
New Taxiway	Rapid exit taxiways and other taxiways	
Access Road	New construction for new Terminal 3 Improvement for existing Terminal 1 and Terminal 2 and new domestic terminal	
Apron	Expansion and reconstruction area: around 1,000,000 m^2 Apron Spot: 29 → 64	
Terminal 3	Around 260,000 m^2	
New Domestic Terminal	Around 15,000 m^2	1.4 mppa
Existing Terminal 1 and Terminal 2	Following renovations: Check-in counter no.: 56 → 84 Gate no.: 15 → 20 Increase number of arrival immigration counter	
Navigation Aids	Upgrade of ILS from CAT-I to CAT-II New installation of AWOS Relocation of PSR/SSR	
Support Facilities	Relocation, expansion, and/or new construction of the following facilities: VVIP Complex, Rescue and firefighting services (RFFS), Sewage treatment plant, Intake power plant, PSR/SSR, ATC tower, Maintenance hangar, Catering building, Cargo complex, and GA apron and hangar	The locations of the support facilities are shown in Figure 6-3.

Source: CAAB

Source: CAAB

Figure 6-3 Support Facilities

While the second runway will be constructed by 2035 according to the report, the JICA Study Team has obtained the information from CAAB that the construction of the second runway was excluded entirely in this project. The JICA Study Team has received a separate master plan layout (Figure 6-4) concurring with this information, in which the second runway will not be constructed by 2035.



Source: CAAB

Figure 6-4 Future Master Plan Layout Without Construction of the Second Runway

6.2.2 Master Plan Report (June 2015 version)

(1) Introduction

The capital airport of HSIA is the air gateway to Bangladesh, but it is insufficient to handle the growing air traffic demand. In order to realize its role as the major international gateway airport, the development plan was formulated for the airport. This master plan describes the framework for the development of HSIA up to 2035. The master plan process commenced with a review of the existing facilities and the forecast of future traffic demand.

(2) Existing Facilities

The airport has a single runway (14/32), 46 m wide and 3,200 m long, with taxiways provided parallel to the runway and a number of runway exits. The length of the runway is insufficient for long-haul flights of large aircraft and the capacity of the single runway would be reached within the master plan framework period.

The existing passenger apron stands are 24 and there are aprons for VVIP, cargo, maintenance, and general aviation. During peak hour, congestion is observed in the contact gates for Code E aircrafts.

The HSIA was designed on a linear terminal configuration with frontal aircraft stands layout. The PTBs, consisting of two connected 2-level terminals, Terminal 1 and Terminal 2, for international operations and a smaller single-level domestic terminal, have a combined design capacity of around 7-8 mppa. The airport is currently handling passenger traffic of about 6.5 mppa with 85% being international passengers.

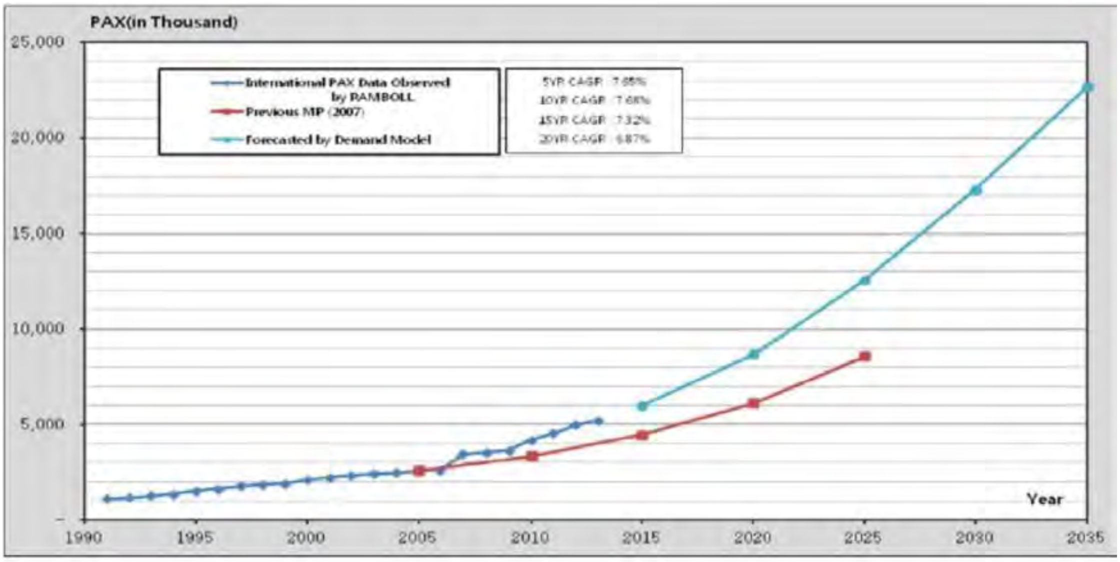
One acute problem is the congestion during the peak hours on the New Airport Road leading to the airport. Severe traffic jams are a daily occurrence especially at the roundabout access to the airport. Space for car parking will also be facing severe shortage in the near future due to the increase in passenger volumes.

For the navigational aids (NavAids) and AGL facilities at HSIA, precision approaches are available up to the end of Runway 14. The CAAB has recently taken up the initiative of upgrading the existing ILS to Category II.

Related facilities like utilities (water supply, sewage, and electricity) are provided for the existing facilities; however, the installation a new system for Terminal 3 will be required.

(3) Air Traffic Demand Forecast

Based on a review of economic drivers, the unconstrained forecast of demand is shown in Figure 6-5. The growth rate is expected to be 6.9% per annum, while the previous master plan expects a growth rate of 6.2% per annum.



Source: CAAB

Figure 6-5 Air Traffic Demand Forecast

Table 6-5 shows the passenger forecast (international and domestic) based on the model with GDP growth scenario for twenty years up to 2035.

Table 6-5 Passenger Forecast

(Unit: thousands)

	2015	2020	2025	2030	2035
International	5,997	8,671	12,564	17,313	22,659
Domestic	685	796	926	1,056	1,179
Total	6,682	9,467	13,490	18,369	23,838

Source: CAAB

The number of annual operations has been calculated by considering the annual demand, aircraft size, and load factor. Low, medium, and high growth assumptions were also taken into account. The total aircraft movement forecasts for HSIA are given in Table 6-6.

Table 6-6 Aircraft Movement Forecast

(Unit: Operations)

	2015	2020	2025	2030	2035
International	37,300	53,100	75,900	102,800	132,300
Domestic	21,100	24,000	27,400	30,700	33,700
Others	11,000	12,500	14,400	16,500	19,000
Total	69,400	89,600	117,700	150,000	185,000

Source: CAAB

Aviation demand is normally projected using GDP as an explanatory factor, but sufficient analysis was not done on the trends of departure and destination countries, the situation of import and export cargoes, and the impact of airline fare reduction due to low-cost carrier (LCC) service. Since these elements are not included as explanatory factors in the prediction model, it is necessary to analyze these factors separately, and develop a demand projection inclusive of the factors.

The air traffic demand forecast conducted in this preparatory survey is compared in Chapter 5.

(4) Master Plan Recommendations

The next step of the planning process is to identify a recommended development plan based on the projected needs. The layout process involves conducting an evaluation of the areas required to be procured for development and then developing the optimum layout designs and configurations.

The expansion plan was developed to accommodate the projected air traffic demand for 2035 of approximately 24 mppa.

Airfield Facilities

- Extension and widening of existing runway
- New second runway
- Additional taxiways
- New passenger apron to accommodate 35 aircraft parking stands
- New apron taxiway, taxi lanes, and ground service equipment (GSE) road
- Expansion of cargo and maintenance apron

Terminal 3 and Related Facilities

- New Terminal 3 with connection to the existing Terminal 1 and Terminal 2
- New landside roadways and car parks
- New multi-storied car park cum commercial building

- New domestic terminal with connection to the existing Terminal 1 and Terminal 2
- New VVIP complex
- New intake substation
- New sewage treatment plant

Navaids and AGL

- Upgrade existing ILS and AGL system to CAT-II
- New CAT-II ILS and AGL system for second runway
- Relocation of existing equipment

Support Facilities

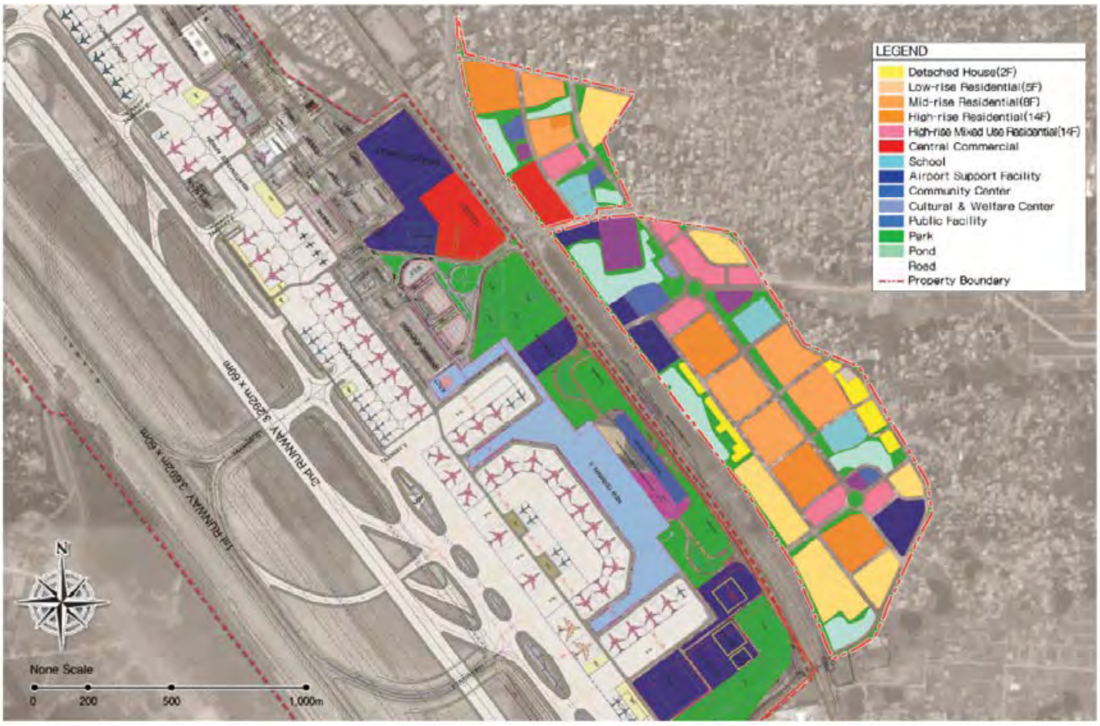
- New RFFS substation
- Relocation of general aviation facilities
- Relocation of ATC tower
- Relocation of catering facilities
- Expansion of cargo and maintenance facilities

(5) Phased Development Plan

All facilities excluding the second runway and the adjoining taxiways will be constructed in phase-1. Only the second runway and the adjoining taxiways will be constructed in phase-2.

(6) Land Use Plan

The CAAB has a land area of 941,597 m^2 on the east side of HSIA. The land, located around the east side of Terminal 3, is very close to the airport. It means that its place has very high potential for business and commerce. Therefore, there are many plans of development of business and commercial complexes.



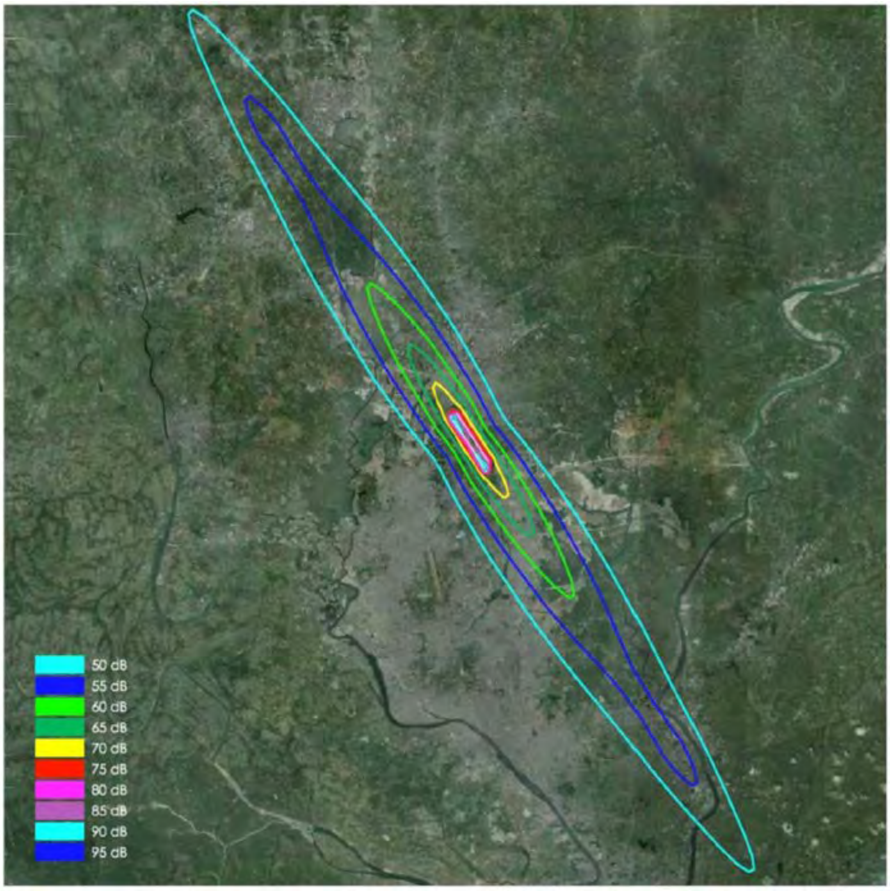
Source: CAAB

Figure 6-6 Land Use Plan at CAAB's Area

(7) Environmental Screening

This expansion project is included under the "Red Category in item 60" as per ECR 1997. Therefore, the location clearance certificate (LCC) and environmental clearance certificate (ECC) are required to obtained from the Department of Environment (DOE) to implement the project. For the application of LCC, initial environmental examination (IEE) along with environmental management plan (EMP) has to be prepared. For the application of ECC, environmental impact assessment (EIA) is needed.

Since aircraft movements at HSIA will be high, the noise impact analysis around HSIA in 2035 was conducted. The result of the noise impact analysis is shown in Figure 6-7.



Source: CAAB

Figure 6-7 Noise Contour of HSIA in 2035

(8) Economic Analysis

The basic premises of the economic analysis is that airport investments are viewed as public investments. It is desirable that the total sum of benefits to the traveling public exceeds, or is close to, the amount of investments. The measured benefits are converted into monetary terms. Because the benefits are measured in a time unit, the concept of value of time (VOT) and aircraft operating cost are required. The VOT employed Federal Aviation Administration (FAA) recommendation.

The result of the economic analysis for the expansion plan described in the report is summarized in Table 6-7.

Table 6-7 Economic Analysis

	NPV (USD in millions)	B/C	IRR (%)	Note
Baseline Scenario	974	1.6	8.2	VOT

Source: CAAB

Based on the underlying assumptions, the construction of the second runway and other infrastructure development works at HSIA are economically reasonable.

(9) Financial Analysis

Financial analysis was conducted viewing the project as an airport investment project by the private sector. Operating period is assumed to be 30 years after the completion of the expansion.

The result of the financial analysis based on the assumed capital expenditure, operating expenditure, operating aeronautical revenue, and operating non-aeronautical revenue is shown in Table 6-8.

Table 6-8 Result of Financial Analysis

	FNPV (M USD)	PI	FIRR (%)	Recovery Period (year)
Optimistic Scenario	956	1.3	11.5	14
Baseline Scenario	202	1.1	8.8	27
Pessimistic Scenario	-552	0.8	5.6	N/A

Source: CAAB

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CHAPTER 7 ANALYSIS OF AIRPORT CAPACITY AND VALIDITY OF THE PROJECT

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Chapter 7 ANALYSIS OF AIRPORT CAPACITY AND VALIDITY OF THE PROJECT

7.1 Analysis of Capacity of Current Airport Facilities

This chapter evaluates whether the current capacity of HSIA is sufficient to meet the projected demand for 2020, when the phase 1 facilities will be completed. The analysis will include the runway, taxiway, PTB, cargo terminal,car park and access road. The summary of the capacity analysis is shown in Table 7-1, and result of the capacity analysis is described in the following sections.

Table 7-1 Summary of Capacity Analysis of Each Facility of HSIA

Items		Current Condition/ Capacity	Requirement in 2020	Evaluation
Runway	No.	Approximately 170,000 movements/year	103,830 movements/years	It is possible to meet the demand until 2020 with one runway by maximizing utilization of the operational capacity.
	Length	3,200 m	3,200 m	The longest flight in operation in 2015 is Dhaka-London by B777-300. Therefore, all flights can be operated, except for some long-haul flights using large aircraft which will require restriction on luggage,.
	Width	46 m	46 m	Width of 60 m is unnecessary, although desirable for operation of Code F aircrafts.
Rapid Exit Taxiways and Connection Taxiways	Peak hour aircraft movement	35movements/ hour	24 movements/hour	The peak hour aircraft movement in 2015 was 18, which will increase to 24 in 2020; therefore, existing facilities have no problem.
Taxiway	Width	23 m	23 m	Width of 25 m is unnecessary, although it is desirable for operation of Code F aircrafts.
Apron	No. of Spots	29	32	Although the demand will exceed the current capacity in a few years later, the aprons in front of cargo terminal and maintenance area could be used during peak hour.
International Passenger Terminal Building	Check-in Check-out Counters	56	60	The capacity of the existing international terminal building (T1/T2) is 8 mppa. According to the aviation traffic demand forecast in this study, the demand of international passenger in 2020 will reach 8.7 mppa. Therefore, low service level will be found temporarily during peak hour, However, emigration counters, baggage retrieval conveyors and security checkpoints
	Security Checkpoints	19	19	
	Emigration Counters	38	21	
	Immigration Counters	22	25	
	Baggage Claim Counters	8	8	
Domestic Passenger Terminal Building	Check-in Counters	12	11	The capacity of the existing domestic terminal building is 640,000. Domestic passengers have already reached beyond 910,000. Therefore, chronic congestion will be found in 2020.
	Security Checkpoints	3	4	
	Baggage Claim Counters	1	4	

Items		Current Condition/ Capacity	Requirement in 2020	Evaluation
Cargo Terminal Building	Area	27,800 m^2 Export: 12,800 m^2 Import: 15,000 m^2	42,000 m^2 Export: 14,000 m^2 Import: 28,000 m^2	According to future demand requirement, the capacity of cargo terminal is expected to fall short in 2020.
Car Parking	No. of Cars	1,000 cars	1,008 cars	Although excess demand over capacity at peak hour is a concern, it will not considerably affect airport operations.
Utility	Power Supply	8 MVA	TBD	Temporary capacity overload of each facility are concerns since the capacity of T1/T2 will be exceeded in 2020. However, it will not considerably affect the operation of the airport.
	Water Supply	Tube well	TBD	
	Waste Water Treatment	TBD	TBD	
	Fuel	TBD	TBD	
Confidential due to security reasons.				

Source: JICA Study Team

7.1.1 Capacity of Runway

In the CAAB Master Plan, the current runway capacity is approximately 170,000 movements per year.

In 2015, the aircraft movement, including GA and military, in HSIA was 73,235. Even if the separation between civil and military aircraft or between arrival and departure is considered, the current runway capacity is sufficient up to 2030.

7.1.2 Taxiway

There are four taxiways, which consist of south taxiway, north taxiway, central taxiway, and high speed exit taxiway. The south and north taxiways connect to both runway ends; the central taxiway is used for arrival aircraft from both runway directions and the high speed exit taxiway is used for arrival aircraft from Runway 14.

At present, approximately 90% of operations are for the south wind and the large jet ratio is about 45%, with the remainder small aircraft or turboprop aircraft. Therefore, there are no issues with the current number and location of taxiways if the current aircraft movements and equipment configuration are maintained.

On the other hand, when the airport operates in the opposite wind direction, the high speed exit taxiway cannot be used. However, the current runway capacity still has enough margin and there is no severe impact on airport operations caused by increased runway occupancy time during north wind operation resulting in delay of arrival and departure aircraft.

According to the demand forecast in this study, the aircraft movement will increase by approximately

2.9 times in 2035. Also, the study shows that turbo prop aircraft will be replaced by small jet and large aircraft will increase. Therefore, the installation of new high-speed exit taxiway should be considered for decreasing runway occupancy time and increasing runway capacity.

7.1.3 Apron

The current apron situation is described in Chapter 3 and the existing apron stands are shown in Figure 3.10 and Table 3.4. The current specification of operational aircraft for domestic and international flights is that almost all domestic flights are operated by turbo prop or small regional jet types and international flights are operated by B777 and B737 class aircrafts. As mentioned above, spots with boarding bridge are used for international flights and domestic flights use open spots.

In addition, according to Table 5.5, there will be 21 international flights and 16 domestic flights during peak hour in 2020. Although the future required number of apron stands in 2020 will exceed the existing number, some aircraft may park in the maintenance area and cargo terminal area during peak hours.

7.2 Passenger Terminal Building

(1) Existing Terminal (Terminal 1 and Terminal 2) Capacity

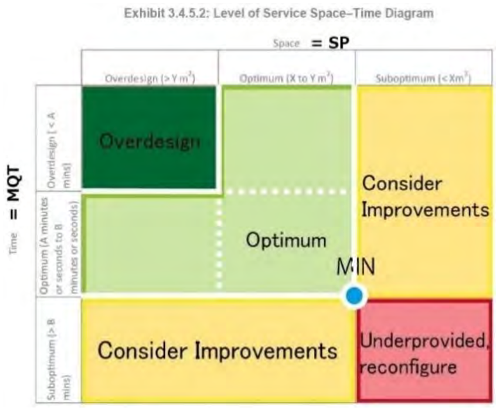
The JICA Study Team confirms that the capacity of existing international Terminal 1 and Terminal 2 (8 mppa in CAAB Master Plan), is able to satisfy the passenger demand until Terminal 3 opens.

1) The number of check-in counters and other facilities

The JICAStudy Team calculated the required number of check-in counters and other facilities based on future passenger demand forecast. The required number is compared with the existing facilities.

The following items are the premises used to calculate the required facilities:

- Calculation formula is based on the International Air Transport Association’s (IATA) Airport Development Reference Manual (ADRM) 10th edition.
- The level of service (LOS) is assumed at the low level in optimum range.



Source: IATA

Figure 7-1 IATA ADRM 10th LOS Table

- For the demand forecast for peak hour passenger, the direction factor is 65%, based on the data in CAAB Master Plan.
- Processing time is also based on CAAB Master Plan data.
- Because there is no condition given in the CAAB Master Plan, the gate security check time duration is set at 120 seconds, based on the data collected directly by the JICA Study Team on site.
- Baggage claim calculation during peak hour is one conveyor per flight, the operation standard used in the present international terminal (T1/T2).
- The forecast calculation formula is based on the conditions shown in Table 7.2.

Table 7-2 Condition for Calculation of Required Number

	Facility	Process Time (sec/pax.)	Max Waiting Time in Optimum Low in LOS (min)	Comment
Departure	Check-in Counter	180	20	
	Emigration	20	10	
	Security	20	10	Gate Security
Arrival	Immigration	50	10	
	Baggage Claim	-	-	Based on peak flight nos.

Source: JICA Study Team

The required numbers in 2020 and current number of facilities calculated based on Table 7.2 is shown in Table 7-3. Security check point, emigration counter, and baggage claim will be enough to satisfy the demand forecast in 2020. On the other hand, check-in counters and arrival immigration counters will not be enough to satisfy the demand forecast. Long lines in immigration procedure will make it difficult to guarantee the proper service level. However it is possible to maintain the same service level and improve the queuing condition by taking space from the waiting room next to the immigration area to expand the immigration area.

The time duration for arrival immigration processing time in CAAB Master Plan is 50 seconds, which was also used for the JICA Study Team, but it should be possible to shorten the processing time by improvements in operation.

As mentioned above, the existing terminal will satisfy the demand forecast by improvement of operations and partial renovation.

Table 7-3 Comparison of Capacity Between Existing and Required Facilities in Terminal 1/2

		Existing Terminal	Required Number (2020)
	Million Passenger Per Annum (mppa)	8.0	8.7
Departure	Check-in Counter	56	60
	Security Check Point	19	19
	Emigration	38	21
Arrival	Immigration	22	25
	Baggage Claim	8	8

Source: JICA Study Team

2) Gate Lounge Capacity

Confidential due to security reasons.

Table 7-4 Gate Lounge Capacity Basic Unit

Confidential due to security reasons.

Table 7-5 Processing Time for Different Aircraft Size

Confidential due to security reasons.

(2) Evaluation of Existing Domestic Terminal Capacity

The JICA Study Team evaluated the the capacity of existing domestic terminal (0.64 mppa in CAAB Master Plan) to meet the projected passenger demand in 2020.

The required number of facilities in domestic terminal in 2020 is calculated by the conditions of Table 7-6.

Table 7-6 Required Number of Check-in Counters and Other Facilities in Domestic Terminal

Items		Existing Terminal	Required Facility (2020)
Condition	Passenger (mppa)	0.64	1.38
Check-in Counters		12	11
Security Check Points		3	4
Baggage Claim		1	4

Source: JICA Study Team

According to Table 7-6, the number of security check points and baggage claims in the existing domestic terminal will not satisfy the future demand. Therefore, severe congestion and decrease in service level will be expected.

7.2.2 Cargo Terminal

Approximately 80% of export cargo in HSIA is cloth and/or textile. Therefore, it is assumed that the operational capacity per square meter is much more than the base unit of operational capacity in cargo terminal at IATA ADRM 10th edition.

On the other hand, import cargo terminal is expected to handle some products which would normally be transported by maritime or land transportation, due to the geographical characteristics and insufficient infrastructure in Dhaka. Furthermore, the JICA Study Team will adopt the low automated category base unit in IATA ADRM 10th, for import cargo terminal due to the conditions and operations in the existing facilities.

The selected base unit for export and import cargo terminal is shown in Table 7-7.

Table 7-7 Existing Cargo Terminal Base Unit

Facilities	Unit (t/m²)
Export Cargo Terminal	20
Import Cargo Terminal	5

Source: JICA Study Team

The expected export and import cargo volume is shown in Table 7-8 and the resulting required cargo terminal area is shown in Table 7-9.

Table 7-8 Demand Forecast and Current Volume in International Air Cargo

Category	Ratio	2015	2020
Export	67 %	172,007 t	278,768 t
Import	33 %	86,003 t	139,384 t
Total	100 %	258,010 t	418,152 t

Source: JICA Study Team

Table 7-9 Required Cargo Terminal Area

Planned Year / Facility	Existing Facility	Required Current Cargo Terminal Area (2015)	Required Cargo Terminal Area (2020)
Export Cargo Terminal	12,800 m^2	9,000 m^2	14,000 m^2
Import Cargo Terminal	15,000 m^2	17,000 m^2	28,000 m^2
Total	27,800 m^2	26,000 m^2	42,000 m^2

Source: JICA Study Team

Table 7-9 shows that the existing cargo terminal will not satisfy the cargo demand forecast in 2020. Therefore, the shortage of cargo terminal area has to be improved by introducing efficient operation as well as deploying automated racking system.

7.2.3 Car Parking

The condition of current car park is shown in Table 7-10. The future parking demand forecast for 2020 is 1008 spots. Lack of capacity will be a concern during peak hours, since present capacity is less than demand. However, this will not cause severe issue, because both numbers are very close.

Table 7-10 Situation of Car Parking in HSIA

	Existing Car Park		Future Demand Forecast (2020)
	Parking Lots	Area (m²)	
Existing (International Terminal)	800	24,500	806
Existing (Domestic Terminal)	200	2,000	202
Total	1,000	26,500	1008

Source: CAAB

7.2.4 Utilities

(1) Power Supply

The power demand of the existing HSIA is estimated to be 8 MVA, supported by two intake power substations. The power for HSIA is maintained by two power supply lines and backup generator; therefore, 24/7 operation stability is ensured.

The total amount of power demand is normally calculated by estimated power usage per unit area in each facility. There is no plan of expanding the existing facilities for future demand increase until 2020; therefore, it is assumed that power demand in 2020 is almost the same as current demand.

As mentioned above, the current power supply system will be enough for future power demand in 2020.

(2) Water Supply

The existing water demand at HSIA is sustained by three tube-wells. The JICA Study Team could not confirm precise data of amount of water supply per day in each tube well and capacity of water reserve per day in each water supply; however, the JICA Study Team did not find any issue concerning water supply volumes in this study.

The demand for water depends mainly on the number of passengers in the airport. The shortfall of water supply during peak hour in 2020 is a concern because the international passengers demand forecast in 2020 (8.6 mppa) will be slightly beyond the capacity of Terminal 1 and Terminal 2 (8 mppa). However, since CAAB is planning to develop three new tube wells for Terminal 3 and the new VVIP, the capacity of the existing system is sufficient to meet the demand for Terminal 1/Terminal 2 in 2020.

As seen above, the existing water supply system will sufficiently meet the future demand in 2020.

(3) Wastewater Treatment

Wastewater of HSIA is treated by sewage system located in the northern corner of the airport. At present, the existing sewage treatment facility is not in operation because of problems. The JICA Study Team could not obtain clear data on the capability of the existing sewage system; however, no reports of issues with the sewage system have been confirmed.

The amount of wastewater, similarly to water supply, depends on the number of passengers in the airport. Therefore, the lack of capacity of the sewage system in 2020 is a concern, because the projected passenger demand in 2020 is slightly beyond the existing facility’s capacity. Although current issues and improvement plan have not been clarified, CAAB urgently needs to improve the existing facility. The plan should include adding efficient treatment method or functionality, which could allow some excess capacity over demand for wastewater treatment. Furthermore, the passenger demand forecast is very close to the capacity of the existing terminal. As a result, the amount of wastewater in 2020 is within the range of error of the capacity limit of the existing sewage system. As mentioned above, the existing sewage system will be able to treat wastewater demand in 2020.

7.2.5 Navigation Aids

Confidential due to security reasons.

7.3 Confirmation of the Necessity and Validity of the Expansion Project

Based on the capacity analysis of the existing HISA and the CAAB Master Plan, the necessity and validity of the project planned by the Bangladesh government are shown in this section. The summary of the evaluation of the necessity and validity of the project are shown in Table 7-11.

Table 7-11 Summary of the Project Scope and Evaluation

Facility	CAAB Master Plan (Target Year: 2035)	Phase-1 Plan (Target Year: 2025)	Evaluation
Existing Runway	Extension and widening From “3,200 x 46 m” to “3,692 x 60 m”	None	Importance and priority are low; although, extension and widening are desirable for Code F aircraft operation in the future.
New Runway	3,292 x 60 m	None	Importance and priority are not high for 2025, although it will be necessary for long-term plan in view of future demand.
New Taxiways	Rapid exit taxiways and other taxiways	Rapid Exit Taxiway: 2 Attached Taxiway (RWY 14): 1 Attached Taxiway (Parallel Taxiway): 9	It is reasonable for maximizing the capacity of one runway.
Landside Service Road	Landside service road for the new Terminal 3	Landside service road for the new Terminal 3	It is necessary for operation of the new Terminal 3.
Apron	Area of expansion and reconstruction: approximately 1,000,000 m^2 Apron Spot No: from 29 to 64	Apron expansion: Approx. 520,000 m^2 Apron Spot No: 42	Since apron expansion and number of apron spots were set based on future demand the planned figures are deemed appropriate for phase-1. The improvement of current apron is under CAAB funding and not included in scope for phase-1.
New Terminal 3	Approximately 260,000 m^2 3 Stories Passenger Capacity: 16.2 mppa	Approximately 220,000 m^2 3 Stories Passenger Capacity: 12 mppa	Based on future demand, the expansion of 220,000 m^2 set for phase-1 is deemed appropriate. Phase-2, will need to expand to 260,000 m^2.
Existing International Terminal T1/T2	Following renovation works: - No. of check-in counters: from 56 to 84 - Addition of immigration and emigration counters Passenger Capacity: 8 mppa	None	There is no urgency for expansion up to 2020. Renovations are required to meet additional demand after 2025.
New Domestic Terminal	Approximately 15,000 m^2	None	Based on priority of facilities, a new domestic terminal will be

Facility	CAAB Master Plan (Target Year: 2035)	Phase-1 Plan (Target Year: 2025)	Evaluation
			needed in phase-2. In phase-1, the existing domestic terminal will continued to be used and parts of T1/T2 will be used temporarily as necessary.
Cargo Terminal	40,000 m^2 (Existing export cargo terminal: 12,800 m^2, Import cargo terminal: 27,200 m^2)	47,000 m^2 (Export cargo terminal: 27,000 m^2, Import cargo terminal: 20,000 m^2)	The development of cargo terminal is necessary for increasing cargo capacity and operational improvement. Necessary facility capacity requires further study.
VVIP Terminal	Approximately 5,000 m^2	Approximately 5,000 m^2	Relocation is needed due to the construction of new Terminal 3.
Car Park	1,948 lots (T1/T2: 800, Terminal 3: 1,148)	Terminal 3: 1,148 lots	In phase-1, the capacity of new car park for Terminal 3 is sufficient for the demand of all passengers accessing the airport by car.
Confidential due to security reasons.			
Supply Facility	- RFFS	RFFS	New construction is reasonable considering the response time.
	- Wastewater treatment plant	Wastewater treatment plant	Expansion of facilities is needed according to the expansion of the airport.
	- Intake power plant with distribution system	Intake power plant with distribution system	
	- Maintenance hangar	Maintenance hangar	The upgrade and improvement of these facilities are planned under CAAB funding.
	- Catering facility	Catering facility	
	- GA apron and hangar	GA apron and hangar	

Source: JICA Study Team

7.3.1 Analysis of Phased Expansion based on Demand Forecast

As mentioned above, the necessity and validity is high for the scope of the expansion project in the CAAB Master Plan and the planned expansion or new construction of each facility. However, the target year in the CAAB Master Plan is 2035 and there is concern that the design of the CAAB Master Plan may significantly exceed the capacity demand forecast in 2020. The capacity demand forecast is affected by various factors influenced by economic activity in Bangladesh and abroad; therefore, phased development based on demand forecast is appropriate for airport expansion projects.

The phase-1 project in the current CAAB Master Plan will be completed in 2020. Therefore, it is desirable to construct the HSIA expansion project in two phases wherein phase-1 will target 2025 or five years from completion of project facilities and phase-2 will target the additional demand projected for the subsequent five years up to 2030.

Following the phased development plan will allow review of the demand forecast with a five-year interval and to flexibly adjust project scope to match changes in demand forecast or needs of airlines and passengers. This will also allow investment to be set at appropriate and reasonable values for projected demand.

The validity of phased development, based on current demand forecast is shown in Table 7-12.

Table 7-12 Change of Demand Forecast in Each Target Year of Phased Development

Phase	Target Year	Completion Year	Passenger Demand Forecast (mppa)		
			International	Domestic	Total
Operation Start Terminal 3	2020		8.7	1.4	10.1
Phase-1	2025	2020	12.0	2.1	14.1
Phase-2	2030	2025	16.1	3.0	19.1

Source: JICA Study Team

7.3.2 Runway and Taxiway

(1) Runway Length and Width

At present, the Dhaka-London flight, operated by B777-300ER, has the longest flight distance in operation at HSIA. There is no plan to open a new route with a longer flight distance than the London flight. Therefore, the runway length is sufficient for operations in the near future.

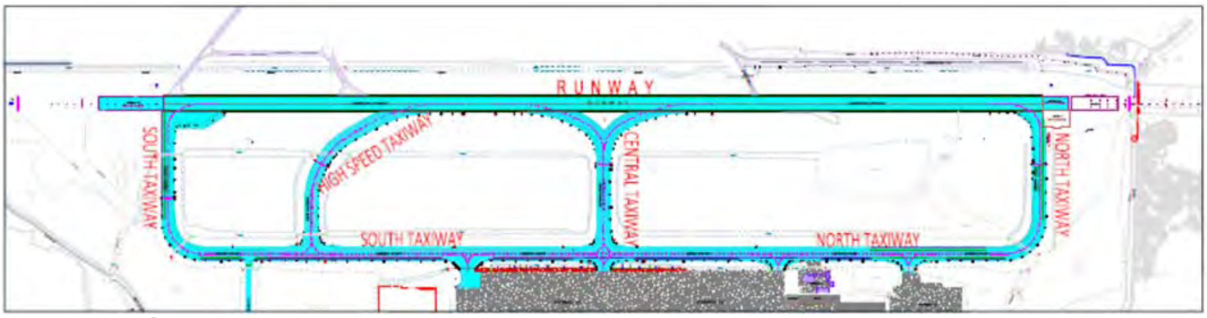
On the other hand, the operation of Code F aircrafts requires a runway width of 60 m in ICAO Annex 14. However, FAA and the European Aviation Safety Agency (EASA) have approved A380 operations under Code 4E, which requirements are satisfied by a 45 m runway width and 7.5 m runway shoulder. There are many airports with A380 flights in operation under the Code 4E requirement for runway width,.

Therefore, the expansion of runway width is not essential.

(2) Taxiway

There are one parallel taxiway, two attached taxiways, central taxiway, and one high-speed exit taxiway in HSIA. The taxiway width and runway width satisfy the operational requirement for A380.

However, there is only one high-speed exit taxiway located 2,350 m from the northern runway end.



Source: JICA Study Team

Figure 7-2 Location Map of Runway and Taxiway in HSIA

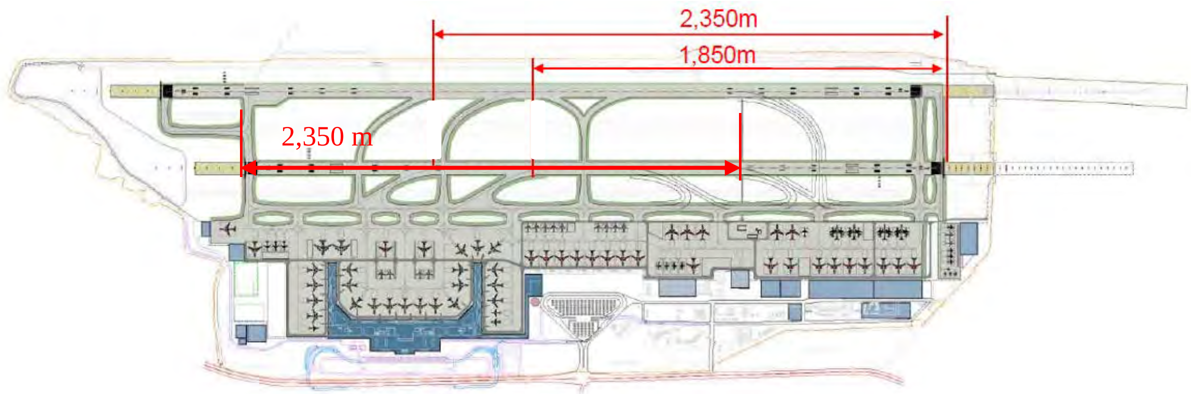
At present, small jets are already in operation for domestic and international flights.and domestic flights currently operating turboprop aircraft are expected to change to small jets in the future.

Therefore, the JICA Study Team evaluated the adequacy of the existing high speed exit taxiway by calculating the minimum landing runway length for B737-800, which will be the major aircraft for domestic and international flights.

According to the aircraft characteristics of B737 provided by Boeing, the minimum landing runway length is 1,750 m at the maximum landing weight. The B737 is operated for short haul international flights and some domestic flights at HISA, but in reality flights landing at maximum landing weight are extremely rare. Therefore, there is concern that the current runway occupancy time is slightly longer than necessary because the distance from the runway edge to the high speed exit taxiway is longer than the minimum landing runway length for B737.

The need for a new high speed exit taxiway is not an urgent issue because there is enough runway capacity and almost all aircrafts for domestic flights are using turbo prop. However, reducing runway occupancy time and increasing runway capacity will be required due to the growth of flight demand and shift of aircraft mix to small jet. As mentioned above, the JICA Study Team considers that the establishment of high speed exit taxiway for small jet in Runway 14 is appropriate.

Furthermore, high speed exit taxiway could not be used for north wind operation, even if it is only about 10% of annual operation. The rapid decrease of runway capacity during that operation is a concern. Therefore, the establishment of high speed exit taxiway in Runway 32 will efficiently minimize the delay due to holding caused by the decreasing runway capacity when HSIA has runway direction change under the increase of air traffic demand in the future.



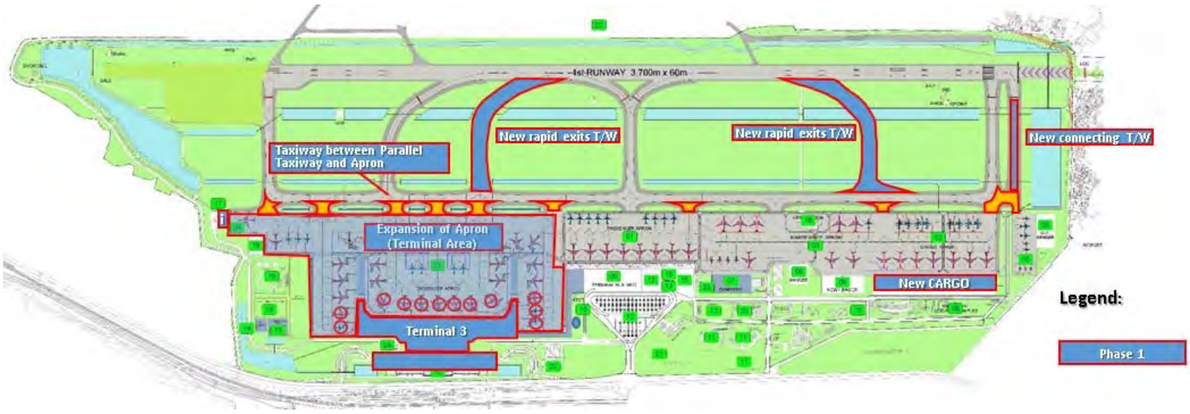
Source: JICA Study Team

Figure 7-3 Location Map of New High Speed Exit Taxiway

At airports where air traffic demand is high, several rapid exit taxiways are laid out at runway ends. This allows for departure aircraft to utilize several different taxiways and increase the number of aircraft waiting for takeoff. This contribute towards increasing the runway capacity by maximizing the efficiency of departure aircraft operations such as reversing the departure order in consideration of wake turbulence in some instances. In addition, when departure aircraft encounter trouble, they are able to execute ground turns (turning back without taking off) without occupying the runway. Therefore, it is reasonable to provide a number of rapid exit taxiways at both runway ends for this project in order to maintain smooth operations at HSIA.

The width of the high speed taxiway and attached taxiway is 23 m, and the width of both shoulders is 7.5 m.

The location of attached taxiway which connects between the parallel taxiway and apron is shown in Figure 7-4



Source: JICA Study Team

Figure 7-4 Location Map of New High Speed Exit Taxiway

The necessary and appropriate project scope for each phase is shown in Table 7-13.

Table 7-13 Project Scope in Each Phase (Runway and Taxiway)

	Runway		Taxiway
	Length	Width	
Phase-1 (Target Year: 2025)	–	–	High Speed Exit Taxiway x 2 (for RWY 14 and 32) Attached Taxiway x 9 (for Parallel Taxiway) Attached Taxiway x 1 (for RWY 14 Edge)
Phase-2 (Target Year: 2030)	Extension from 3,200 m to 3,692 m	Expansion from 45 m to 60 m	Attached Taxiway x 1 (for RWY 32 Edge)

Source: JICA Study Team

7.3.3 Apron

The required number of spots is calculated by the following steps. In this calculation, the JICA Study Team used aircraft mix and the number of flights during peak hour, which are described in Sections 6.6.1 and 6.7.4.

- Peak Hour Landing for Each Aircraft Type
- Number of Planned Spot for Each Aircraft Type
- Number of Required Spot

(1) Peak Hour Landing for Each Aircraft Type

In this survey, based on the interview with several airlines, it is assumed that the aircraft mix will change as shown in Table 7-14.

Table 7-14 Aircraft Mix for Domestic and International Flights

	Reference Code	2015	2020	2025	2030	2035
Domestic	Code B	80%	75%	60%	50%	40%
	Code C (Turbo Prop)	20%	20%	20%	20%	20%
	Code C (Jet)	0%	5%	20%	30%	40%
	Total	100%	100%	100%	100%	100%
International	Code B	2%	0%	0%	0%	0%
	Code C (Turbo Prop)	25%	22%	15%	9%	1%
	Code C (Jet)	25%	30%	35%	40%	45%
	Code D	2%	2%	2%	2%	2%
	Code E	45%	45%	47%	48%	51%
	Code F	1%	1%	1%	1%	1%
	Total	100%	100%	100%	100%	100%

Source: JICA Study Team

Also, the aircraft movements for domestic and international flights during peak hour are shown in Table 7-15.

Table 7-15 Aircraft Movements during Peak Hour

2015		2020		2025		2030		2035	
International	Domestic	International	Domestic	International	Domestic	International	Domestic	International	Domestic
14	13	21	16	28	19	35	20	43	22

Source: JICA Study Team

As mentioned above, the peak hour landing for each aircraft type (PAi) is calculated by the following formula:

PAi = Peak Hour Landing * Aircraft Mix * 0.5 … (1) (i: Aircraft Type)

The peak hour landing for each aircraft type calculated from formula (1) is shown in Table 7-16.

Table 7-16 Peak Hour Landing for Each Aircraft Type

	2015		2020		2025		2030		2035	
	International	Domestic	International	Domestic	International	Domestic	International	Domestic	International	Domestic
Code B	0.14	5.2	0	4.8	0	5.7	0	5	0	4.4
Code C (Turbo Prop)	1.75	1.3	2.31	1.6	2.1	1.9	1.58	2	0.22	2.2
Code C (Jet)	1.75	0	3.15	1.6	4.9	1.9	7	3	9.68	4.4
Code D	0.14	0	0.21	0	0.28	0	0.35	0	0.43	0
Code E	3.15	0	4.73	0	6.58	0	8.4	0	10.97	0
Code F	0/07	0	0.11	0	0.14	0	0.18	0	0.22	0

Source: JICA Study Team

(2) Number of Planned Spots for Each Aircraft Type

The number of planned spots for each aircraft type is calculated by the following formula:

PSi = PAi * Spot Occupancy Time * Surplus Ratio … (2)

The spot occupancy time is assumed as shown in Table 7-17 because the spot occupancy time for each aircraft type is different between domestic and international flights.

Table 7-17 Spot Occupancy Time (min)

Reference Code	International	Domestic
Code B	80	60
Code C（Turbo Prop）	80	60
Code C（Jet）	80	60
Code D	120	—
Code E	120	—
Code F	120	—

Source: JICA Study Team

The spot occupancy time is set with surplus ratio to allow for delays. The JICA Study Team set the surplus ratio based on the result of the investigation of the delay ratio over one week.

Table 7-18 Delay Ratio

Date	Departure		Arrival		Delay Ratio (%)
	Delay	Total	Delay	Total	
April 27	6	104	6	88	6.25
April 28	14	102	11	102	12.26
April 29	17	99	10	98	13.71
April 30	17	95	15	98	16.58
May 1	18	102	17	101	17.24
May 2	19	99	9	99	14.14
May 3	16	103	5	94	10.66
Total	107	704	73	680	13.01

Source: JICA Study Team

Based on the result of actual flights from April 27 to May 3, 2016, the delay ratio for one week was 13%. According to this result, the surplus ratio is set as 1.2, which includes a safety factor. The number of planned spots for each aircraft type is calculated by formula (2) and shown in Table 7-19.

Table 7-19

Table 7-19 Number of Planned Spots for Each Aircraft Type

	2015		2020		2025		2030		2035	
	Inter-national	Domestic	Inter-national	Domestic	Inter-national	Domestic	Inter-national	Domestic	Inter national	Domestic
Code B	1	5	0	4	0	5	0	4	0	4
Code C	6	2	10	4	12	4	15	5	17	6
Code D	1	0	1	0	1	0	1	0	2	0
Code E	8	0	12	0	16	0	21	0	27	0
Code F	1	0	1	0	1	0	1	0	1	0
Total	24		32		39		47		57	

Source: JICA Study Team

(3) Number of Required Spots

The number of required spots (AS) is calculated by the following formula:

AS = $\sum PSi$ + Spare Spot + Night Stay Spot … (3)

The spare spot is used for considering long time parking due to mechanical trouble and short-time parking by charter flight or diverted flight. In this study, one spare spot for each ten planned spots was set.

On the other hand, this study did not consider night stay spots because the spots are sufficient for night stay of domestic aircrafts. International flights could use normal spots as night stay spots if required, since HSIA operates 24 hours a day and Biman Bangladesh Airlines is the only company based in HSIA operating international flights.

From the above, the number of required spots in each phase is shown in Table 7-20.

Table 7-20 Number of Required Spots

	Phase-1			Phase-2			CAAB Master Plan		
	International	Domestic	Total	International	Domestic	Total	Terminal3	T1/T2*	Total
Code B/C	13	9	22	16	10	26	10	9	19
Code E	18	0	18	23	0	23	23	14	37
Code F	2	0	2	2	0	2	2	0	2
Total	33	9	42	41	10	51	35	23	58

* The number of spots in T1/T2 is considered about reduction by construction Terminal 3.
Source: JICA Study Team

Phase-1 project will be completed around 2021 and Terminal 3 will start to operate at the same time. The number of required spots in 2020 is 32 as shown in Table 7-19. The lack of spots is expected during peak hour, because the current number of spots is 29. However, if the maintenance area apron and export cargo apron are utilized, the current spot number and arrangement will be sufficient until the completion of expansion project.

The number of required spots in the CAAB Master Plan is very similar to the result of the study based on the demand forecast. Therefore, the proposed number of required spots and composition of spots in the CAAB Master Plan are appropriate. In addition, the CAAB Master Plan shows that the number of spots around Terminal 3 corresponds with the required number of spots for international flights in phase-1. Therefore, it is valid to develop the spots around Terminal 3 according to the CAAB Master Plan. On the other hand, deficiency of spot numbers located around Terminal 3 for international flight will occur in phase-2. If part of the spots in Terminal 1/Terminal 2 are released for international flights, the available number of spots will match future demand of spots for international flights.

(4) Number of Cargo Spots

First, the JICA Study Team calculated the number of cargo flights during the peak hour based on the number of cargo flights during the peak day in Section 6.7.4. Second, the number of required spots for cargo is calculated as well as the passenger flights spot. The necessary conditions for calculation are as follows:

- The number of cargo flights during peak hour is calculated by the formula for international flight during peak hour, which is described in Section 6.7.3.

Number of Flight during Peak Hour = 1.05 / Aircraft Movement per Day + 0.114

- Current aircraft mix for cargo flight is Code C: 8% and Code E: 92%. Basically, large jets are used for freighter. Therefore, the JICA Study Team assumed that this composition of aircraft type will not change.
- The spot occupancy time is 180 min.
- The surplus rate is 1.2 for cargo as well as for passenger aircraft.

Based on the above conditions, the peak hour landing for each aircraft is calculated as shown in Table 7-21.

Table 7-21 Peak Hour Landing for Each Cargo Aircraft Type

Code	2015	2020	2025	2030	2035
Code C	0.06	0.07	0.08	0.10	0.11
Code E	0.69	0.80	0.95	1.11	1.32

Source: JICA Study Team

Based on the above results, the numbers of planned spots for each cargo aircraft type and required spots are calculated as shown in Table 7-22 and Table 7-23, respectively. Also, the number of spare spot is set as one.

Table 7-22 Number of Planned Spots for Each Cargo Aircraft Type

	2015	2020	2025	2030	2035
Code C	1	1	1	1	1
Code E	3	3	4	5	5
Total	4	4	5	6	6

Source: JICA Study Team

Table 7-23 Number of Required Spots for Cargo in Each Phase

	Phase-1	Phase-2	CAAB Master Plan
Code C	1	1	7
Code E	5	6	7
Total	6	7	14

Source: JICA Study Team

The number of required spots based on cargo demand forecast in this survey and the number of spots in CAAB Master Plan for Code E is almost the same. Therefore, the number of spots for cargo aircrafts, type Code E, is valid. On the other hand, there is over capacity in the planned number of spots for Code C, because the cargo demand forecast in the CAAB Master Plan is lower than that of JICA study. In addition, the current trend where domestic cargo, which is assumed to mainly use Code C aircraft, is significantly lower than international cargo is expected to continue in the future.

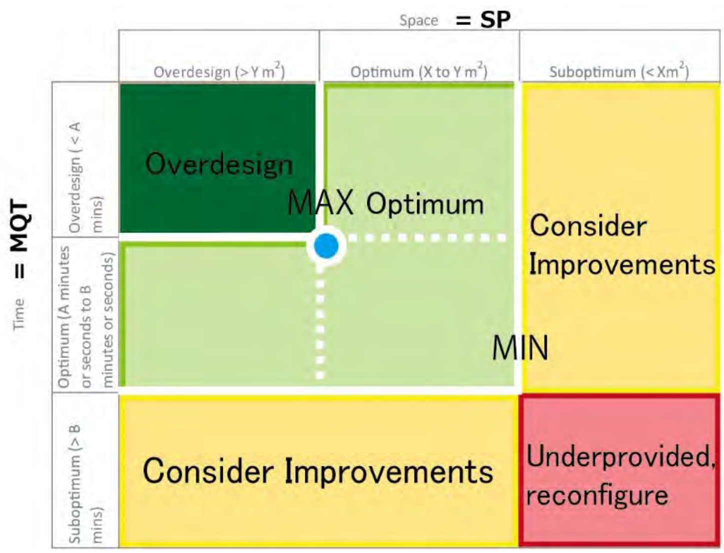
7.3.4 Passenger Terminal Building

The calculation of the processing capacity for the new Terminal 3 is based on the CAAB Master Plan and the assumptions of the JICA Study Team. The objective is to calculate the capacity of the facilities for the peak hour passenger (PHP) demand forecasts in 2025 and 2030.

(1) Pre-conditions

The pre-conditions for the calculation formula are as follows:

- The LOS is set at the high point level in optimum based on IATA ADRM standard.
- The calculation method is based on IATA ADRM book 10th edition.
- Processing time is referred to the conditions of the CAAB Master Plan.
- Since the new Terminal 3 security check facilities will be required to meet international airport standards, it should be possible to set processigng times equivalent to Japanese domestic airports. Since there is no condition given by CAAB Master Plan for security check process, the calculation will assume 20 seconds from the actual process time at Japanese domestic airports.
- Baggage claim will be based on the current T1/T2 operations of one conveyor per flight during peak hour condition.



Source: IATA

Figure 7-5 IATA ADRM 10th LOS Table

Standard conditions for the calculation are shown in Table 7-24. Security check in the existing international terminal (Terminal 1 and Terminal 2) employs the gate security system. The security check process time at the new Terminal 3 will be different from the existing terminals since it has a designated security check area.

Table 7-24 Processing Time Parameter for Departure and Arrival Passengers

	Facility	Process Time (sec/pax)	Max Waiting Time in Optimum Low in LoS (min)	Comment
Departure	Check-in Counter	150	10	
	Emigration	20	5	
	Security	20	5	
Arrival	Immigration	50	5	
	Baggage Claim	-	-	Number of Flight Base

Source: JICA Study Team

(2) Calculation Result and Validation

Table 7-25 shows the calculation result of the current design capacity by the JICA Study Team.

In phase-1, reduction of Terminal 3 area is appropriate because the planned Terminal 3 area on the CAAB Master Plan exceeds the demand in phase-1 timeframe. If Terminal 3 piers are delayed until phase-2, the terminal development plan will become appropriately matched with future demand for the target years of both phase-1 and 2. The total floor area of Terminal 3, excluding the piers, is approximately 220,000 m^2. The floor area per passenger during peak hour in 2025 will be 46 m^2, which is appropriate. Therefore, Terminal 3 capacity in phase-1 is appropriate.

In phase-2, the required facilities for departures and arrivals will exceed the planned facilities in the CAAB Master Plan. Even after the piers are extended in phase-2, the capacity of Terminal 3 will not be able to match future demand. Therefore, it is necessary to renovate and reuse Terminal 1/Terminal 2 to accept part of the future demand in phase-2. At that time, the airside corridor, which connects between Terminal 3 and Terminal 1/Terminal 2, will be necessary.

Table 7-25 Required Number of Check-in Counter and Other Facilities in Terminal 3

		2025 (Phase-1) Required Number	2030 (Phase-2) Required Number	CAAB Master Plan Planned Number
Condition	Passenger (mppa)	12.0	16.1	14.8
Departure	Check-in Counters	114	130	120
	Security	33	45	46
	Emigration	33	45	24
Arrival	Immigration	44	53	46
	Baggage Claim	9	12	13

Source: JICA Study Team

(3) Confirmation of Existing Domestic Terminal Facilities Availability and Processing Capacity

The capacity of the existing domestic terminal is lower than the current demand. Considering the situation, CAAB agreed that the new import cargo terminal will be constructed in phase-1 (2025) and the new domestic terminal will be developed in phase-2 (2030) after removing the existing import cargo terminal.

The existing domestic terminal will be continuously used during phase-1 and a part of Terminal 1/Terminal 2 will be used for domestic terminal, if necessary.

The required capacity of the new domestic terminal in phase-2 will be 15,000 m^2, when calculated from the number of passengers during peak hour and the required area of each passenger during peak hour, which is 15 m^2. The planned capacity of the new domestic terminal in the CAAB Master Plan corresponds with the JICA Study Team's result; therefore, the required capacity is appropriate.

7.3.5 Cargo Terminal

(1) Dimensions of the Cargo Terminal

While import cargo at HSIA shows an average increase of 9% between 2011 and 2015, exports show a dramatic increase of 14% annually for the same period. The export and import volumes for 2015 are 200,560 tons and 84,379 tons, respectively.

The size of the existing cargo terminal is shown in Table 7-26.

Table 7-26 Dimensions of the Existing Cargo Terminals

Facility	Existing Floor Area
Export Cargo Terminal	12,800 m^2
Import Cargo Terminal	15,000 m^2
Total	27,800 m^2

Source: JICA Study Team

Based on the site investigations on the existing operations carried out on 21 December 2016, the following are confirmed:

1) Export Cargo Terminal Building

The export cargo terminal building is operated without exhibiting much crowding inside, but the truck yard is heavily congested. It was confirmed that there were issues with the capacity for scanning cargo when transported into the building.

Furthermore, cargo are scanned as individual items resulting in a large number of scanning operations compared with the volume service.

Since the existing facility is servicing over 200,000 tons of cargo in the 12,800 m^2 floor area with adequate interior space, which converts to 15.6 tons/ m^2 unit added capacity from the commencement of operation of the rack system already in place, the base unit for service capacity is expected to be 17~ 20 tons/m^2.

Confidential due to security reasons.

Figure 7-6 Export Cargo Terminal Building

2) Import Cargo Terminal

The import cargo terminal was extremely crowded at the time the study was conducted and cargos were observed to be overwhelming the facility.

The lack of space was especially acute in the breakdown area for arriving cargo; and at present, breakdown is being carried out on the apron in the open.

The area used for breakdown on the apron is approximately 40 m by 230 m (11,500 m^2) and the existing terminal floor area is 15,000 m^2 for a combined area of approximately 26,500 m^2 in actual operational use.

The reported import volume for 2015 was 85,000 tons handled, resulting in a base handling unit of 3.4 tons/m^2.

However, the present handling operations were confirmed to have the following issues:

- Cargo arrives on a 24-hour basis, but customs and quarantine services are only available between 9:00 a.m. to 5:00 p.m. This causes the need for excessive space for breakdown, but under-utilized space was sporadically observed in the interior of the building, resulting in a very low base handling unit value.
- Single parcels are extracted in the breakdown area, causing uneven handling of cargo and exacerbating the lack of space with unneeded breakdowns.
- The need of claimers and cargo discharge is not synchronized, since the operation of large trucks is limited to night time, resulting in unclaimed cargo unnecessarily taking up the limited space.

Due to these situations, the base unit for import handling diminished to a very low value. It is assumed that the base unit can be doubled to about 7 tons/m^2 by improving the import facilities, including the refurbishment of the under-utilized equipment in the existing facility to allow multi-level storage of cargo during the time the customs services are shut down.

Confidential due to security reasons.

Figure 7-7 Import Cargo Terminal Building

Confidential due to security reasons.

Table 7-27 Base Unit for Future Cargo Facilities

Facility	Handling Unit (t/m^2)
Export Cargo Terminal	20
Import Cargo Terminal	7

Source: JICA Study Team

Table 7-28 Floor Space for International Cargo Terminal Building

Category	Distribution	Phase-1 (2025) Cargo Volume	Phase-1 (2025) Required Floor Space (m^2)
Export	67%	400,781 t	20,040
Import	33%	200,391 t	28,630
Total	100%	601,172 t	48,670

Source: JICA Study Team

7.3.6 Car Parking

The number of parking lot and area in the existing car park and planned car park for Terminal 3 is shown in Table 7-29.

Table 7-29 Details of Car Park in Expanded HSIA

Items	Parking Lot	Area (m^2)
Existing (International Terminal)	800	24,500
Existing (Domestic Terminal)	200	2,000
Expansion (Terminal 3)	1,148	50,000
Total	2,148	76,500

Source: CAAB

In addition, the details of car park for Terminal 3 are shown in Table 7-30.

Table 7-30 Details of Car Park for Terminal 3

	Usage	Parking Lot
Ground Floor Level	General	402
	VIP	58
Ground Floor Mezzanine Level	General	402
First Floor Level	General	286
Total	―	1,148

Source: CAAB

The required capacity of car park based on the traffic volume for each access mode in HSIA, which is described in the following sections, is assumed as shown in Table 7-31.

Table 7-31 Required Capacity of Car Park

Target Year / Facility	Existing Facility	Phase-1 (2025) Required Capacity	Phase-2 (2030) Required Capacity	CAAB Master Plan Planned Capacity
Car Park for International Terminal	800 lots	1,280 lots	1,700 lots	1,948 (T1/T2: 800 lots) (Terminal 3: 1,148 lots)

Source: JICA Study Team

The required capacity of car park in phase-1 is 1,280 and the planned capacity in the CAAB Master Plan is 1,148 for Terminal 3. Therefore, the demand of car access to HSIA will satisfy the new Terminal 3 car park in phase-1 timeframe. On the other hand, the required capacity of car park in phase-2 is expected to reach about 1,700. In phase-2, it is planned that the existing Terminal 1/Terminal 2 will be renovated and used for international terminal. Therefore, considering the use of its car park is a rational idea. In that case, the total capacity of car park will reach about 2,000. As a result, the current car park capacity plan and phased development plan are appropriate.

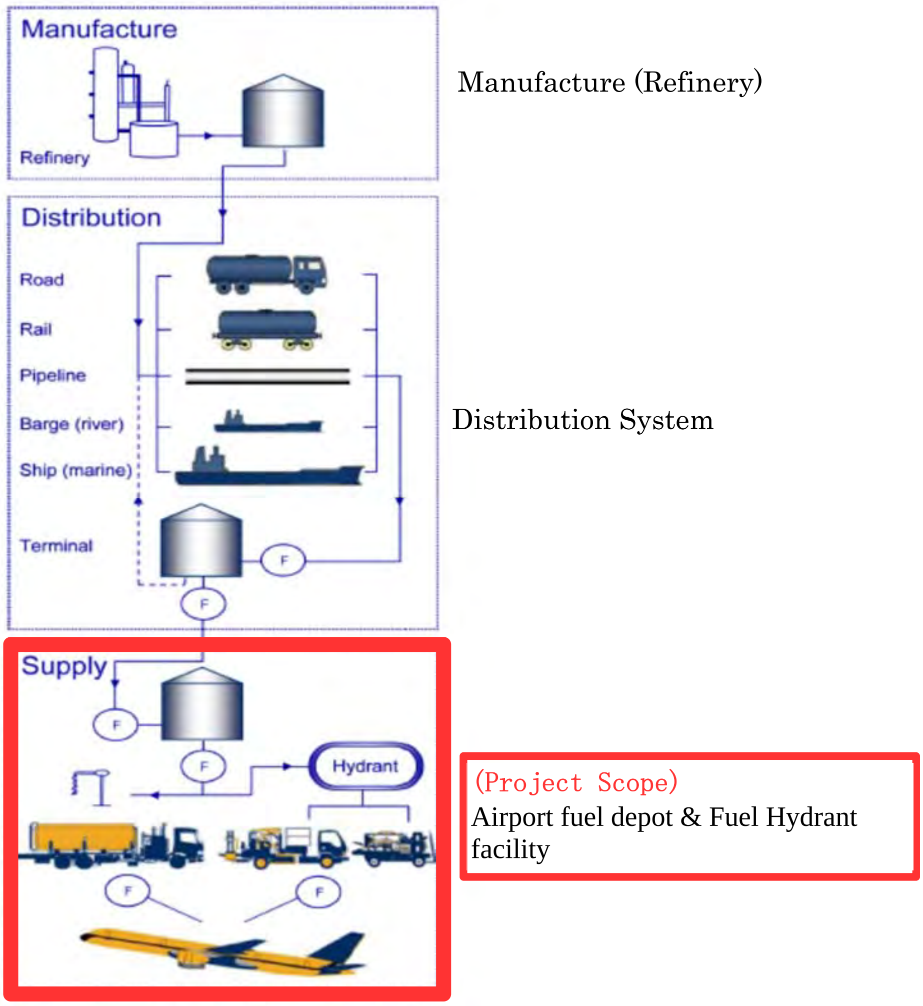
7.3.7 Fuel Supply Facility

The fuel supply facility is not indicated in the CAAB Master Plan. However, according to the development of new terminal 3 (T3), the hydrant facility for new parking spots at T3 is required.

Fuel supply system consists of following facilities;

- Jet Fuel Refinery
- Distribution System of Jet Fuel
- Fuel Depot (Storage Tanks, Hydrant Pumps, etc.,)
- Hydrant Facilities (Apron)

Schematic diagram of fuel supply system is shown in Figure 7-8. The project scope is indicated in the red square box.



Source: EI1550 (Reference of ICAO Doc9977)

Figure 7-8 Schematic Diagram of Fuel Supply System

(1) Treatment of existing facility and T3 facility

The treatment of the existing facilities and T3 facility are defined as follows;

- The fuel depot and hydrant facility are a single fuel supply system and cannot be segregated individually. Therefore, the implementation of fuel supply system (Fuel depot and hydrant facility) for T3 must also be implemented as an integrated system.
- However, the construction time for the existing fuel supply facility and new fuel supply facility will differ and the facility design codes/standards, equipment specifications and equipment capacity/pressure are all different between fuel supply facility for T3 and existing facilities. Therefore, the fuel supply facilities for T3 and existing facilities must be developed and installed individually.
- Accordingly, the existing fuel supply facility will continue to supply jet fuel to T1, T2 and cargo area, etc., while a land fuel depot and hydrant system to supply fuel to T3 will be separately required.

- The existing storage tanks currently have 2,880kl capacity and the three additional storage tanks under construction each have a capacity of 2,500kl for a total storage capacity of 7,500kl. The combined capacity is not sufficient to meet requirements (17,000kl) after the completion of T3, and a dedicated storage facility is required separately for T3.
- The three 2,500kl storage tanks under construction by Padma Oil Co., Ltd., shall be considered solely for the supply to T1 and T2 at Phase 2 stage. Therefore, these tanks are not considered for the development of fuel supply facility at Phase 1 stage.
- According to the meeting between CAAB and Padama Oil Co., Ltd. held on 24th October 2016, the relocation of existing pipeline under T3 terminal building and installation of new hydrant pipeline to GA apron at the north area will be developed by Padama Oil Co., Ltd. was confirmed, butt the hydrant facility for T3 was not discussed. The hydrant facility for T3 is under coverage of Japan Yen Loan Package and further discussion with Padama Oil Co., Ltd. concerning its plans for the fuel supply system to T3 and detailed demarcation of work.

(2) Planning of Supply Volume

1) Current fuelling capacity at HSIA

The current fuel supply capacity is shown in Table 7-32.

Table 7-32 Current Fuel Supply Capacity at HSIA

Item	current(2015)	Basis
Annual passenger demand	12.42mppa	JICA Study Team data
Annual fuel supply	356,000kl./year	Data from Padma Oil
Average daily fuel supply	1,000 kl/day	Annual fuel supply/365

Source: JICA Study Team

2) Projected fuelling capacity at HSIA

The projected fuel supply capacity is shown in Table 7-33.

Table 7-33 Projected Fuel Supply Capacity at HSIA

Item	Phase 1(2025)	Phase 2 (2030)	Basis
Annual passenger demand	14.127mppa	19.041mppa	JICA Study Team data
Annual fuel supply	776,000kl./year	1,046,000kl./year	Data from Padma Oil
Average daily fuel supply	2,126 kl/day	2,866 kl/day	Annual fuel supply/365

Source: JICA Study Team

3) Projected fuelling capacity at T3

The fuel supply to Terminal 3 is set out for passenger capacity of 12 mppa. The required fuel reserve capacity will be seven days to manitain stable suupply of fuel at the airport.

The estimated fuel capacity and required reserve capcity are shown in Table 7-34.

Table 7-34 Estimate of Fuel Supply Volume and Required Reserve Capacity

Item	Phase 1(2025)	Phase 2 (2030)	basis
Planned T3 passenger capacity	12.42mppa	16.082mppa	JICA Study Team data
Estimated annual Fuel supply for T3	661,000kl./year	883,000kl./year	Based on increased passenger numbers
Average daily fuel supply of T3 facilities	1.811 kl/day	2,419 kl/day	Annual fuel supply/365
Required reserve capacity	12,667 kl	16.993 kl	Daily fuel supply x 7

Source: JICA Study Team

4) Planning of Reserve Tank Capacity based on required Reserve Capacity

The new reserve tank facilities for T3 are shown in Table 7-35. 3 tanks of 4,500kl capacity will be required in phase-1 and 4 tanks in phase 2.

Table 7-35 Planned Reserve Tank Facilities

Item	Phase 1(2025)	Phase 2 (2030)
Required reserve capacity (7 days)	12,677 kl	16,933 kl
Capacity of one tank	4,500kl	4,500kl
No of tanks	3	1
Total tank capacity	13,500 kl	18,000 kl
Reserve days	7.5 days	7.4 days

Source: JICA Study Team

The following considerations were made in the planning

- The unit cost for tank become lower as tanks are made bigger. Small tanks are not planned and the largest possible sizes are selected.
- The additional units are made the same size to simply operations.
- Tank operations operated with three tanks as a system with one receiving tank, one stilling tank and one discharge tank in order to maintain quality and therefore require three tanks as a minimum. Therefore, each unit is planned as one thirds the required reserve capacity for phase 1 with three units in total for efficiency. As a result the additional tank planned for phase 2 can be used as the reserve unit.

(3) Fuel Hydrant Capacity Planning for Terminal 3

Fuel hydrant facilities with the capacity to meet the peak hour departures at terminal3 will be required.

The flow rate for hydrant facility at Terminal3 is shown in Table 7-36.

Table 7-36 Hydrant Flow Rate

Items	Phase-12025)	Phase-2（2030)	Basis
Aircraft movement at peak hour	28 times/hour	35 times/hour	JICA Study Team reports
Simultaneous fueling	6 aircrafts	10 aircrafts	

Phase-1 Hydrant flow rate	817 kL/h (3,600 gpm)	817 kL/h (3,600 gpm)	Hydrant servicer @600 us-gpm
Phase-2 Hydrant flow rate	-	545 kL/h (2,400 gpm)	
Phase-1,Phase-2 Total	817 kL/h (3,600 gpm)	1,362 kL/h (6,000 gpm)	

Source: JICA Study Team

The refuelling service shall be done by fueller (lorry with fuel tank) at the new cargo terminal because the fuelling volume is small.

1) Planning and Realization of Facility Capacity

The planned dimensions for the fuel supply system are shown in Table 7-37 and Figure 7-9.

Table 7-37 Summary of Current Capacity of Fuel Supply Facility

Item		Phase-1 (2025)	Phase-2 (2030)	Total
Fuel Tanks	Phase 1	4,500kl x 3 units	-	4,500kl x 3 units
	Phase 2	-	4.500kl x 1 units	4,500kl x 1 units
	Total	4,500kl x 3 units	4,500kl x 1 units	4,500kl x 4 units
Hydrant flow rate	Phase-1	817 kL/h	-	817 kL/h
	Phase-2	-	545 kL/h	681 kL/h
	Total	817 kL/h	545 kL/h	1,362 kL/h

Source: JICA Study Team

<u>Capacity of Existing Fuel Depot</u>
Fuel Storage Capacity :
2,880kl+(7,500kl)
Hydrant Pump : Unknown

Pipeline Diameter 14” and 8”
Flow Rate: 2,400gpm

Fuel Supply to the Existing T1, T2, Cargo and GA

<u>Required Storage and Hydrant Pump Capacity (Phase 1)</u>
Storage Capacity: 13,500kl
Hydrant Pump : 817 kl/h (3,600gpm)

Pipeline Diameter 16” x 2 lines
Flow Rate: 817 kl/h (3,600gpm)

Fuel Supply for New T3

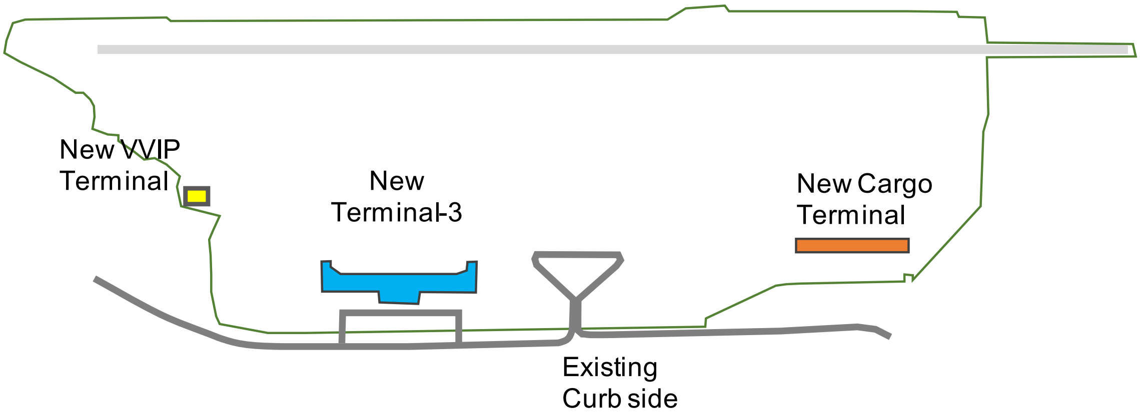
Note: 1,000gpm = 227kl/h
Source: JICA Study Team

Figure 7-9 Summary of Fuel Supply Facility Plan

7.4 Proposal of Phased Development Based on Priority of Each Facility

7.4.1 HSIA Phased Development

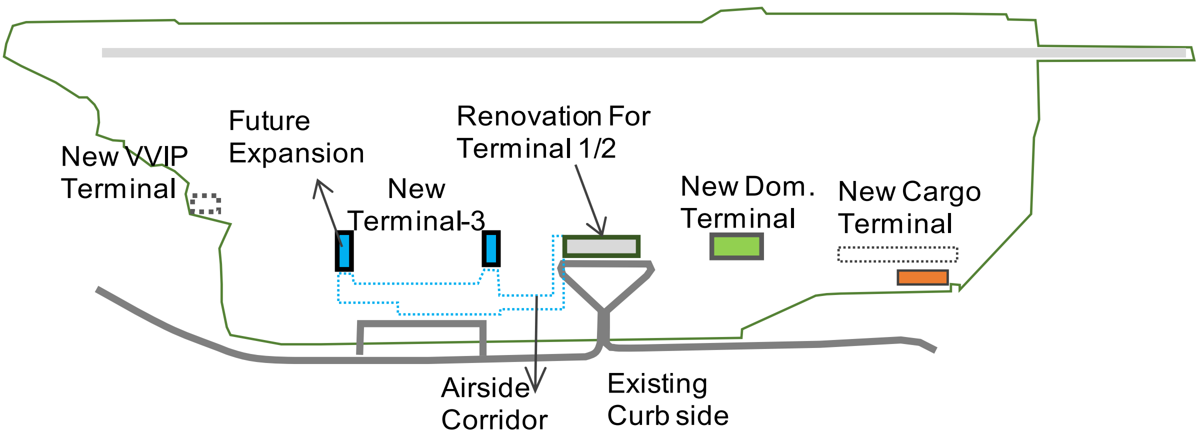
After the discussions with CAAB, it was confirmed that the future development of the HSIA airport facilities would be divided into two phases. During phase-1 (2020) development, the new Terminal 3 will be built without the piers on both left and right sides. In the next step, the pier extension will be planned based on future demand.



Source: JICA Study Team

Figure 7-10 Phase-1 of HSIA Development

During phase-2 development as shown in Figure 7-9, the piers for international flights will be extended at T3. It is projected that the current domestic terminal will not have enough capacity to satisfy future demand. Part of current terminal (T1/T2) can be renovated and used as the domestic terminal or a new domestic terminal constructed on its northwest side. After moving the domestic terminal into new location, the existing terminal (T1/T2) will be renovated and connected to the new Terminal 3, and operated as an international passenger terminal to increase the operation capacity of international passengers. In this case, to ensure that all the functions of the original terminal can be performed normally, the connection with the new Terminal 3 shall be taken by airside corridor.



Source: JICA Study Team

Figure 7-11 Phase-2 of HSIA Development

CHAPTER 8 AIRPORT IMPROVEMENT PLAN

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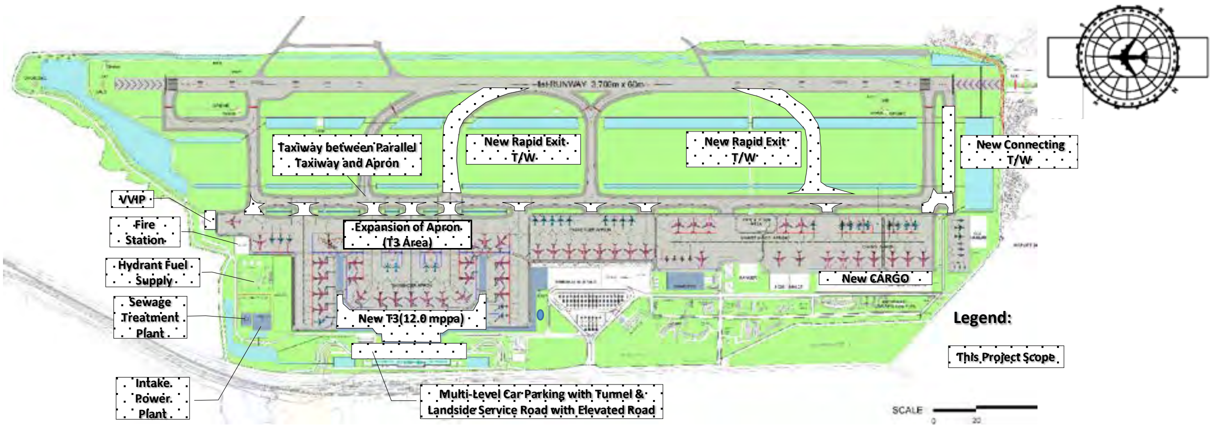
Chapter 8 AIRPORT IMPROVEMENT PLAN

The scope of the the Airport Improvement Plan is examined based on the present condition and required size of the facilities as shown in Table 8-1 and Figure 8-1. The target of the plan is 12 mppa in 2025, five years after the commencement of services at the new international terminal (Terminal 3). The Airport Improvement Plan follows the capacity of necessary facilities calculated in the data collection survey.

Table 8-1 Details of Scope of Works (Phase - 1)

Works	Division	Facilities
Building	New Passenger Terminal Building (Terminal 3)	Three-story building with area of approximately 220,000 m^2 including supply of related equipment with capacity of 12.0 mppa
	Multi-Level Car Parking with Tunnel	Area of approximately 62,000 m^2
	New Cargo Complex	Area of approximately 42,200 m^2
	VVIP Complex	Area of approximately 5,000 m^2
	Rescue and Fire Fighting Facilities	
Civil	Parking Apron (Terminal 3 Area)	Approximately 520,000 m^2
	Taxiways	9 connecting taxiways connecting to the Terminal 3 apron: approximately 35,000 m^2
	Landside Service Road with Elevated Road	
	Taxiways (two rapid exit and one connecting taxiway for the runway 14 threshold)	Approximately 60,000 m^2
	Improvement of Drainage System	
Utility	Water Supply System	
	Sewage Treatment Plant	Area of approximately 3,000 m^2
	Intake Power Plant with Distribution System	Area of approximately 7,000 m^2
	Hydrant Fuel Supply System	
	Communication System	
	Security and Terminal Equipment	

Source: JICA Study Team



Source: JICA Study Team

Figure 8-1 Layout of Scope of Works

8.1 Passenger Terminal Building

8.1.1 Area and Location Plan

In the improvement plan for Terminal 3, the contact stand will secure 12 spots in accordance with the improvement plan area (about 220,000 m^2) corresponding to the target planning year (2025) of Terminal 3. The case that C1 line in Figure 8-2 is set as the boundary line of Phase-1 was confirmed in a meeting with CAAB. The result of confirmation with CAAB is shown in Figure 8-2 to Figure 8-5.

In case the scale of Phase-1 is up to the C1 line, the area is minimal, and passenger flow is not to be troublesome. However, it is necessary to consider the adjustment of the gate lounge area on the first floor and the concession area since the gate lounge area on the first floor is not large enough in this case. For this adjustment, a meeting with CAAB is necessary. Also, in the next stage, the detailed design based on the Phase-1 function is necessary.

In the 2nd meeting with CAAB held on 6th Feb 2017, the above scope of Phase-1 facilities was reconfirmed. The necessity for rearrangement of layout to satisfiy functional requirements of a 12 mppa terminal, especially the detailed design of M&E, TE, Security and Police Rooms required in the next stage was also comfirmed.

8.1.2 Phased Improvement Plan and Construction Term

Confidential

Figure 8-2 Improvement Area of Phase-1（Up to GRID LINE C1）

Confidential

Figure 8-3　Second Floor Plan

Confidential

Figure 8-4　First Floor Plan

Confidential.

Figure 8-5 Ground Floor Plan

8.2 Cargo Terminal

8.2.1 Layout Plan, Schedule and StagedConstruction Plan and Process

More than a decade has passed since the construction of the current export cargo terminal, based on the explanation of CAAB and a structural evaluation is necessary regarding the soundness of the building.

In addition, unused equipment is left abandoned inside the building and layout of some equipment is not appropriate for operations.

In addition, part of the existing export cargo terminal building is included in the scope of the apron construction plan, and partial removal is necessary at the time of apron constraction.

Even if the existing building is kept available for the export cargo terminal, a drastic change of the layout, removal of some equipment, and installation of new equipment are considered necessary.

On the other hand, it is not permitted to close an existing export terminal during operation. Therefore, the new export cargo terminal will be built on the right side (northwest side) of the existing export cargo terminal. After moving export cargo operations to the new facility, the new import cargo terminal will be constructed on the left side (southeastern side).

At present export and import cargo terminal are operated separately. On site inspections revealed serious issues with the space for breakdown and build-up operations. Rebuilding the import and export cargo terminals as a single integrated structure is essential for the improvement of basic handling unit.

Confidential due to security reasons.

Figure 8-6 Cargo Terminal Layout

8.3 VVIP Buiding

The policy of the improvement plan for the VVIP building is as follows:

- The functions of the new VVIP building will follow that of the existing VVIP building.
- It was confirmed with CAAB that only general drawings (plan view, elevation view, sectional view) exist for the new VVIP building, and since there are no further drawings, detailed designs including recommended improvements are required.

8.4 Fire Fighting Facility

Confidential due to security reasons.

Table 8-1 Planning Scale of Fire Fighting Facility

Confidential due to security reasons.

8.5 Apron

8.5.1 Design Aircraft and Design Load

Based on aircraft movement forecast in this survey, the aircraft traffic volume for apron pavement design is shown in Table 8-2. The design period for apron pavement is 20 years, from 2016 to 2035.

Table 8-2 AircraftTraffic Volume for Apron Pavement Design

ICAO Aerodrome Reference Code (Aircraft Type)	Total Departure and Arrival (from 2016 to 2035)			Total Departure	Average Annual Departure for 20 years (number per year)	Input
	Domestic (20 years)	International (20 years)	Total (20 years)			Design Traffic Volume (number per year)
B (Small Propeller)	676,723	0	676,723	338,362	16,918	16,918
C (Turboprop)	250,587	147,124	397,711	198,855	9,943	9,943
C (Small Jet)	325,625	608,047	933,672	466,836	23,342	23,342
D (Medium Jet)	0	31,064	31,064	15,532	777	777
E (Large Jet)	0	751,448	751,448	375,724	18,786	18,786
F (A380)	0	15,532	15,532	7,766	388	388
Total	1,252,936	1,553,215	2,806,151	1,403,075	70,154	70,154

Source：JICA Study Team

8.6 Taxiway

8.6.1 Design Aircraft and Design Load

Since only 10% of aircraft land in runway 32 direction, the design traffic volume for the north rapid exit taxiway of the taxiway constructed in Phase-1 is 10% of total arrival aircrafts. Based on the aircraft movement forecast in this survey, the aircraft traffic volume for the north rapid exit taxiway pavement design is shown in Table 8-3. The design period for the rapid exit taxiway is 20 years, from 2016 to 2035.

Table 8-3 Aircraft Traffic Volume for the North Rapid Exit Taxiway Pavement Design

ICAO Aerodrome Reference Code (Aircraft Type)	Total Departure and Arrival (from 2016 to 2035)			Total Departure	Average Annual Departure for 20 years (number per year)	Input
	Domestic (20years)	International (20years)	Total (20years)			Domestic (20years)
B (Small Propeller)	676,723	0	676,723	338,362	16,918	1,692
C (Turboprop)	250,587	147,124	397,711	198,855	9,943	994
C (Small Jet)	325,625	608,047	933,672	466,836	23,342	2,334
D (Medium Jet)	0	31,064	31,064	15,532	777	78
E (Large Jet)	0	751,448	751,448	375,724	18,786	1,879
F (A380)	0	15,532	15,532	7,766	388	39
Total	1,252,936	1,553,215	2,806,151	1,403,075	70,154	7,015

Source: JICA Study Team

The aircraft traffic volume used for the design of pavement for the rapid exit taxiways, excluding the north rapid exit taxiway, is the same as that for apron pavement design. The design period for rapid exit taxiway pavement is 20 years, from 2016 to 2035.

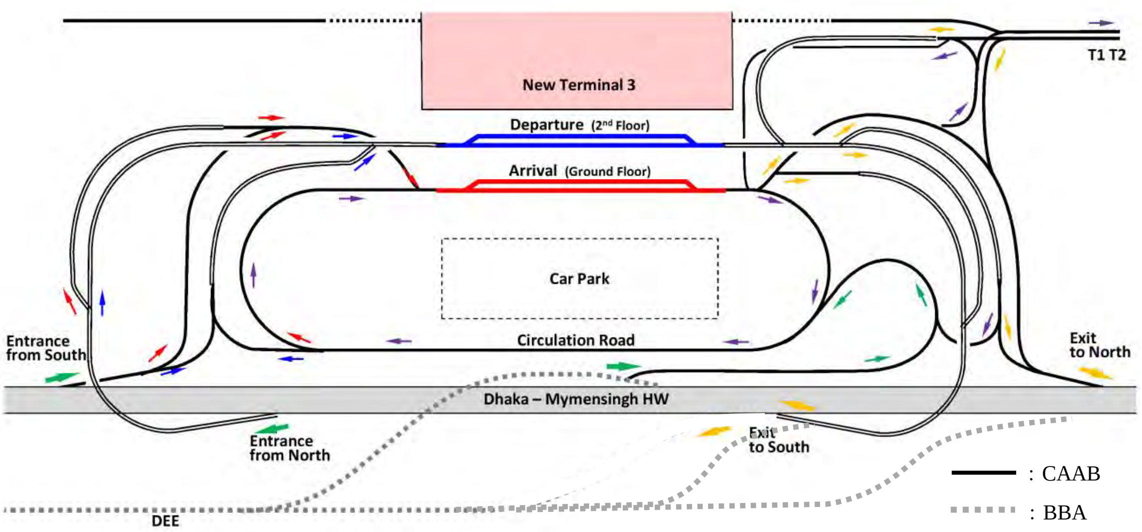
8.7 Internal Road

8.7.1 Road

(1) Basic Policy

The basic policy for planning the internal road is shown below.

- The road layout will follow the past conceptual design.
- The crossing of a major road should adopt elevated crossovers for smooth traffic.
- The circulation road should be provided for functional access in internal area.
- Highest possible service level should be provided in the limited landside space.
- The roads and bridges should be designed for easy recognition of directions.



Source: JICA Study Team

Figure 8-7 Traffic Line of Access / Approach Road

(2) Road Classification

1) Design Standard

Landside road is based on the design standards of Bangladesh and will also refer to the standards of Asian Highway, Japanese road, and IATA manual.

- Geometric Design Standards / Oct 2000 / Roads and Highways Department
- Road Design Standards / May 2004 / Planning Commission

2) Road Classification

The road classification of internal road is equivalent to Type-4 of the Roads and Highways Department (RHD), and the target design speed is 40 km/h. In unavoidable cases, a reduced value will be adopted due to the limited landside spaces. However, a higher service level should be provided whenever possible.

Table 8-4 R oad Classification

Parameter	Bangladesh			Asian Highway		Japan		Proposed
Road Classification	Type3	Type4	Type5	Class2	Class3	3-2	Ramp-B	
Design Speed km/h	50-80	40-65	30-50	40-80	30-60	40-60	30-60	40 (20-30) *1

*1: The reduced value of 20-30 km/h is adopted in a part of curves and curbsides.
Source: JICA Study Team

3) Lane Number

The required number of lanes is analyzed based on the traffic demand forecast in the airport in 2035. In the main internal road, more than two lanes should be provided in consideration of manintaining service levels and the mixture of low speed vehicles such as buses.

Table 8-5 Analysis of Lane Number

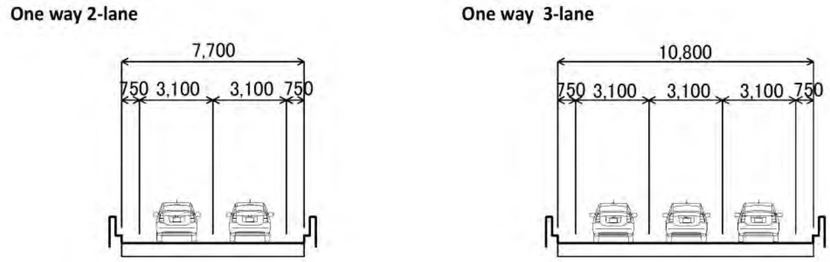
Traffic Capacity

	Basic Capacity Value (pcu/h)	Correction Factor: Lane Width	Correction Factor: Lateral Clearance	Correction Factor: Roadside Condition	Correction Factor: Large Vehicle	Service Level	Traffic Capacity (veh/h)
Multi Lane	2,200	0.94	0.95	0.75	0.86	0.90	1,140

Required Number of Lane (2035)

Road		Total Traffic Volume (veh/h)	Distribution (%)	Traffic Volume (veh/h)	Traffic (veh/h)	Required Number of Lane: Calculated Value	Required Number of Lane: Recommend
Entrance	N3 South	4,300	30%	1,290	1,140	1.14	2
	N3 North		30%	1,290	1,140	1.14	2
	DEE		40%	1,720	1,140	1.51	2
Exit	N3 South & DEE		70%	3,010	1,140	2.65	3
	N3 North		30%	1,290	1,140	1.14	2

Source: JICA Study Team

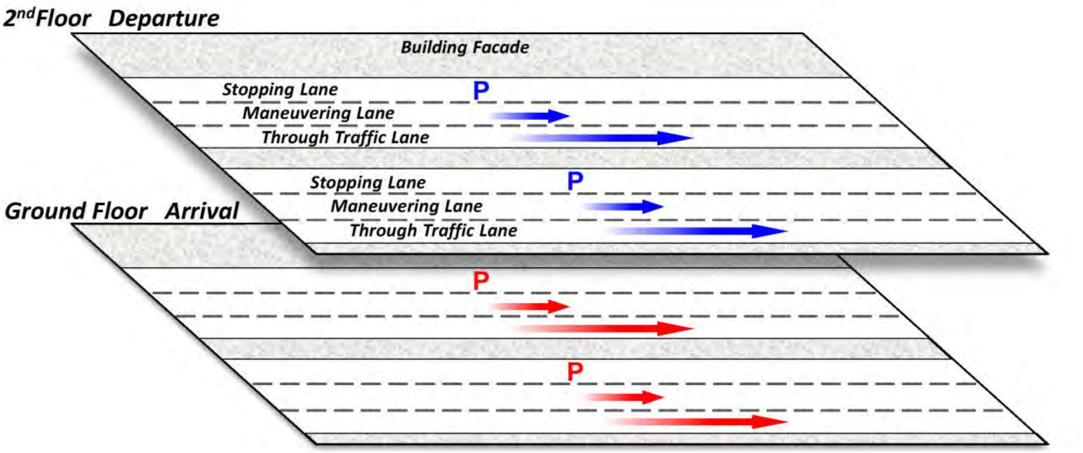


Source: JICA Study Team

Table 8-6 Cross Section of Access / Approach Road

4) Kerbside

The departure and arrival floors are each provided with two kerbsides for smooth traffic at peak hour, al of which will be composed of three lanes for stopping, through traffic, and maneuvering.



Source: JICA Study Team

Figure 8-8 Layout of Kerbside

CHAPTER 9 STUDY OF MULTIMODAL HUB FUNCTION

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Chapter 9 STUDY OF MULTIMODAL HUB FUNCTION

9.1 Current Condition

The daily trip number at HSIA was surveyed in the project for the Revision and Updating of the Strategic Transport Plan for Dhaka (RSTP) by the Japan International Cooperation Agency (JICA) in 2015.

- ✈ The daily trip number of airline passengers and well wisher/greeters is estimated at about 60,000 persons, of which about 56,000 persons (93%) visited the international terminal and 4,000 persons (7%) visited the domestic terminal. Only 11,000 persons (18%) out of the 60,000 are airline passengers and the other 49,000 persons (82%) are well-wisher/greeters of the airline passengers.
- ✈ The survey results show that almost all visitors used road transportation for access such as CNG (12%), car/taxi (17%), bus (44%), and microbus (26%). The Study found that no passenger use of the railway Airport Railway Station to access the airport.
- ✈ The Airport Railway Station of Bangladesh Railways (BR) is heavily used with an estimated daily access by 43,355 railway passengers and well wisher/greeters. Almost all railway access is by bus. Station access survey by RSTP shows the modal share for the Airport Railway Station to be: bus (65.8%), car/taxi (2.7%), and CNG (14.5%).

The Airport Railway Station actually functions as the northern railway hub for long-distance trips to all parts of Bangladesh, and also as the commuter hub from northern Dhaka to the Kamalapur Railway Station hub in central/southern Dhaka.

Although the Airport Railway Station is located only 600 m from the entrance to the exisiting terminal building at HSIA, there are no pedestrian facilities connecting the Airport Railway Station and the Airport Terminal Building and access is very difficult at present.

In the general vicinity of the Airport Railway Station, a five-star hotel and shopping mall are under construction on the opposite side of the Airport Road. However, pedestrian accessibility between the Airport Railway Station and these commercial facilities is not yet available, although a new pedestrian bridge crossing over the Airport Road is now under construction.

9.2 Urban Transportation Network Development Plan Connecting with HSIA

The RSTP proposed a mass transit network for Dhaka City by 2035, which consists of five mass rapid transit (MRT) and two bus rapid transit (BRT) lines. The existing BR lines are also a significant part of the public transportation network of Dhaka City. However, it is doubtful that high density train operation on the BR lines between the Airport Railway Station and Kamalapur Railway Station is feasible considering that the existing double track railway is at-grade and various level crossings exist, which would seriously disrupt the traffic flow in the city. Based on the future railway network in Dhaka, the JICA Study Team assessed the possibility of twin hubs development with multimodal transport functions. One is the northern hub at the Dhaka International Airport and the other is the southern hub at the Kamalapur Railway Station. The northern hub, i.e., HSIA, will have access through MRT Line-1, BRT Line-3, and double-double track of BR. In addition, the Dhaka Elevated Expressway (DEE) will be connected with HSIA.

9.3 Traffic Demand Forecast for HSIA

9.3.1 Assumption of Traffic Volume at HSIA

Daily passengers were calculated from total domestic and international passengers numbers for 2015 obtained from CAAB. Total number of well-wishers is estimated from the ratio of passengers and well-wishers according to the RSTP Study.

Modal share is applied based on the above reports to allocate domestic and international terminal visitors into passengers and well-wishers for each transport mode.

Table 9-1 Daily Total Passengers and Staffs for Each Transport Mode in 2015

	Domestic		International		Staffs	Total
	Passengers	Well-wishers	Passengers	Well-wishers		
CNG	368	1,047	1,992	10,274	23	13,704
Car	416	1,184	12,825	29,476	371	44,272
Microbus	813	2,315	3,378	15,412	179	22,097
Bus	1,412	4,019	291	29,055	1,202	35,979
Total	3,009	8,565	18,486	84,216	1,776	116,053

trip / day
Source: JICA Study Team

In order to calculate the traffic volume at HSIA, the daily total passengers, well-wishers, and staffs for each transport mode are divided by the average occupancy rate. Average occupancy rate is given by the RSTP screen line survey. This survey was conducted within the Dhaka central area. It is considered that much more passengers are riding together in the airport access car and microbus compared with those in the Dhaka central area because the majority of well-wishers are family members. Two additional fellow passengers are estimated for private cars and microbuses as summarized in Table 9-2.

Table 9-2 Average Occupancy Rate

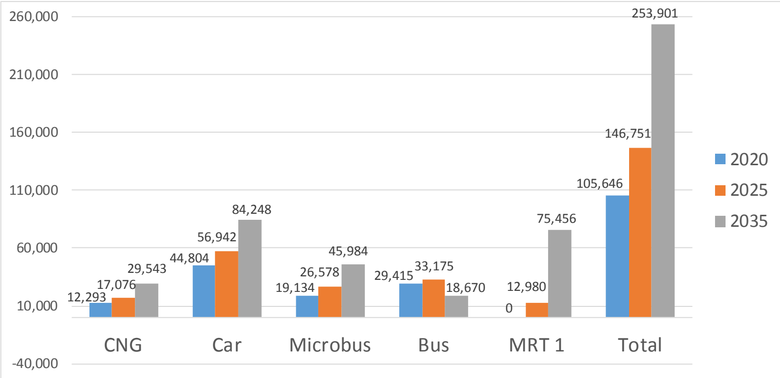
Vehicle Type	Obtained from RSTP	Modified by the JICA Study Team
CNG	2.3	2.3
Car	2.4	4.4
Microbus	3.8	5.8
Bus	42.3	42.3

Source: RSTP and JICA Study Team

9.3.2 Preliminary Future Airport Access Traffic Demand Forecast

(1) Future Person Trip Demand at HSIA

Applying the above future demand and modal share, the future traffic demand is assumed as summarized in Figure 9-1.

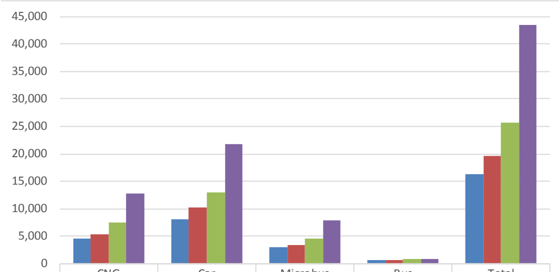


Source: JICA Study Team

Figure 9-1 Future Person Trip Volume

(2) Future Traffic Demand at HSIA

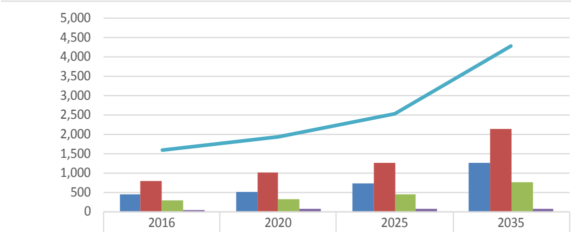
Total assumed traffic volume is shown in Figure 9-2, and total assumed hourly peak hour traffic volume is shown in Figure 9-3.



	CNG	Car	Microbus	Bus	Total
2016	4,549	8,153	2,908	622	16,232
2020	5,345	10,183	3,299	696	19,523
2025	7,425	12,942	4,583	785	25,735
2035	12,845	21,743	7,929	894	43,411

Source: JICA Study Team

Figure 9-2 Total Assumed Traffic Volume



	2016	2020	2025	2035
CNG	450	529	735	1,271
Car	807	1,008	1,280	2,151
Microbus	288	326	453	784
Bus	62	69	78	88
Total	1,606	1,932	2,546	4,295

Source: JICA Study Team

Figure 9-3 Total Assumed Hourly Peak Hour Traffic Volume

9.4 Current Development Plan for Multimodal Hub Facilities

9.4.1 Overview of the Development Plan Proposed by Bangladesh Railway

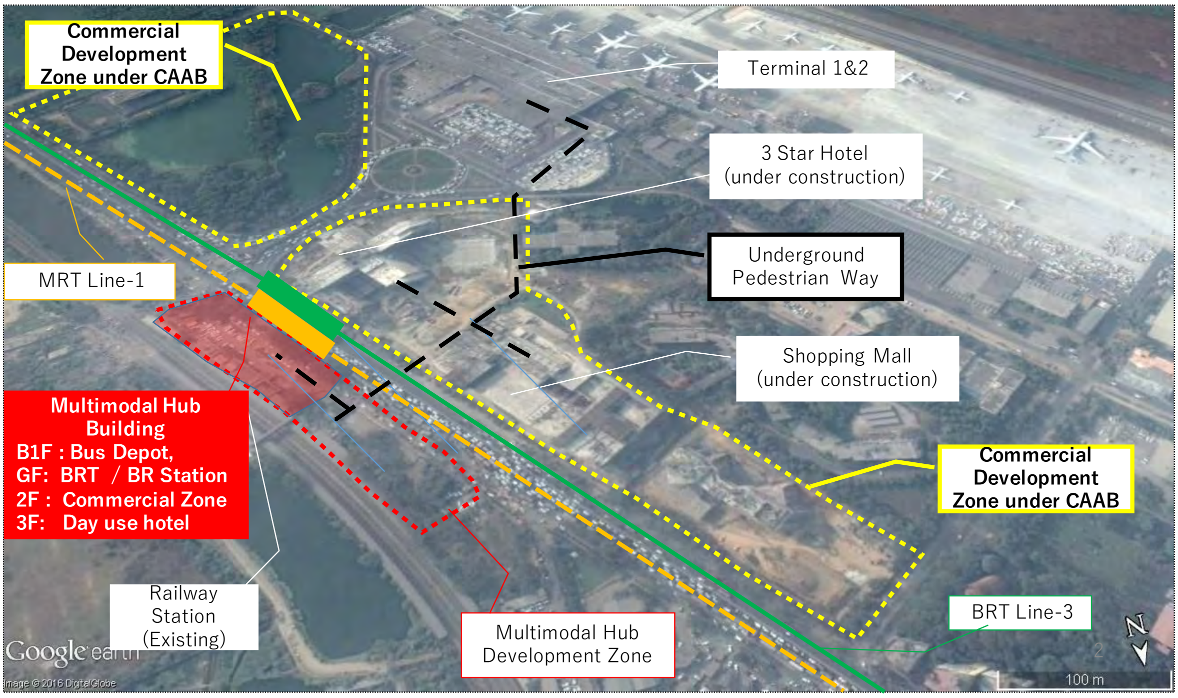
A multimodal transport hub has been considered in the Greater Dhaka Sustainable Urban Transport Project (GDUSTP) (BRT, Airport-Gazipur) to facilitate easy and smooth transfer from one mode to another, especially between BRT and rail. These multimodal transport hub facilities, as envisaged in the Development Project Program (DPP) of the BRT Line-3 Project, were planned to be constructed on a public-private partnership (PPP) basis, premised on including revenue generating facilities at the hub. A pre-feasibility study prepared under GDSUTP (BRT, Gazipur-Airport) has been submitted for consideration of the Ministry of Railways. BR owns land nearby the airport, out of which more than 7,000 m^2 of land could be utilized to develop this multimodal hub, although part of this area is already utilized by the existing railway station.

The outline of the multimodal hub facilities is as follows:

- B1F: Depot for 30 buses, waiting room for railway passengers, and shopping mall
- GF: BRT station and U-turn facility, rest space for operators, and railway signal operation room
- 2nd Floor: Commercial space
- 3rd Floor: Hotel (for international passengers, 2-3 star class).

In the plan, MRT Line-1, planned for future construction, is also considered to connect to the hub facilities. MRT Line-1 is planned as an underground station and will connect with the multimodal building through an underground pedestrian tunnel is to be constructed to connect to the commercial zone in the airport landside and to the existing terminal building.

In summary, the multimodal transport hub plan at the existing Airport Railway Station yard will be integrated with the BR line, BRT Line-3, MRT Line-1, and existing Terminal 1 and Terminal 2 of the airport as well.



Source: JICA Study Team based on the plan of BR and RSTP

Figure 9-4 Current Multimodal Hub Development Plan

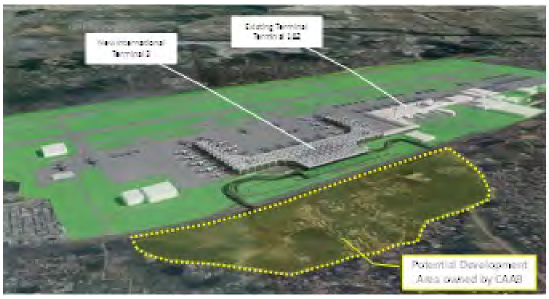
The review points on the multimodal hub facility development are summarized as follows:

- Current location of the proposed multimodal hub facility is too far for pedestrian access to the new Terminal 3.
- BR is planning to develop 3rd and 4th tracks of BR Dhaka (Kamalapur) – Airport Station – Tongi, and additional platform will be required at the Airport Station.
- BR is considering to relocate Airport Railway Station southward, as the current platform is located on a curved portion and not suitable from the safety viewpoint.

- BRT Line-3 is about to start implementation and obliged to change operation plan as depot for 30 buses is expected to be provided in the multimodal hub facilities.
- PPP scheme is not realistic at this moment, as no private investors are interested in financing. Restructuring the development plan is essential for implementation.

9.4.2 Distribution of Airport Users Due to the Relocation of International Terminal

There is a huge plot owned by CAAB in front of the new terminal of HSIA on the opposite side of the Airport Road. The total area is 9.4 ha, which is currently used as residential area of CAAB staff. The land use plan is formulated in the master plan in February 2015, in which the area is still planned as residential area of CAAB staff and for the maintenance aspects such as education and airport supporting complex.



Source: CAAB Master Plan, Feb.2015

Figure 9-5 General View of CAAB Land

The proposed structure plan of the land in front of Terminal 3 is summarized as follows:

- Concept of Structure Plan
  - Planning Population: 21,500
  - Pop. Density: 515 persons/ha
  - 40% land to distribute as residential area of CAAB staff.
  - 20% land to distribute as park and 20% for public facilities,
  - 8% land to distribute central commerce and 12% for support facilities to boost economy around Dhaka International Airport.

The Land Use Plan may not consider the development potential of Airport Front Area

Source: JICA Study Team

Figure 9-6 Existing Land Use Plan of CAAB Area in front of Terminal 3

On the other hand, the land in front of the new terminal might have high development potential, and may be not suitable as residential area because of the following reasons:

- The area can be identified as International Gateway City of Bangladesh, as the location is directly in front of the international terminal. There are many other examples of development of gateway city nearby the international airport, such as Bangkok, New Delhi and so on.
- Airport accessibility through public transportation should be taken into account. It is not convenient for the airport users to use the proposed multimodal hub facilities at the existing BR Airport Station. New stations for BRT and MRT are anticipated to be located in front of the international terminal for easy access. BRT/MRT access are secured in almost all major international airports, such as Delhi, Bangkok, Kuala Lumpur, Haneda, and so on. A part of the residential area can be used for multimodal access to the international airport.
- Residential purpose in front of the international terminal would not be suitable in view of environmental, noise pollution, and security aspects.
- Taking the above into account, it is recommended to review the land use plan in front of the international airport terminal.

9.5 Proposed Plan for Multimodal Hub Function at HSIA

Based on the above studies and analysis through the demand forecast, traffic counting survey, and so on, the following measures are proposed related to the multimodal hub function at HSIA:

9.5.1 Separate Functions on BR's Multimodal Hub Facilities and Public Access Mode on HSIA Terminal 3

Considering the following, it is proposed that the BR's multimodal hub facilities would contribute to the better access to HSIA, particularly for the new international Terminal 3. It is therefore recommended that the BR multimodal hub facility shall be considered separately from the airport access development function, and not to be considered in the Airport Expansion Project.

- BR railway is heavily congested and scheduling is not frequent, making it difficult to use BR railway with heavy luggages.
- The distance between the BR Airport Railway Station and existing airport terminal is too close to use taxi/CNG, but too far for pedestrian traffic with heavy luggages. Therefore, there will be few airport users using the railway.
- It is quite difficult to cross over the Airport Road between the Airport Railway Station and existing airport terminal. The road is always heavily congested and no pedestrian bridge with escalator over the Airport Road is available.
- BR Airport Railway Station is functioning as multimodal hub for commuters in northern Dhaka. The passengers are not airport users but residents of northern Dhaka for commuting to central and southern Dhaka City.

9.5.2 Provision of Public Transportation Access to HSIA

Provision of public transportation mode is very important and should be considered in the Airport Expansion Project. Conceivable public transportation access would be by BRT, MRT, city buses and taxi in addition to private vehicles. Particularly, MRT would be the most important access mode for HSIA by public transportation because traffic congestion in Dhaka City is very severe and the impact on time savings by using MRT would be significant compared to road transportation. It often takes one to two hours from the airport to major terminals in the city by car, taxi, or bus, but it will take only 15 minutes from Kamalapur Railway Station to Terminal 3 via MRT. BRT and airport bus services should also be developed to supplement public access where MRT cannot have coverage.

Table 9-3 Comparison of Airport Access Mode of Asian International Airports

City	Kuala Lumpur		Singapore		Delhi		Dhaka	
Access Mode	Time	Fare	Time	Fare	Time	Fare	Time	Fare
Railway	28 min	MYR35	30 min	SGD 2.2	20 min	INR 100	15 min	-
Airport Bus	60 min	MYR 10	30-60 min	SGD 9.0	50 min	INR 75	60-120 min	-
Taxi	60 min	MYR 70-90	20-40 min	SGD 20-40	50 min	INR 400-500	60-120 min	-

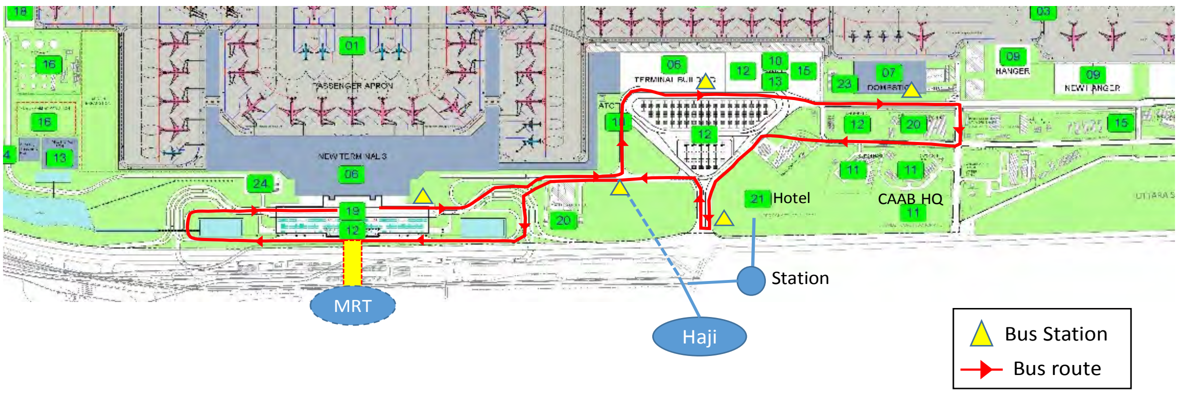
Source: Travel information through internet for Kuala Lumpur, Singapore, and Delhi; JICA Study Team estimation for Dhaka

9.5.3 Provision of Airport Bus Services and Planning for Bus Stops

Airport bus service from/to airport and major places in the city, such as railway station, bus terminal, major hotels and so on, shall be planned by CAAB. This mode would be the most convenient for international visitors, who are not familiar with the Dhaka City area. The airport bus should be basically exclusive to transport airport users carrying luggages to/from major transport hubs in Dhaka and hotels. The considered destinations are as follows:

- ✈ Major Bus Terminals (Saidabad, Gabtoli, Mohakhali, others)
- ✈ Railway Station (Kamalapur (BR), Airport Station (BR), Uttala Center (MRT6))
- ✈ Ferry Terminal (Sadar Ghat)
- ✈ Hotels (Major hotels in the city)

Airport shuttle bus connecting Terminals 1, 2, and 3 is also required. The route shall be within the airport land. The bus stops at nearby BR Airport Station in the airport area should be provided if necessary.



Source: JICA Study Team

Figure 9-7 Airport Shuttle Bus Station and Route

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CHAPTER 10 AIRPORT FACILITY PLANNING

（SUMMARY OF AIRPORT FACILITY DESIGN）

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Chapter 10 AIRPORT FACILITY PLANNING（SUMMARY OF AIRPORT FACILITY DESIGN）

Facilities and equipment based on the earlier design condition are to be summarized by making questionnaire and clarifying unresolved issues.The summarized design is aimed to calculate the cost of this project. The required drawings for the above are to be minimal and based on the earlier design and conditions.

In addition to the above, the summarized design is to be reviewed and developed to reduce cost and shorten construction schedule while maintaining quality. It shall also review applicable Japanese technologies and standards. Moreover, the airport security equipment shall consider the situation in Bangladesh and related international standards.

10.1 Passenger Terminal Building（T3）

Meetings with Civil Aviation Authority, Bangladesh (CAAB), were held to confirm the scope of Phase-1 and requirements. The confirmed issues and conditions will form the basis for the airport facilities design.

(1) Results of Interview with CAAB

- There was no explanation by consultants (CPG and Yooshin) of final drawings and function of the Master Plan.
- The VIP arrival flow through the boarding bridge is mixed with ordinary passenger flow in the original design. The VIP arrival flow should be reconsidered.
- BHS design, especially VIP BHS circulation, in the original design is not clear.
- The mosque indicated in the original layout plan is independent from the terminal structure. It is not a prayer room and whether to include it in the scope of the project should be confirmed.
- After the meeting, JICA confirmed the mosque is part of the scope of this project, since the mosque is considered as one of the facilities in this airport.
- The required rooms of CIQ were verbally instructed by CAAB to CPG; however, the final drawings are not adequate. This issue shall be clarified.
- CAAB recognizes the need to confirm functions and the design intent in the original design for the Master Plan with the M/P consultant.

(2) Definate Design Requirement

JICA Study Team presented about the following matters at the 2nd CAAB meeting and confirmed that further re-check and re-arrangement shall be continued in the next stage.

- The Functional Occupation List to confirm the requirement of each room.
- The colored layout plans which show the function of airport facilities.

(3) Elevation and Section

- Elevation and section design is basically not changed from the original design.

10.2 Cargo Complex Terminal

In cargo buildings, it is necessary not only to improve the processing capacity but also to design facilities and equipment for smooth operations and eliminate lost cargo, as well as improve cargo flow.

There are various approaches to layout in the basic design, and JICA Study Team inquired about the possiblity for changes to facility layout after study of the local operation situation. CAAB responded by requesting proposals for improvement of operations, including facility layout, operational support facility and systems etc.

Also, CAAB requested for the introduction of a fully automated system.

Against this background, JICA Study Team decided to organize the issues and concepts of existing facilities shown in the next section and propose a new layout proposal.

In the second meeting, the following comments were received from CAAB.

- A report on the integration the import and export in one building is requested.
- The export cargo terminal is designed in the north side, but existing export cargo terminal building is located in the south. The possible of extension of the existing export cargo terminal building should be explored.
- 24 hour operation custom inspection is expected in the future and this should be reflected in future plans.
- Conversion and reuse of existing semiautomatic equipment should be attempted whenever possible.
- A medium-sized inspection machine (tunnel size = 1.8m) should be installed.
- The large-sized inspection machine is unnecessary.

Based on the above request, JICA Study Team developed concepts, equipment and layout of the cargo terminal building as described below.

(1) Condition of existing cargo terminal building

Confidential due to security reasons.

Confidential due to security reasons.

Figure 10-1 Smoke Detector

Figure 10-2 Existing Drive Deck

Confidential due to security reasons.

Figure 10-3 Fire Fighting Facility

Figure 10-4 Present Cargo Inspections

(2) Issues during the construction for expansion

In planning for expansion, it is important to install new equipment and facilities without stopping the operation of existing cargo terminal buildings, but assuming a migration plan, the following issues were confirmed。

- With the expansion of the apron of phase 2, about 50 m from the building on the airside side of the cargo terminal building is planned to be demolished.
- In the existing cargo terminal building, the drive deck and racks are not used, while the process before the build-up is congested.
- Therefore, there is concern that construction work for expansion in the existing export cargo terminal building or adjacent site will cause major disruption on operations, resulting in increased cargo delays and confusion.
- Introduction of automated equipment will require sufficient training, but there is not enough space to carry out training activities.

Based on the above, the new export cargo terminal building should be planned in a different location to allow single day transfer of operations that does not stop cargo processing.

Confidential due to security reasons.

Figure 10-5 Truck Yard

Figure 10-6 Truck Yard

Confidential due to security reasons.

Figure 10-7 Existing Cargo Terminal and Apron Expansion Plan

(3) Countermeasures to Issues During Operation

Both export and import operations are divided between separate companies (cargo terminal building, Biman Cargo, ground handling, Biman Bangladesh Airline). The communication between the two sides is insufficient, resulting in defective cargo operations.

For this reason, both sides attend only to their own responsibilities, moving cargo to handover zone without considerations for the next process was observed sporadically. In a remarkable example, export cargo scheduled for nighttime loading was immediately transported to the apron after completion of build-up so that they had already been taken outdoors at 2 p.m. Perishable goods are included in these cargo and damage to cargo due to sunshine, rain etc. is serious.

To solve this problem it is necessary for the sending side to promptly accommodate the cargo in the storage facility and secure the work area upon completion of preparation. Meanwhile, on the receiving side, timely receipt of cargo according to the flight situation of the aircraft must be made available.

Therefore, equipment for cargo storage are required for both import and export.

Confidential due to security reasons.

Figure 10-8 Cargo Storage

Figure 10-9 Cargo are Waiting Longtime

(4) Separate and Integrated lans

Cargo terminal buildings can be constructed as separate export and import structures as at present or by combining into an integrated structure.

In this project, we recommend to provide temporary storage facilties for both export and import cargo. In this case, in general, the processes for both export and import are divided with the arrival of the aircraft as the boundary. For this reason, in the case of separation, there is concern that the capacity of the equipment will overlap and the cost will increase.

It is expected that in the future, a large volume of export cargo will be built up outside the airport along with security inspection and customs clearance. In such cases, it is assumed that the cargo terminal building to be constructed in this project will be operated as an import cargo terminal building. In order to minimize the necessary renovation work at such a time, we recommend integrated construction

Based on the above demands and background, the following policy will be observed for the design of the facilities.

- Integrate exports and imports, layout functions for flexible operations and design to be responsive to future changes in operations.
- For MHS and ASRS will be installed for both import and export.
- Built-up Unit Load Device (ULD) and pallets are to be stored until ground handler is ready for pick up. Material Handling System (MHS) etc. will also be arranged to allow cargo pick up in accordance with breakdown progress.
- If automatic system is chosen, Automatic Storage Rack System (ASRS) for daytime storage of cargo after customs inspection completion during the period large vehicles cannot enter should be provided.
- In an automated system, ASRS for cargo after completion of breakdown should automatically manage and transport cargo according to the situation at customs inspection and cargo pick up.
- ASRS is rarely used for export cargo in an automated system. However, in order to cope with the adverse flight conditions and accidents, the system should be capable of separate management of export cargo.
- Install inspection machine with higher performance equivalent to multi-view or better for efficient inspection.
- Space for installation of large inspection machine in the future will be reserved.

In the existing plan, neither the facilities listed above nor CAAB requests are satisfied. Therefore, the JICA Study Team conducted a study on a new layout in this Preparatory Study.

It was confirmed with CAAB, that the final concepts, functions and layouts will be discussed in the next stage to determine the layout and necessary equipment for detailed design.

(5) Semi-automated, Full-automated

CAAB is requesting for the installation of fully automated equipment.

On the other hand, installation of fully automatic equipment increases not only installation cost but also maintenance cost. Also, unless efficient maintenance of the equipment is carried out, breakdowns will occur, causing major disruption in services.

Accordingly, two layouts were prepared, one with fully automated equipment and the other with semi-automatic equipment.

In the next stage, CAAB will be engaged to finalize the operation method and equipment specification after cost estimates are reviewed.

(6) Setimation of the Cargo Terminal Building Handling Volume

The cargo volume is set according to Table 10-1.

Table 10-1 Cargo Volume

Year	2025
Cargo volume per year (ton)	601,172
Daily cargo volume (ton) (1/330)	1,822
Import cargo volume per year (ton)	200,395
Import daily cargo volume (ton) (1/330)	607
Export cargo volume per year (ton)	400,781
Export daily cargo volume (ton) (1/330)	1,214

Source: JICA Study Team

(7) Required Area of the Cargo Terminal Building

The required area of the cargo terminal building for the estimated cargo volume is set according to Table 10-2 and Table 10-3.

Table 10-2 Area of Cargo Terminal (Import)

Import Area	Area (m^2)	Remarks
ULD storage	4,500	477 ULD
Breakdown	3,650	
Storage, Custom, Dispatching	12,250	
Delivery	2,100	
Truck yard	6,150	
Total	28,650	Unit rate 7 tons / m^2

Source: JICA Study Team

Table 10-3 Area of Cargo Terminal (Export)

Export Area	Area(m2)	Remarks
Truck yard	6,150	
Unloading	3,300	
Ramp	2,700	
Security inspection	1,250	
Buildup	3,400	
ULD storage	1,900	
Total	18,700	Unit rate 21.4 tons/m2

Source: JICA Study Team

(8) Cargo Terminal Building Equipment

Confidential due to security reasons.

Table 10-4 Cargo Terminal Equipment (Full automated)

Confidential due to security reasons.

Table 10-5 Cargo Terminal Equipment (Semi automated)

Confidential due to security reasons.

Confidential due to security reasons.

Figure 10-10 Example of MHS (other airport)

Figure 10-11 Example of ETV (other airport)

Confidential due to security reasons.

Figure 10-12 Example of ASRS (other airport)

Figure 10-13 Example of large inspection machine (other airport)

The layout for the detailed design and the confirmation of necessary equipment for both cases (Full automated and semi automated) will be carried out in the future.

Confidential due to security reasons.

Source: JICA Study Team

Figure 10-14 Draft Cargo Terminal Layout (Full automated)

Confidential due to security reasons.

Source: JICA Study Team

Figure 10-15 Draft Cargo Terminal Layout (Semi automated)

10.3 VVIPTerminal

The survey and interview about existing VVIP Terminal were implemented during the first meeting with CAAB. The new VVIP Terminal shall be designed as suitable for the VVIP based on the functions of the existing facility. CAAB will continue to be consulted on future development of proposed facilities.

In the meeting with CAAB held on 6th February, CAAB requested that barrier free design for handicapped or elderly passenger flow to be considered. Further discussion and study will be continued in the next stage.

10.4 Fire Station

Confidential due to security reasons.

Table 10-6 Plan of Fire Station

Confidential due to security reasons.

Confidential due to security reasons.

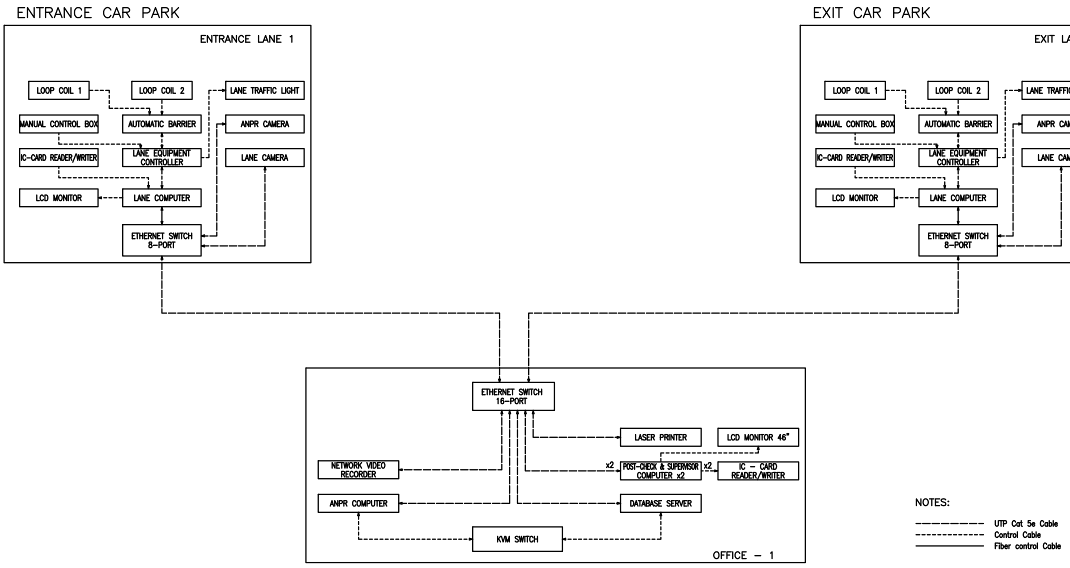
Figure 10-16 FFS Layout

10.5 Multi-level Car Parking

There are no indications of car parking system and details in original drawings. The design conditions and requirement shall be clarified as following items. In the meeting held on 6th Feburuary 2017, JICA survey team explained about the summary of Car Parking Control System. The design will be developed further in the next stage.

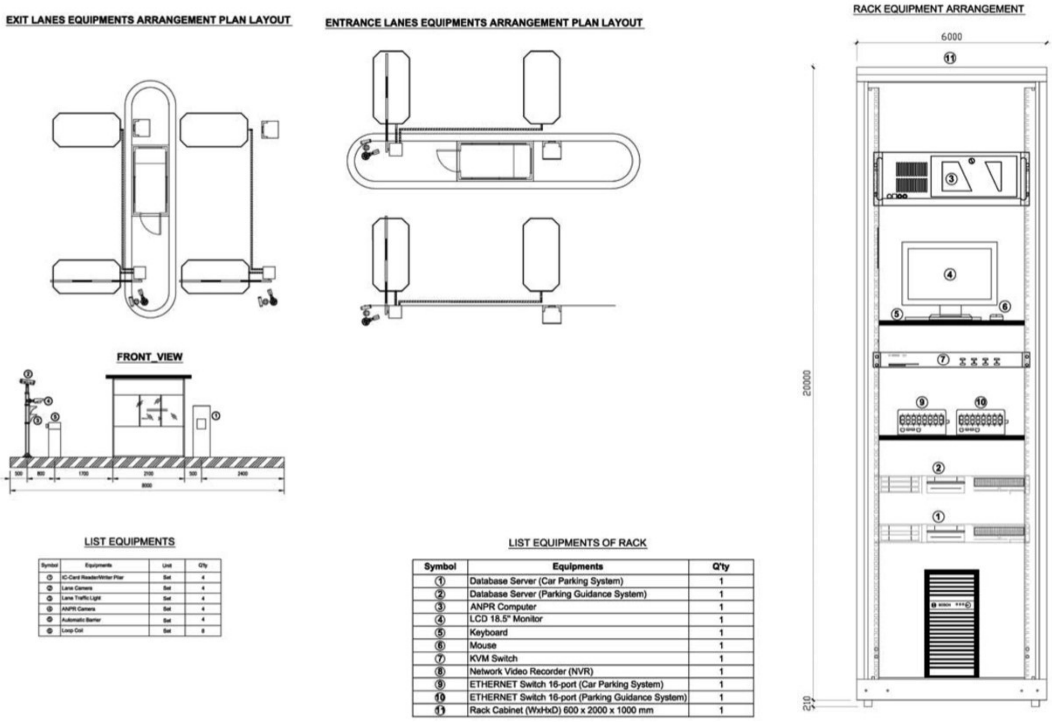
(1) Car Parking Control System

The basic design conditions for car parking are shown in the following figures. Control room is located at an office on the first floor.



Source: JICA Study Team

Figure 10-17 Parking Control System

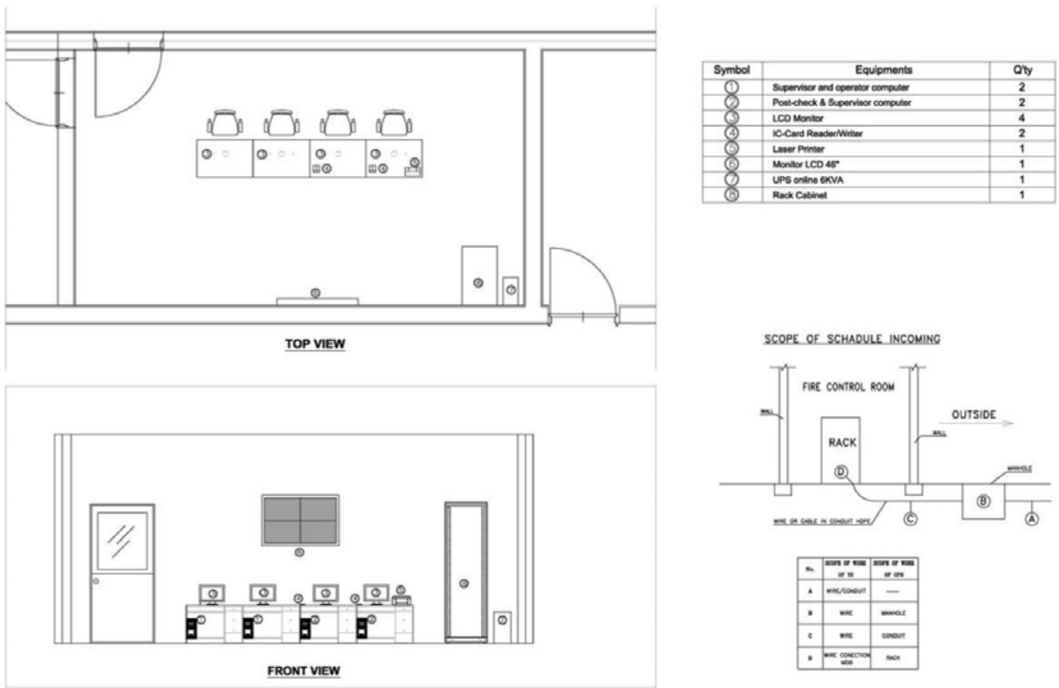


Symbol	Equipments	Unit	Q'ty
1	IC-Card Reader/Writer Pilar	Set	4
2	Lane Camera	Set	4
3	Lane Traffic Light	Set	4
4	ANPR Camera	Set	4
5	Automatic Barrier	Set	4
6	Loop Coil	Set	8

Symbol	Equipments	Q'ty
1	Database Server (Car Parking System)	1
2	Database Server (Parking Guidance System)	1
3	ANPR Computer	1
4	LCD 18.5" Monitor	1
5	Keyboard	1
6	Mouse	1
7	KVM Switch	1
8	Network Video Recorder (NVR)	1
9	ETHERNET Switch 16-port (Car Parking System)	1
10	ETHERNET Switch 16-port (Parking Guidance System)	1
11	Rack Cabinet (WxHxD) 600 x 2000 x 1000 mm	1

Source: JICA Study Team

Figure 10-18 Toll Booth



Symbol	Equipments	Q'ty
1	Supervisor and operator computer	2
2	Post-check & Supervisor computer	2
3	LCD Monitor	4
4	IC-Card Reader/Writer	2
5	Laser Printer	1
6	Monitor LCD 46"	1
7	UPS online 6KVA	1
8	Rack Cabinet	1

No.	SCOPE OF WORK OF TD	SCOPE OF WORK OF CPD
A	WIRE/CONDUIT	——
B	WIRE	MANHOLE
C	WIRE	CONDUIT
D	WIRE CONECTION MDB	RACK

Source: JICA Study Team

Figure 10-19 Control Room Layout

(2) Security System in Car Parking

Confidential due to security reasons.

(3) Security Zoning as Airport Facility

Confidential due to security reasons.

(4) Demarcation of Scope of Work

The demarcation of scope of work between car parking, elevated roadway, and terminal building is not clear in the original design. The demarcation of scope shall be clarified for terminal roof support columns, concourse connecting the terminal building and car parking, and the design of expansion joints.

(5) Room functions

Offices and toilets are located only on the first floor in the original design. Through the interview and discussion with CAAB, the requirement of rooms and operation shall be clarified.

(6) Access and Security

Confidential due to security reasons.

Confidential due to security reasons.

Figure 10-20 Second Floor Plan

Confidential due to security reasons.

Figure 10-21 First Floor

Confidential due to security reasons.

Figure 10-22 Mezzanine Floor

Confidential due to security reasons.

Figure10-23 Floor

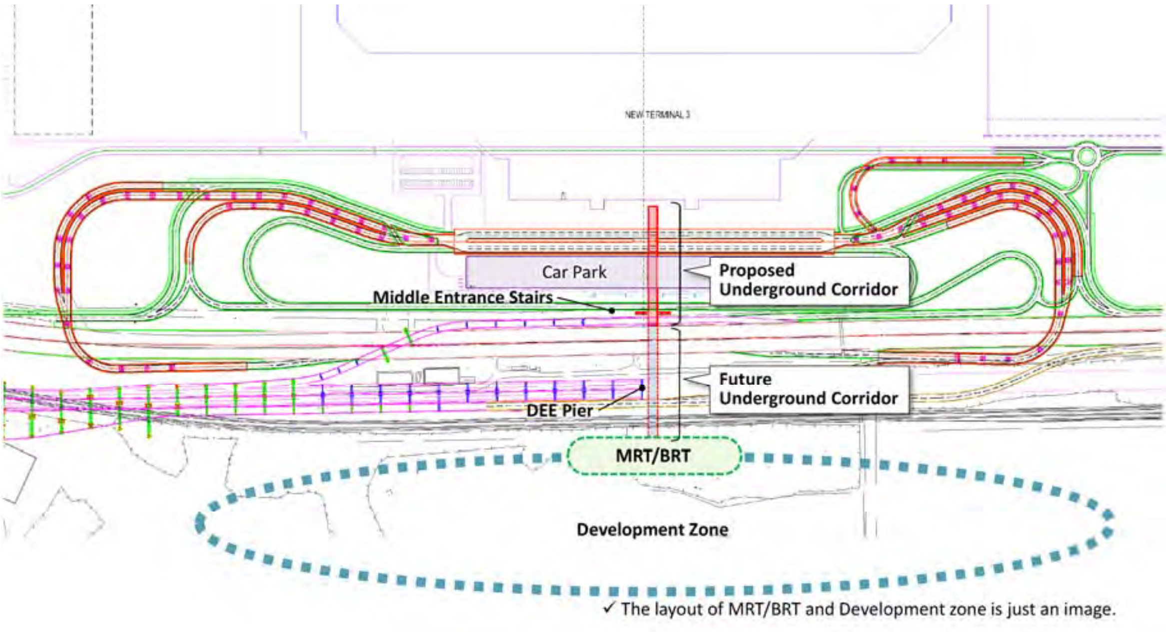
(7) Elevation and Section

Elevation and section design is basically not changed from the original design.

10.6 Underground Pedestrian Corridor

(1) Corridor Layout

In front of Terminal 3, the new MRT/BRT station and other developments are under separate studied to ensure public traffic access. Although the layout of a new station plaza and a development plan are still undecided, the underground pedestrian corridor should be provided for airport users' convenience between Terminal 3 and the new station plaza. On the other hand, the new parking building is planned over the underground corridor. Therefore, the underground corridor take into account future development and should be constructed in the airport landside in advance. Along with the new terminal construction. In addition, the DEE pier is expected opposite the center of the Terminal 3 building. Thus, the layout of the underground corridor should be adjusted to avoid the DEE pier.



Source: JICA Study Team

Figure 10-24 Layout of Underground Pedestrian Corridor

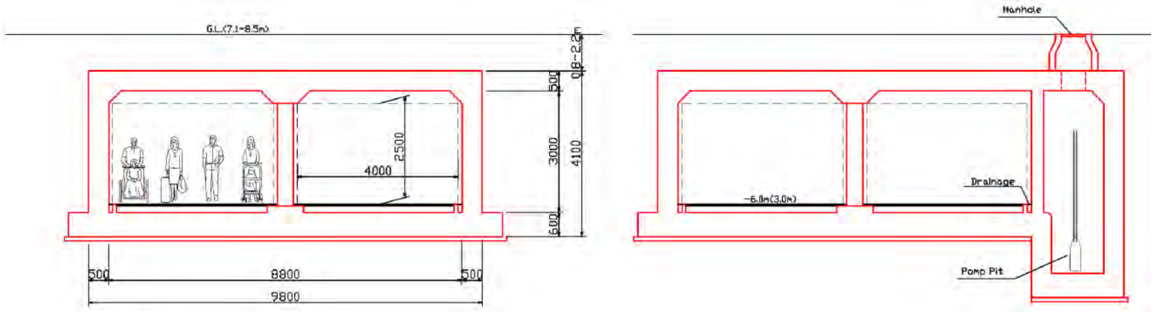
(2) Interior Dimensions

Working width should be planned with enough margin in consideration of future effective utilization.Vertical clearance, 2.8~3.0 m, should be ensured in consideration of some margin such as lighting and advertisement in addition to 2.5 m of pedestrian space. The passageway width is caciuulated for the case where the number of MRT users is assumed to be 30% of airport visitors in 2035:

Number of MRT users in 2035 : 75,500 per/day (JICA Study 2016)
In case of peak10%,

Number of Pedestrian :	$Q = 7{,}550$ per/h	(126 per/min)
Pedestrian Density :	$k = 0.3\text{per/m}^2$	
Walk Speed :	$v = 60$ m/min	
Traffic Capacity :	$q = k \cdot v$	= 18 人/min・m
Required Width :	$w = Q / q$	= 7.0 m (3.5m x 2)

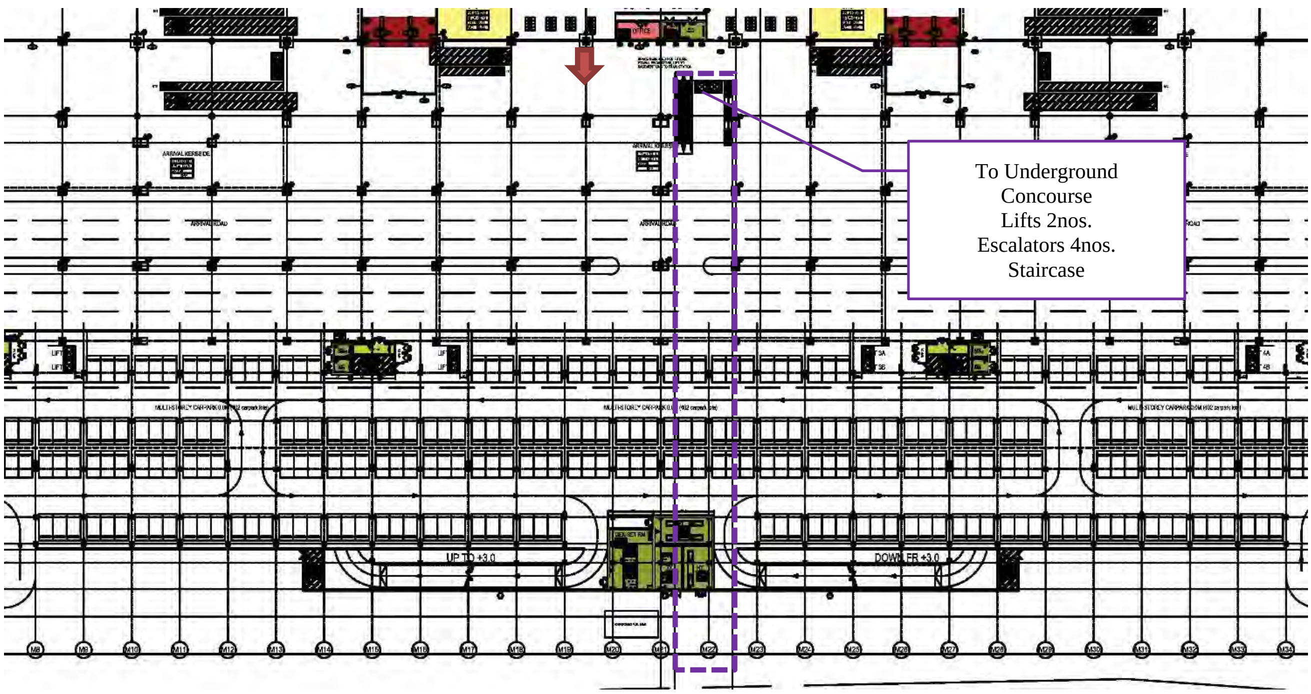
For the effective width of one side, 4.0 m is recommended in consideration of personal space and margin in addition to the above required width.



Source: JICA Study Team

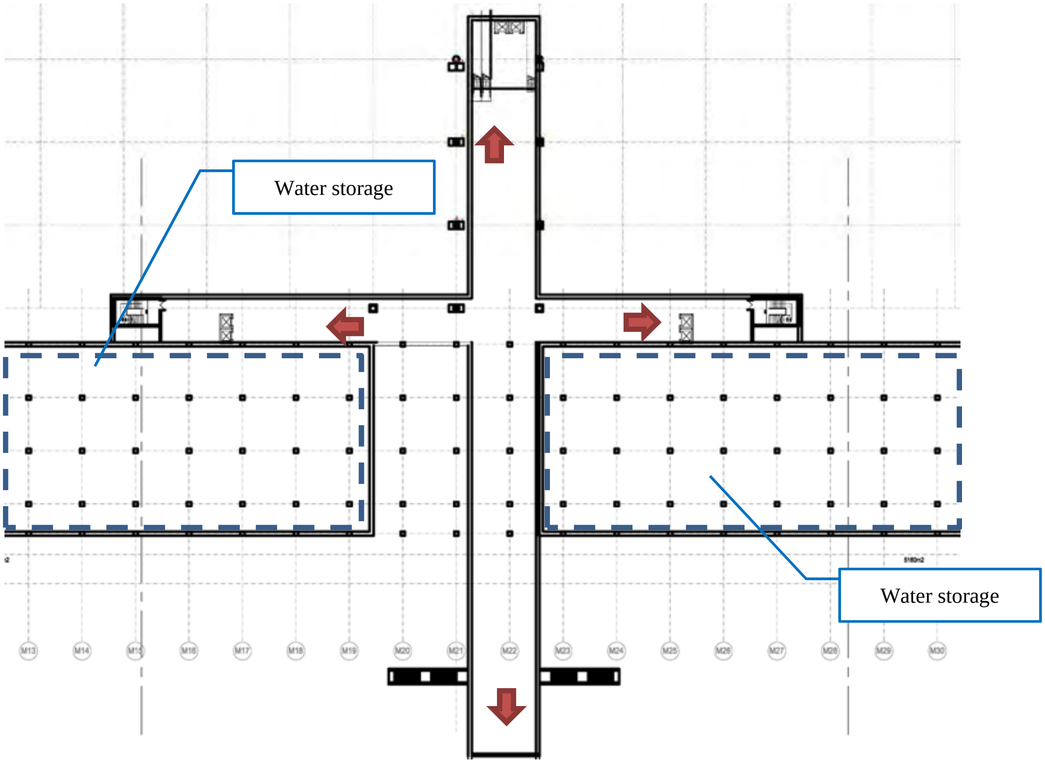
Figure 10-25 Cross Section of Underground Pedestrian Corridor

The level of the underground concourse is considered to be the same as the basement floor in the terminal building based on the original design of the terminal building; however, it will be necessary to coordinate with the underground water storage and design level of BRT/MRT. In this case, the underground water storage shall be designed as two separated tanks and requiring consideration of the details of the water storage system. Another option is to set the level of the underground concourse under the water storage; however, the depth will be required to be around 10 m deep. Considering the additonal cost, construction schedule, and waterproofing issues, this option is not suitable. In the meeting with CAAB held on 6th Feb 2017, JICA Study Team explained the above and confirmed to continue the detailed design in the next stage.



Source: JICA Study Team

Figure10-26 Layout of Parking on the Ground Floor



Source: JICA Study Team

Figure10-27 Layout of Parking on the Underground Floor

(3) Future Tasks

In the detailed design stage of this project, it is necessary to examine the design and location of the underground pedestrian corridor while adjusting with MRT line 1 project.

10.7 Apron (Terminal 3 Area)

New apron area for T3 is designed as follows based on the existing master plan in the view of reduction of construction period and quality assurance.

(1) Consideration for Apron Spot Location

In this survey, apron spot location is reconsidered based on the reviewed demand forecast and phasing development for T3.

(2) Consideration for Cost Reduction by Reviewing Pavement Structure

In the existing master plan, the bending strength of apron pavement structure is 4.5 N/mm2. On the other hand, there is a possibility to reduce of cost and shorten the construction period in the case of application of the bending strength of the japanese design standard, since the bending strength of the japanese design standard is 5.0 N/mm^2 and it can thin the thickness of apron pavement. However, since it is difficult to manufacture the concrete which has high bending strength such as 5.0 N/mm2 in Dhaka, it is necessary to confirm the possibility of procurement of it through the hearing to japanese company in Dhaka. If it can reduce the cost, the pavement structure should be modified.

(3) Consideration for Apron Structure

1) Design Criteria

Design criteria is primarily based on the master plan design criteria and the air traffic movement is based on the adjusted demand by this study.

Design Year: 20 years for apron and 10 years for apron shoulder

Design CBR: 7%

Pavement Thickness: Calculated based on AC150/5320-6F and FAA RFIELD

2) Design Air Traffic

Based on the adjusted aircraft movement forecast in this survey, the aircraft traffic volume for apron pavement design is shown in Table 10-6. The design period for apron pavement is 20 years, from 2016 to 2035.

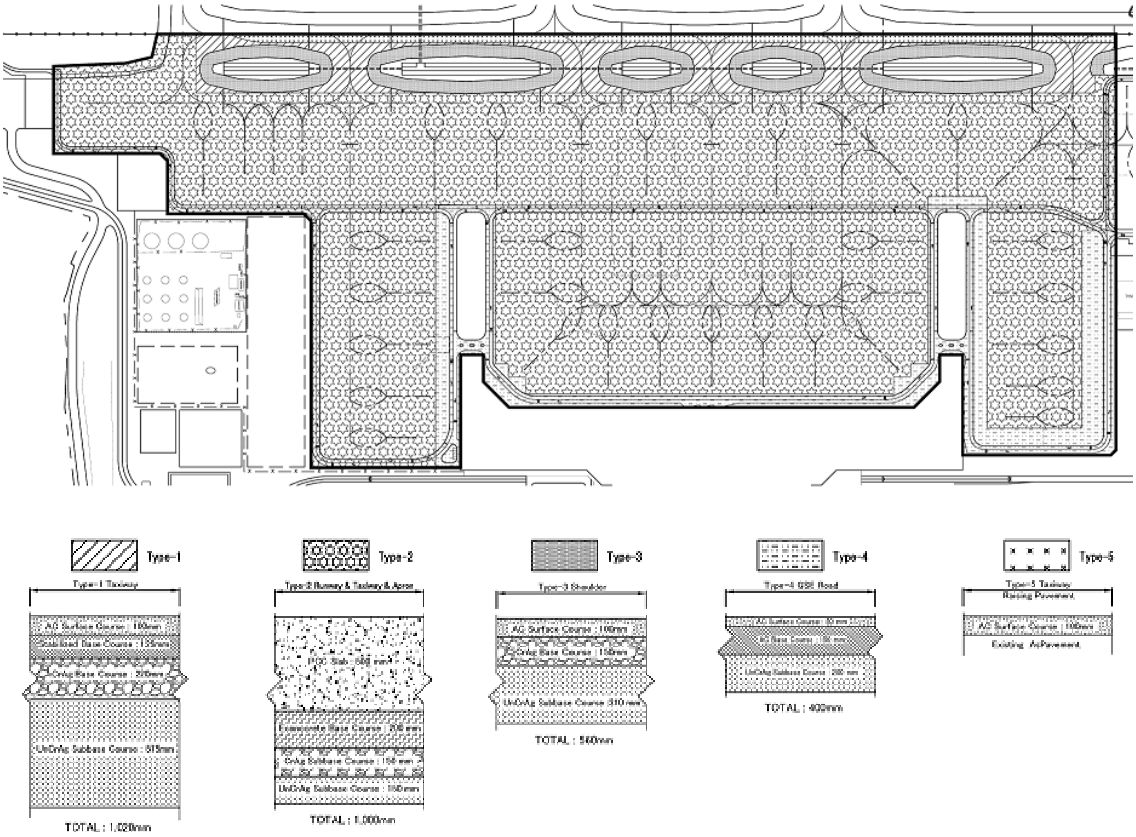
Table 10-7 AircraftTraffic Volume for Apron Pavement Design

ICAO Aerodrome Reference Code (Aircraft Type)	Total Departure andArrival (from 2016 to 2035)			Total Departure	Average Annual Departure for 20 years (number per year)	Input
	Domestic (20 years)	International (20 years)	Total (20 years)			Design Traffic Volume (number per year)
B (Small Propeller)	676,723	0	676,723	338,362	16,918	16,918
C (Turboprop)	250,587	147,124	397,711	198,855	9,943	9,943
C (Small Jet)	325,625	608,047	933,672	466,836	23,342	23,342
D (Medium Jet)	0	31,064	31,064	15,532	777	777
E (Large Jet)	0	751,448	751,448	375,724	18,786	18,786
F (A380)	0	15,532	15,532	7,766	388	388
Total	1,252,936	1,553,215	2,806,151	1,403,075	70,154	70,154

Source:JICA Study Team

3) Pavement Thickness

Pavement thickness is calculated by pavement program, FAA RFIELD v1.41 - Airport Pavement Design. The pavement thickness is different from the thickness in the master plan under the same design condition. In the detailed design, the pavement thickness should be recalculated.



Source: JICA Study Team

Figure10-28 Pavement Type of Apron

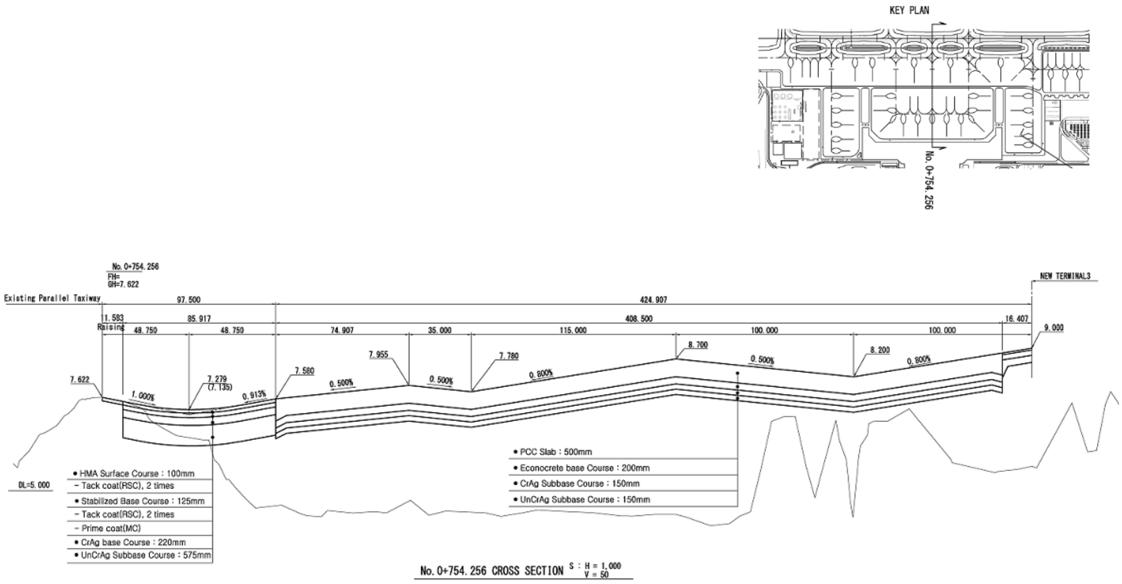
4) Longitudinal and Cross Section

The slope of apron follows the ICAO standards.The design slope of apron is as follows:

Apron: max 1.0%

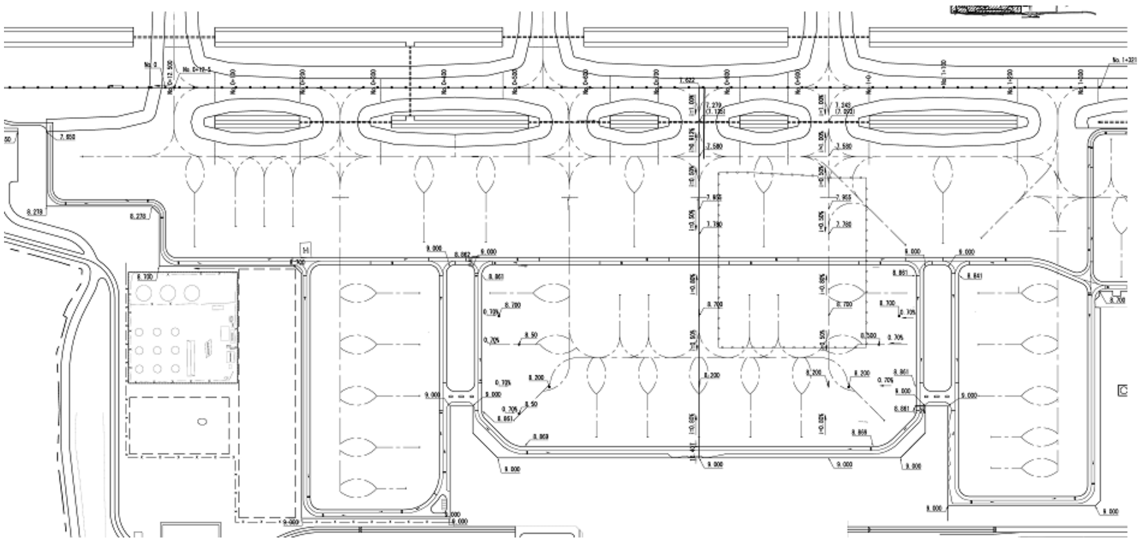
Apron shoulder: max 2.0%

Longitudinal slope: 0.5% to 1.0%



Source: JICA Study Team

Figure10-29 Apron Profile

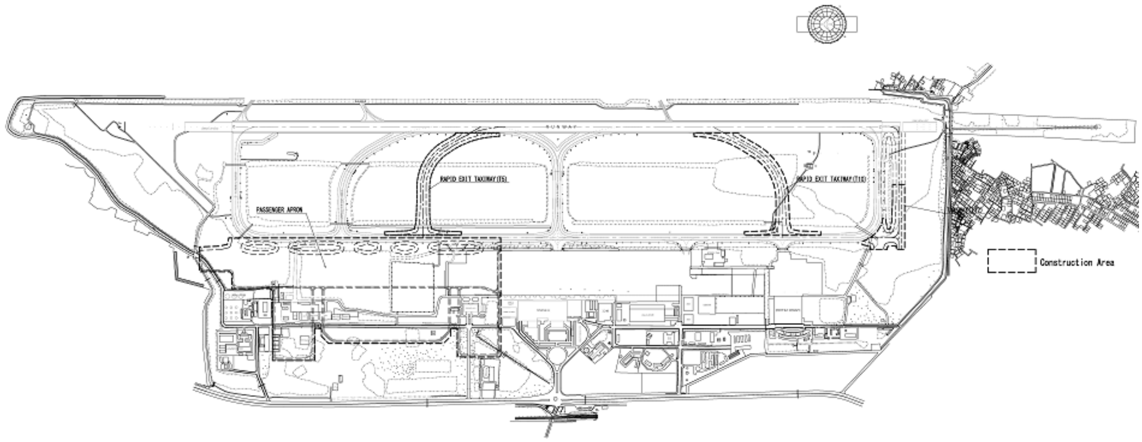


Source: JICA Study Team

Figure10-30 Apron Slope Plan

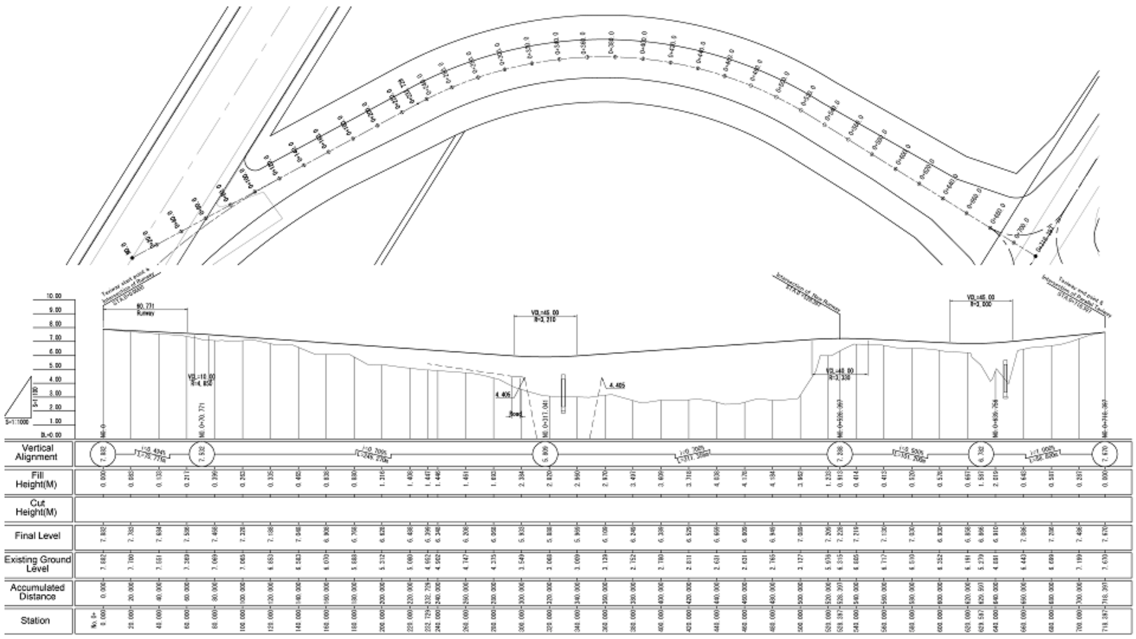
10.8 Taxiway

In the existing master plan, a trafic volume for pavement design of rapid exit taxiway and connecting taxiway is same as the runway pavement. It is possible to reduce the pavement thickness of connecting taxiway since the traffic volume of connecting taxiway may be reduced dependng on connecting location. In the detailed design stage of this project, it is necessary to recalculate the traffic volume and examine the pavement structure of the connecting taxiway taking into account the reviewed demand forecast results.



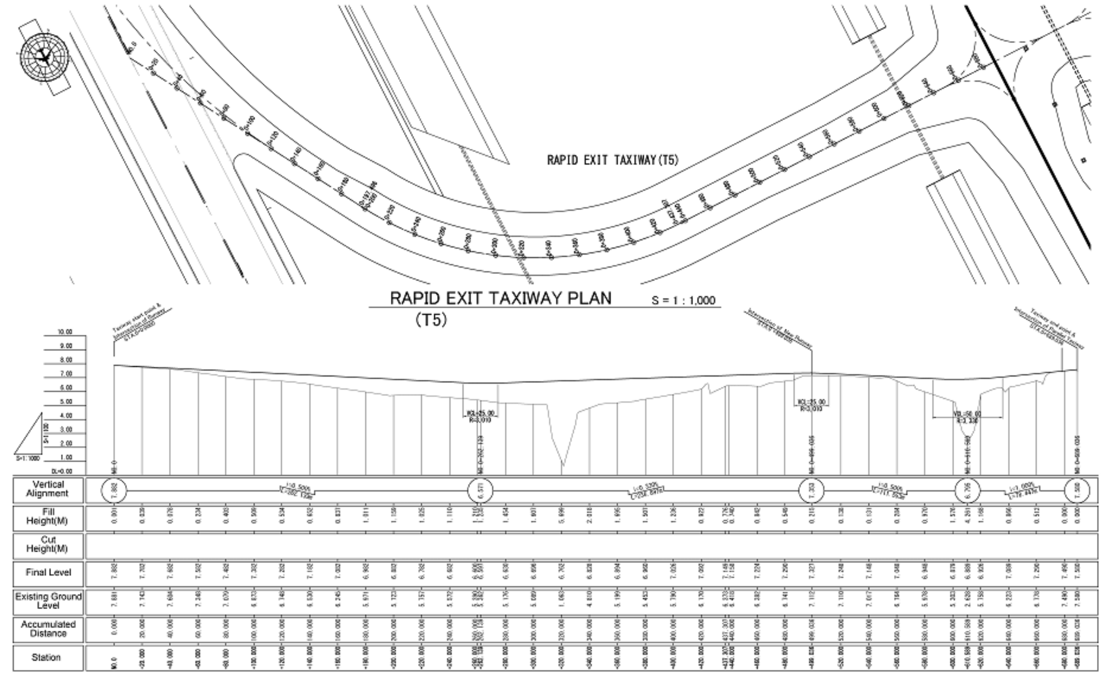
Source: JICA Study Team

Figure10-31 Taxiway Layout Plan



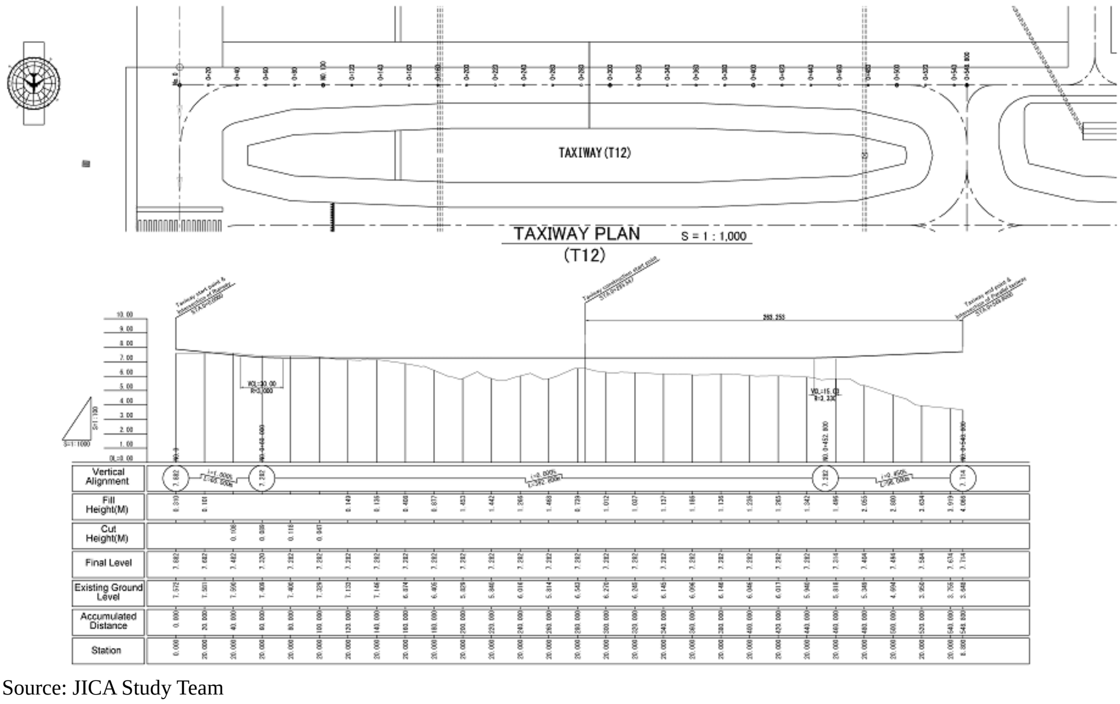
Source: JICA Study Team

Figure10-32 Rapid Exit Taxiway (North) Profile



Source: JICA Study Team

Figure10-33 Rapid Exit Taxiway (South) Profile



Source: JICA Study Team

Figure10-34 Runway End Taxiway Profile

10.9 Internal Road and Bridge (Elevated Road)

10.9.1 Internal Road

(1) Basic Policy

- Road facilities should ensure safe and smooth traffic.
- Possible higher service level should be provided in a limited landside space.

10.9.2 Road Classification and Component of Cross Section

(1) Road Classification

Table 10-8 Proposed Road Classification

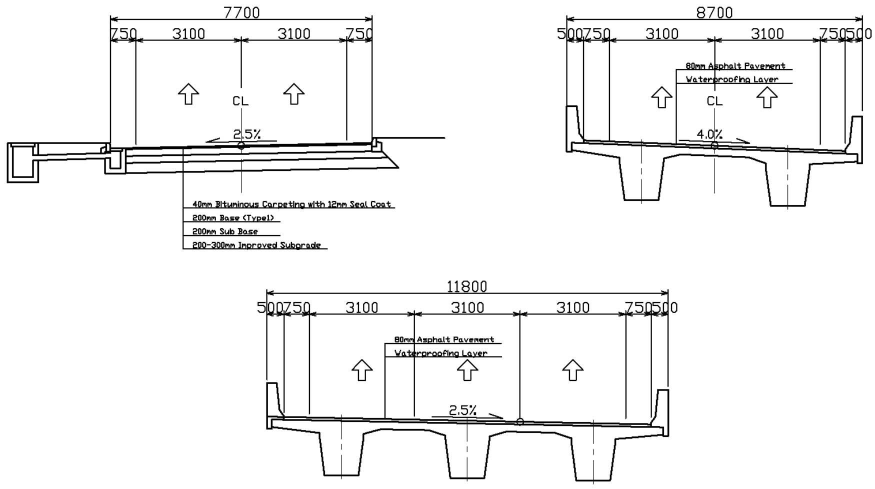
Parameter		Bangladesh			Asian Highway		Japan		Proposed
Road Classification		Type3	Type4	Type5	Class2	Class3	3-2	Ramp-B	
Design Speed	km/h	50-80	40-65	30-50	40-80	30-60	40-60	30-60	40 km/h
Lane Width	m	3.65	3.1	2.75	3.5	3.0 (3.25)	3.25-3.5	3.25	3.1 m*1
Shoulder	m	1.5	1.5	1.2	2.0-2.5	0.75-2.0	L:0.5-1.0 R:0.5-0.75	L:1.5 R:0.75	0.75 m*2
Crossfall	%	---	---		2	2-5	1.5-2.0	1.5-2.0	Standard: 2.5% *3 Kerbside:1.0%
Headroom	m	5.7			---		4.5		5.7 m
Footpath Width	m	(2)					2.0-4.0		2-3 m

*1: Lane width, although wide width is desirable, 3.1 m is adopted in the limited landside space in consideration of multi-lanes and track width.
*2: Shoulder, a reduced value is adopted for compactness, and 0.75 m should be provided for inspection and emergencies.
*3: Crossfall, 2.5% is adopted similar to that of standard road in Bangladesh.
Source: JICA Study Team

(2) Cross Section

1) Access / Approach Road

The cross section of an access/approach road is shown below. In case of one-lane roads, the width of carriageway including shoulder of more than 6 m should be provided for passing of an emergency vehicle.

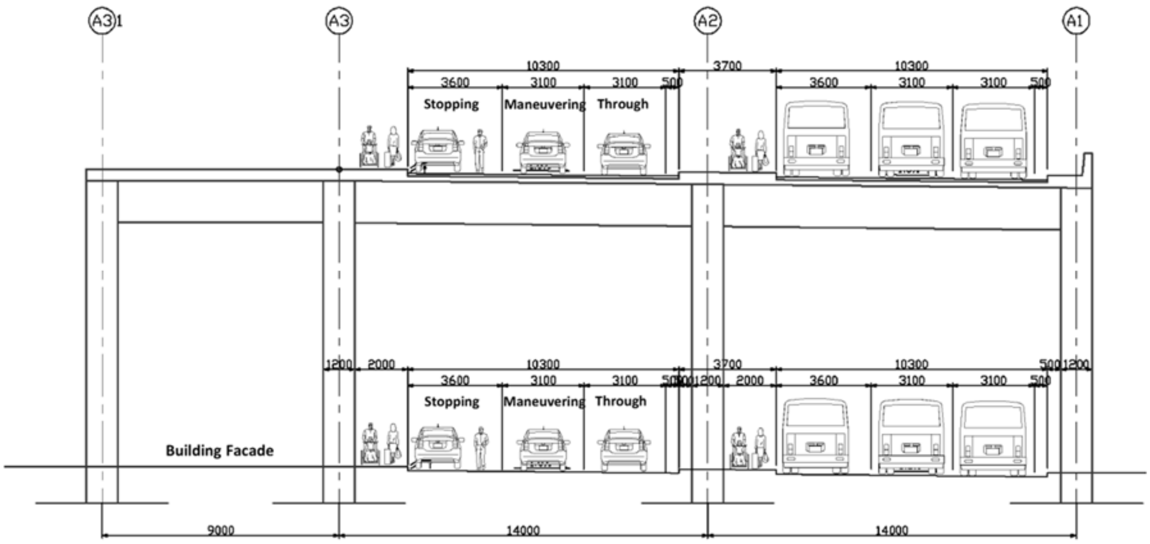


Source: JICA Study Team

Figure 10-35 Cross Section of Access / Approach Road

2) Curbside

Departure and arrival floors are each provided with two kerbsides for smooth traffic at peak hour. Each kerbside consists of three lanes for stopping, through traffic and maneuvering. In the stopping lane, wide width should be provided for stopping to let people get on and off and baggage handling. In a footway, width of more than 2 m should be provided in the resticted space around columns for passenger traffic and visibility.



Source: JICA Study Team

Figure 10-36 Cross Section of Curbside

(3) Geometric Design Standards

The geometric design standards corresponding to design speed is shown below.

Table 10-9 Geometric Design Standard

Item			Design Speed			Summary
			40km/h	30km/h	20km/h	
Sight Distance		SSD	45m	30m	(20m)	GDS/Table 2.3*1
Horizontal Alignment	Minimum Curve Radius	---	65m	35m	---	GDS/Table 2.3
		i=4%	67m	38m	17m	R = V^2 / 127 (i+f) f = 0.15
		i=2%	75m	42m	19m	
		i=0%	84m	48m	21m	
		i=-2%	97m	55m	25m	
Vertical Alignment	Maximum Vertical Gradient	I	Rolling: 5% Hilly: 7%			GDS/Table 6.3
	Minimum Vertical Curve	K-value	SSD: 4 (ISD: 9)*2	SSD: 2 (ISD: 4)	---	GDS/Table 6.1
	Minimum Vertical Curve Length	VCL	20m	15m	---	GDS/Table 6.2
	Maximum Change of Grade Permitted Without Use of Vertical Curve		1.2%	1.5%	---	GSD/Table 6.2

*1: GDS: Geometric Design Standards / Oct 2000 / Roads and Highways Department
*2: SSD: Stopping Sight Distance, ISD:Intermediate Sight Distance
Source: JICA Study Team

1) Horizontal Alignment and Superelevation

- Minimum curve radius is decided in consideration of superelevation and skid friction (f= 0.15).
- Superelevation is maximum 4% for comfort and cargo collapse of low-speed vehicles.

2) Extra Carriageway Width on Curves

The curve radius which is required by a track width of 3.1 m is 15 m for microbus and 60 m for large bus. According to the airport access traffic forecast, small vehicles and vehicle smaller than a microbus have a share of 98%. If a mega bus enters, the traffic effect will be small for multilanes. On the other hand, since road alignment has the continuous curve of multilanes and diverging/merging, the shift of extra width is complicated in the widening for each curve. Thus, standard lane width of 3.1 m is deemed to include widening. In addition, in a small curve and junction corner, carriageway width including road shoulder should consider track width. In that case, margin of more than 50 cm should be ensured.

Table 10-10 Track Width on Curve

Track Width on Curve

U = u + R − (R^2 − Σ Li^2)^(1/2)

AASHTO 3.3.9 Offtracking

	Design Vehicle	Passenger Car	Micro Bus	Large Bus	Mega Bus
Size (m)	Vehicle Width : u	1.7	2.0	2.5	2.55
	Vehicle Length : L0	4.7	7.0	12.0	14.0
	Wheelbase : L1	2.7	3.7	6.5	7.4
	F. Overhang : L2	0.8	1.2	1.5	2.7
Track Width : U (m)					
R (m)	15	2.11	2.82	4.81	6.46
	20	2.01	2.61	4.17	5.29
	25	1.95	2.48	3.81	4.68
	30	1.90	2.40	3.59	4.30
	35	1.88	2.34	3.43	4.04
	40	1.85	2.30	3.31	3.85
	45	1.84	2.27	3.22	3.70
	50	1.82	2.24	3.14	3.58
	60	1.80	2.20	3.04	3.41
	70	1.79	2.17	2.96	3.28
	80	1.78	2.15	2.90	3.19
	90	1.77	2.13	2.86	3.12
	100	1.76	2.12	2.82	3.06
	150	1.74	2.08	2.71	2.89
	200	1.73	2.06	2.66	2.81

Note: Radius R is shown outside line of curve.

Source: JICA Study Team

3) Vertical Alignment

In case of vertical gradient of 5%, the alignment planning is difficult due to restrictions in landside space. Although it is a maximum 7% on the design standard, maximum 6% was adopted for smooth traffic of large vehicles in this study. In addition, HSIA desires a maximum 5%, and that adjustment will be studied in the detail design. The vertical curve radius, SSD (Stopping Sight Distance) and ISD (Intermediate Sight Distance) are shown on the Design standard. Since the Access/Approach road is one way traffic, adoption of the SSD value will be appropriate. In addition, in the case of a small gradient difference (1.2%) in a ground level road, the vertical curve is omissible based on the design standard.

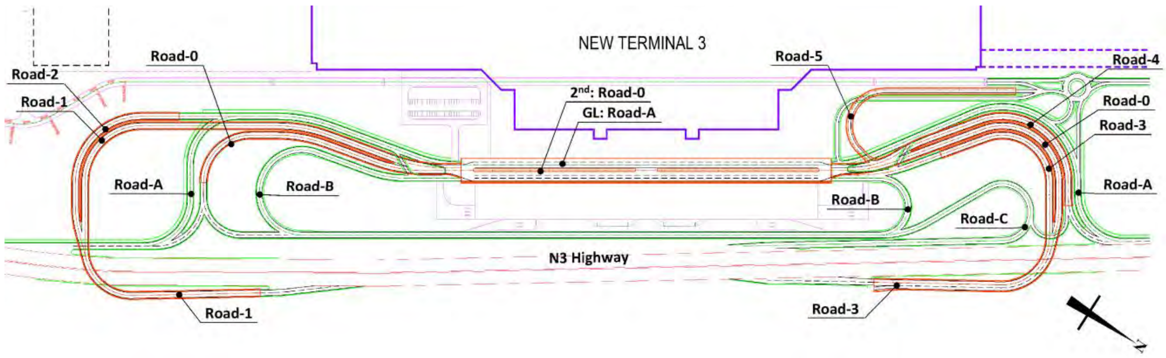
(4) Road Alignment Planning

The access/approach road is constituted by nine roads from Road-0 to Road-5 and Road-A to Road-C.The road alignment should promote route continuity and harmony of horizontal and vertical alignment. It should be decided in consideration of smooth and safe traffic, facilities layout, and landscaping. Especially, since internal road has many diverging/merging sections, suitable visual guidance and diverging interval should be provided for drivers unfamiliar with layout. Each road and horizontal alignment are shown below.

Table 10-11 Access / Approach Road List

Road	Function	Summary
Road-0	Elevated Approach Way to Departure	Road-A > Departure >Road-3
Road-1	Entrance Access Way Elevated Approach Way to Departure	Entrance HW North > Cross HW> Departure
Road-2	Elevated Approach Way to Arrival	Road-1 >Road-A > Arrival
Road-3	ExitAccess Way Elevated Approach Way from Arrival	Arrival> Cross HW> Exit HW South
Road-4	Elevated Approach Way from Departure	Departure >Road-0>Road-A
Road-5	Elevated Approach Way from Termainal 1 / Terminal 2	Terminal 1/Terminal 2 > Road-0
Road-A	Entrance / ExitAccess Way Approach Way for Arrival	Entrance HW South > Arrival> Exit HW North
Road-B	CirculationWay	
Road-C	Entrance Access Way from DEE	Entrance DEE-Exit > Road-B

Source: JICA Study Team



Source: JICA Study Team

Figure 10-37 Access / Approach Road Layout

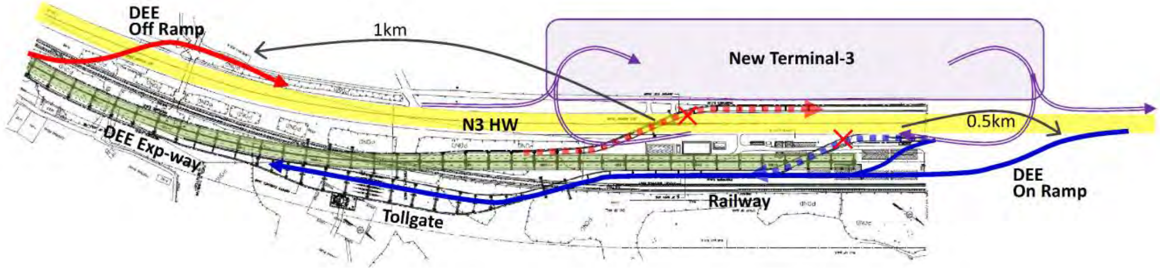
(5) Footpath

The footpath is allocated on the left side (airside) of Road-A for pedestrians from the outer side the airport, such as the highway.Width of 2-3 m should be provided in consideration of pedestrian with baggage.

(6) Access with DEE

The entrance/exit ramp in Dhaka Elevated Expressway (DEE) is planned to be linked near to the existing airport. On the other hand, the entrance ramp from the north for Terminal 3 access interferes with the DEE exit ramp, and the exit ramp to the south interferes with the DEE entrance ramp. According to the master plan in 2015 and feasibility survey, a layout which shifts the DEE exit ramp to the south by 1 km and the entrance ramp to the north by 0.5 km is recommended. However, since the DEE project is already under construction, the replanning of the access method of Terminal 3 and DEE is required. Thus, examination of alternatives was carried out regarding the connection method with DEE.

As a result, the consultant proposed "Alt-2A:Shift Terminal 3 access ramp to the south and U-turn road" as for the connection method with DEE for traffic safety and economy.



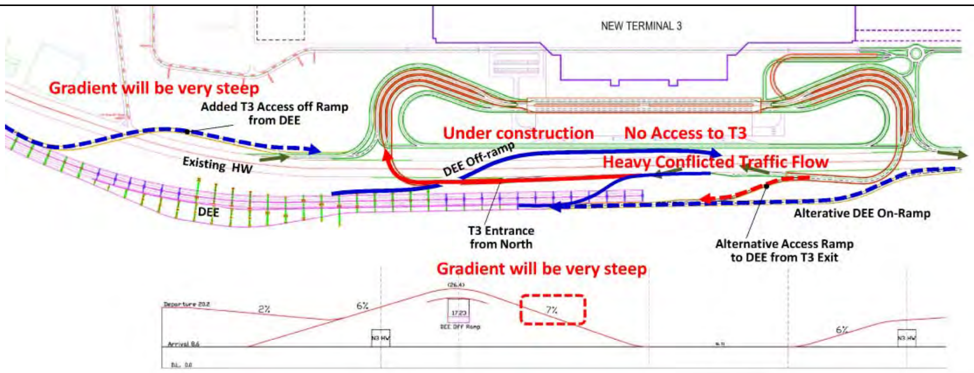
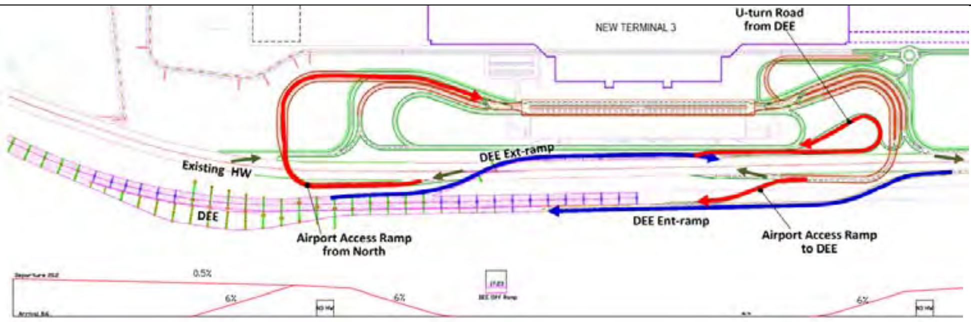
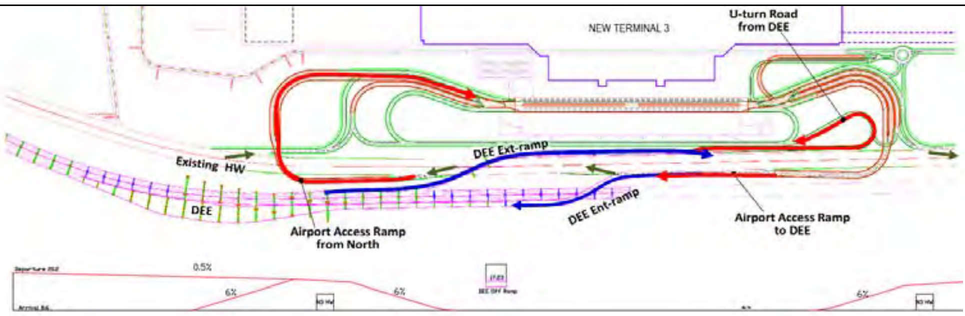
Source: JICA Study Team

Figure 10-38 Proposed Ramp Shift in Master Plan

Source: JICA Study Team

Figure 10-39 DEE Layout and Construction Situation Near Airport

Table 10-12 Alternatives of Connection Method with DEE

Alternative	Plan and Outline
Alt-1 **Adds Access Ramp in South** **& Crosses over DEE**	 • T3 access ramp from DEE is added in Airport Southside. • Access ramp from North is crossed over DEE Ext-ramp. • DEE entrance from North is shifted to Northside.
Alt-2A **Connects by U-turn Road, Shift T3 Ent to South,** **& Shift DEE Ent Ramp to North**	 • Access ramp from North is shifted to Southside. • Traffic to T3 from DEE is accessed using U-turn road in internal area. • DEE entrance from North is shifted to Northside.
Alt-2B **Connects by U-turn Road** **& Shift T3 Ent to South** **(Original DEE Ent Ramp)**	 • Access ramp from North is shifted to Airport Southside. • Traffic to T3 from DEE is accessed using U-turn road in internal area. • DEE entrance from North is used in original design.

Source: JICA Study Team

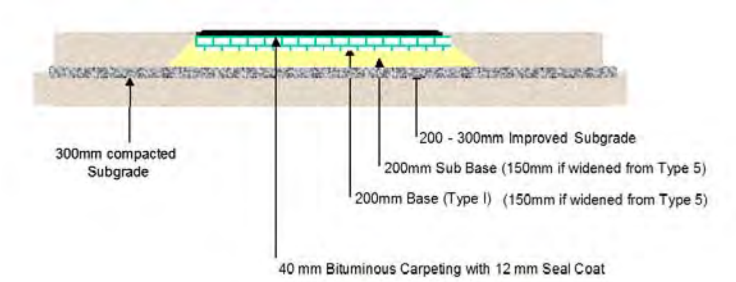
Table 10-13 Comparison of Alternatives

Alternative	Structure	Safety	Comfortable	Cost	Evaluation
Alt-1 Adds Access Ramp in South & Cross over DEE	★ Addition and widening DEE ramp. Extended high and long T3 ramp.	★ Long steep gradient 7% Small curve from down straight Heavy conflict traffic flow	★★ Uncomfortable long ramp.	★★ Extended T3 ramp 250m (Added ramp 400m)	
Alt-2A Connects by U-turn Road, Shift T3 Ent to South, & Shift DEE Ent Ramp to North	★★ Simple U-turn road of ground level. Indirect T3 Ramp	★★★ good	★★ Indirect and small U-turn curve.	★★★ Sifted T3 ramp 160m	Recommend (Requires relocation of DEE entrance)
Alt-2B Connects by U-turn Road & Shift T3 Ent to South (Original DEE Ent Ramp)	★★ Simple U-turn road of ground level. Indirect T3 Ramp.	★★ Conflict traffic flow	★★ Indirect and small curve.	★★★ Sifted T3 ramp 160m	

Source: JICA Study Team

(7) Pavement Design

Pavement design should be decided in consideration of the designed traffic volume, vehicle weight, and subgrade condition. Bridge surface pavement should be studied including installation of the layer of leveling and waterproof in a detail design phase. The standard pavement design of Type 3-4 on RHD is shown below.



Source: JICA Study Team

Figure 10-40 Standard Pavement Design of Type3-4 on RHD

(8) Issues for the Detail Design

- Road alignment was planned based on new T3 terminal of the basic design 2015 in this survey. In a detail design, the benchmark coordinate and elevation should be adjusted with new T3 building, the existing road, and DEE.
- Horizontal alignment should be examined in the detail design to adjustment such as a transition curve and improvement of diverging / merging.
- Adjustment of vertical gradient to accommodate CAAB request for maximum 5% should be studied in the detail design.
- The layout of DEE entrance ramp should allow for maximum weaving length

possible from the existing junction of T1 / T2.

- ✈ The northern section of DEE entrance ramp is not a DEE project but the DAEE (Dhaka Ashulia Elevated Expressway) project. In the detailed layout, adjustment with DAEA will be required.
- ✈ Bridge surface pavement should be studied including installation of the layer of leveling and waterproof in a detail design phase.

10.9.3 Bridge (Elevated Road)

(1) Basic Policy

Elevated roads are composed of two access bridges which cross the existing N3 expressway, and six approach bridges linked to each kerb of arrival (ground floor) and departure (second floor).

- ✈ The bridge planning should be adapted to conditions such as road alignment, topography, geology, weather, and any crossing.
- ✈ The pier layout should consider visibility (safety) and transparency (comfort) in addition to road layout.
- ✈ The bridge type should be decided in consideration of structure, construction, durability, landscape, and economy.
- ✈ The road layout on the ground should be adjusted to account for bridge structure, if needed.
- ✈ The continuous girder should be adopted for dynamics rationality and traffic comfort.

(2) Design Standard

The bridge design standard is decided based on the bridge design standard of Bangladesh and additionally refer to AASHTO and Japanese standards. Design live load is based on AASHTO, and IRC will be taken into consideration if needed. The applied design standard and design live load are as follows:

- Design Standard
  - ✈ Bridge Design Standards / Jan 2004 / Roads and Railways Division
  - ✈ AASHTO LRFD
  - ✈ Specification for Highway Bridges / Japan Road Association
- Design Live Load
  - ✈ AASHTO HS20-44, IRC Class-A

(3) Span Arrangement

The standard horizontal offset distance between a pier and a carriageway is 1.5 m. In case unavoidable, safety facilities such as guard fence and bollard should be installed for pier column guard and driver safety. The main crossing conditions are as follows:

Table 10-14 Crossing Condition

Name	Width	Headroom	Remarks
1) Dhaka-Mymensingh HW	30 m	5.7 m	N3 National HW/RHD, 8-lane
2) Internal Road	6-8 m	5.7 m	Proposed ground level road

Source: JICA Study Team

(4) Bridge Type

1) General

In bridge type selection, a standard type is first picked out based on applicable condition such as span length and curve. The suitable bridge type will be selected through comparison analysis. The standard bridge type and applicable span length are shown below.

Bridge Type				Applicatable Span Length (m) 50 / 100 / 150 / 200	Girder Depth / Span Length H/L	Max Span Length (m)	Curve Applicability
Concrete Bridge	RC Bridge	Hollow Slab			1/15 - 1/18	15	✓
	PC Bridge	Pre-cast Girder	Pre-tension Slab Girder		1/24	24	
			Pre-tension T-girder		1/18	24	
			Post-tension T-girder		1/18	45	
			Post-tension Composite Girder		1/15	45	
		Supporting Erection	Hollow Slab		1/20 - 1/25	49	✓
			Box Girder		1/17 - 1/20	77	✓
			Rigid Frame Bridge		1/32	—	
		Cantilever Erection	Box Girder		1/15 - 1/35	170	✓
			Rigid Frame Bridge		1/15 - 1/35	175	✓
		Portal Rigid Frame Bridge			1/20	—	✓
		Arch Bridge			—	265	
		Extradosed Bridge			1/25 - 1/60	220	✓
		Cable Stayed Bridge			1/40 - 1/100	260	✓
	Other Type	Pre-beam Composite Girder			1/20 - 1/35	—	
		Bi-prestressing System Girder			1/32	—	
Steel Bridge	Plate Girder	Simple Span	H-beem Girder		1/25	25	
			I-girder		1/18	44	✓
			Box-girder		1/20	70	✓
		Continuous	I-girder		1/18	65	✓
			Box-girder		1/23	190	✓
	Steel Deck I-girder				1/25	80	✓
	Steel Deck Box-girder				1/27	300	✓
	π-shaped Rigid Frame Bridge				—	124	✓
	Rationalized I-girder				1/15		✓
	Narrow Box Girder				1/25		✓
	Integrated Bridge				1/18		✓
	Truss Bridge	Simple Truss			1/9	227	✓
		Continuous Truss			1/10	548	✓
	Tied Arch Bridge	Deck Arch	Langer Arch		—	175	
			Lohse Arch		—	305	
		Through Airch	Langer Arch		—	150	
			Trussed Langer Arch		—	329	
			Lohse Arch		—	140	
			Network Arch		—	518	
	Cable Stayed Bridge				—	890	✓
	Suspension Bridge				—	1991	

: Suitable Length : Applicable Length

Source: MLIT of Japan

Figure 10-41 Bridge Types and Applicable Span Length

2) Comparison of Bridge Type

The bridge section has structure characteristics such as loop ramp with a small curve, diverging, and changing width. As for the construction conditions, although new Terminal 3 landside area can be used as a construction yard, the existing traffic should be ensured in the highway crossing. An applicable bridge type is picked out based on the above characteristic conditions, and comparison analysis was carried out in consideration of structure, construction, maintenance, visual, and economy.

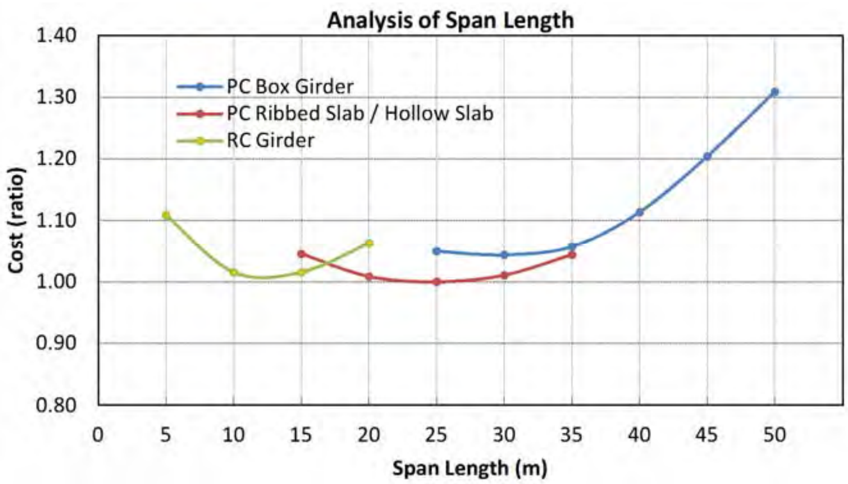
Table 10-15 Comparison of Bridge Type

Bridge Type	Cross Section / Span Length	Structure	Construction	Maintenance	Visual	Economy	Evaluation
Pre-cast PCT-girder	 L=16-40 m	★ Problem girder layout	★★★ Short period	★★★ No painting	★ Complicated	★★★ Good	
PC Hollow Slab	 L=20-30 m	★★	★ Problem of floating void	★★ Inspection of inside the void	★★★ Slender	★★★ Good	
PC Ribbed Deck	 L=20-30 m	★★	★★	★★★ No painting	★★	★★★ Good	Recommended
PC Box Girder	 L=30-60 m	★★	★★	★★★ No painting	★★	★★ Fair	Recommended for cross HW
Steel Box Girder	 L=40-80 m	★★	★★★ Short period	★ Repainting	★★	★ Costly	

Source: JICA Study Team

3) Analysis of Span Length and Cost

The analysis of span length and cost including substructure and foundation was carried out for each bridge type. The trend lines of the result is shown in the following figure.

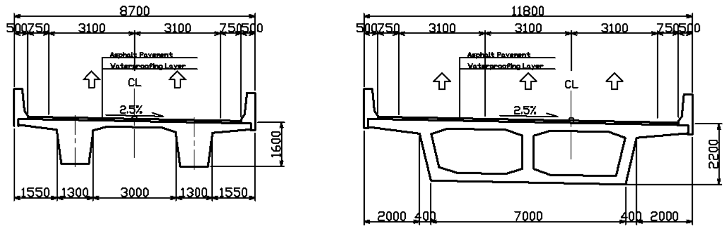


Source: JICA Study Team

Figure 10-42 Analysis of Span Length and Cost

4) Proposed Bridge Type

The consultant proposes "PC Ribbed Deck" with span of about 25 m in the standard section without restrictions. For the section over 40 m in span crossing over the existing highway, "PC Box Girder" is adopted.



PC Ribbed Deck PC Box Girder

Source: JICA Study Team

Figure 10-43 Cross Section of Proposed Bridge Type

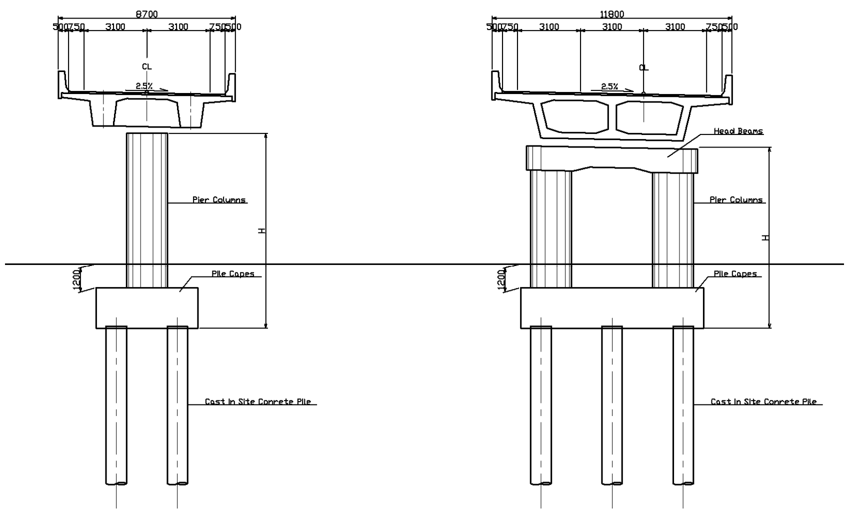
5) Erection Method

The erection method is cast in place concrete with support. As for the highway crossing, traffic restriction such as low clearance (bent supporting 3.5-4 m) or temporary detour road will be required for the existing traffic.

(5) Substructure and Foundation

1) Pier

The elevated road shows a form such as a loop ramp bridge, and there are various ways of setting the direction of the pier. Thus, the circular column type concrete pier is proposed for similar appearance from all view. The earth cover of footing of 1.2 m should be provided for drainage and utility facility.

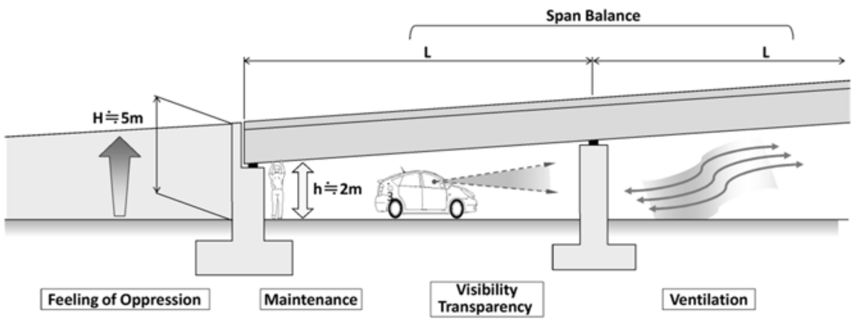


Source: JICA Study Team

Figure 10-44 Column Type Concrete Pier

2) Abutment

The inverted T-type abutment is adopted in consideration of the structure scale and foundation type. The landside environmental aspects such as drivers’ visibility (safety), transparency (environment), and feeling of obstruction (visual intrusion upon the landscape) shall be fully considered. It should be noted that although the shorter bridge lengths have the advantage of favourable costs, in order to meet the above criteria, a setback of the abutment will have to be allowed for and in addition, a vertical clearance of about 2 m shall be secured under the superstructure for maintenance purposes.



Source: JICA Study Team

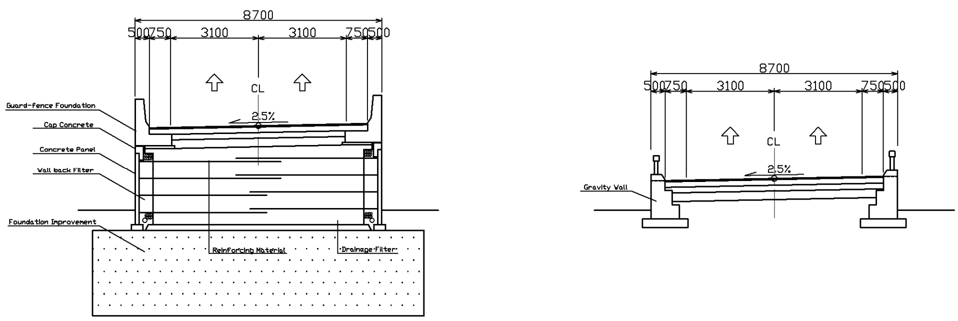
Figure 10-45 Abutment Position and Clearance

3) Bearing Layer and Foundation

According to the geological survey from the past projects, although an interlayer with N-value of more than 30 is rcorded, it does not have suitable continuity. Thus, in this study, S-4 layers (approximately GL-35 m) are thought to be the suitable bearing layer. The foundation type should be cast-in-place concrete pile D800-1200, which is suitable in consideration of structure scale. In addition, the pile length and diameter should be adjusted after detailed geological survey and selection of the terminal building foundation.

(6) Approach Embankment and Retaining Wall

Near the abutment backside, adoption of foundation improvement or earth replacement suitable for the ground situation is assumed for prevention of road surface difference with bridge. The approach embankment and retaining wall are shown below.



Source: JICA Study Team

Figure 10-46 Approach Embankment and Retaining Wall

(7) Issues for the Detail Design

- The topography of the landside has unevenness such as a pond, and the substructure is planned on the precondition such as a certain amount of embankment. The ground development in consideration of land use such as a terminal building, parking lot, and landscaping will be planned, thus the embedded depth of footing and foundation improvement of approach embankment should be studied.
- Additional geotechnical borehole survey based on bridge layout is desired, and the foundation pile should be detail studied based on that survey.

10.10 Water Treatment Plant

The following table and calculation of the required water supply volume at plant and plant facilities scale were prepared, since the exisiting water treatment plant does not provide the required water supply volume.

Raw water is collected and supplied from six deep well pumps. The water supply purification facilities shall be supplied and installed in line with the Bangladeshi water quality standard.

According to the specifications of CAAB, the sewage water volume of sewage treatment facilities is listed as follows:

VOLUME 5 OF 6: BUILDING WORKS DIVISION – 21

SPECIFICATION FOR WASTEWATER TREATMENT PLANT

Inflow Wastewater Characteristic

Black water	2,845	m^3/day
Grey water	655	m^3/day
Total wastewater flow rate	3,500	m^3/day
Peak duration	3	hours
Peak factor	3	
Average flow	145.83	m^3/hour

Black water is sewage water containing feces and urine discharged from toilets. Grey water is wastewater discharged from kitchen, pantry, and lavatory.

The quantity of water for processing by the sewage treatment facilities listed in CAAB specifications exceeds by approximately 20-40% compared with the processing quantity of water calculated from Japanese "building systems design standard" published by the Ministry of Land, Infrastructure, and Transport and in accordance with sections on "calculation of water supply" and Chapter 5 "wastewater treatment equipment", Section 1 "septic tank facilities", fifth "water supply and drainage sanitation", Chapter 1, Section 2, as well as in comparison with the septic tank disposal capacity of Ho Chi Minh’s Tan Son Nhat Airport and Hanoi’s Noibai Airport.

The septic tank inflow quantity of water and the equivalence of the specifications of CAAB made by this report are assumed and the processing quantity of water of water supply processing facilities is calculated in proportion to the septic tank processing quantity of water. Because the processing quantity of water is deemed excessive, sewage treatment plant shall not provide for a spare system as is normal.

(1) Domestic Water Volume

The water supply facilities are targeted for the new buildings such as Terminal3, parking building, VVIP, cargo buildng, WTP, STP, fire station, power house, and the water supply to existing facilities such as catering facility, existing terminal, and control tower are not considered.

The water supply volume is calculated by the number of passengers, employees, pickup persons (pickup persons are not allowed free access to the arrival terminal building, but usage outside of the terminal building is assumed) and the use of staff such as in restaurants. In addition, it is necessary to add cooling tower make-up water for the air conditioning, faucet for the parking building car washing, and the make-up water for airplane.

The target number of people will be calculated from the projected passenger volume and the number of pick up people in existing reports.

After discussion with CAAB, the water supply was calculated separately for the number of employees and for the number of others for food preparation.

Table 10-16 Number of Pick Up Persons

	Passenger	Pick up	Pick up Ratio
CNG	1,992	10,274	5.2
CAR	12,825	29,476	2.3
Micro BUS	3,378	15,412	4.6
BUS	291	29,055	99.8
Total	18,486	84,216	4.6

Source: JICA Study Team

Table 10-17 Target Number of Water Users

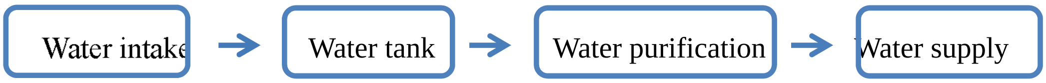
Year		2025
Passenger		12,042
ATM	International	75,260
	International + Domestic	138,4600
Average Flights		207
Passenger	Peak Day Ratio	1/300
	Peak day passengers	40,138
	Peak Hour Ratio	0.1182
	Peak hour passengers	4,744
Pick up Persons		21,822
Staff	Terminal 3	3,320
	Cargo	1,200
	Other	1,762
WTP, STP Total		68,242

Source: JICA Study Team

Table 10-18 Food Preparation

Item	Quantity	Base Water Use unit	Water Volume(m^3)
Passenger	40,138	40 L/man	1,606
Pick up persons	21,822	40 L/man	873
Staff	3,738	100 L/man	374
No. of restaurant	4,385	40 L/meal	171
Other	2,191		1,682
Total	72,274		4,706

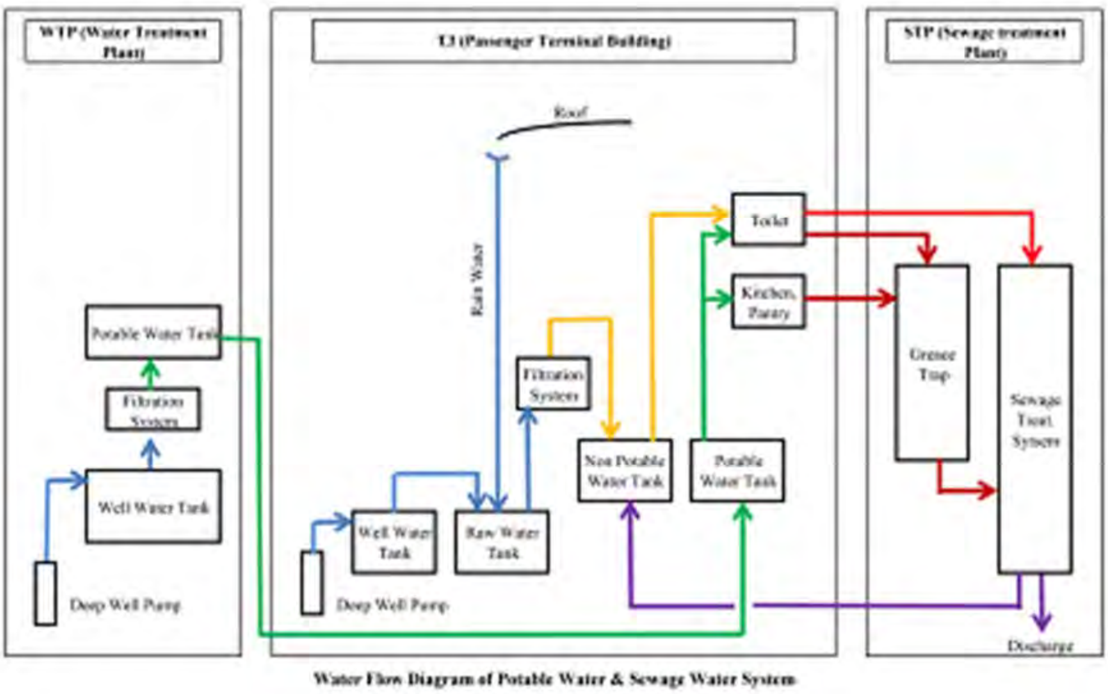
※Others include cooling tower make-upwater, backwash water for filtration system in WTP, make-up water for the chemical feeder.
Source: JICA Study Team



Source: JICA Study Team

Figure 10-47 WTP Flow Sheet

- Raw water is obtained from six deep well pumps as mentioned in the specifications of CAAB.
- The storage water facilities are reserve facilities for water from deep well.
- The filtration facilities choose a filter device depending on raw water turbidity and do not install iron and manganese removal device because there are few cases where iron content and manganese content is mixed with the raw water
- The filtered water undergoes chlorination to maintain a value of residual chlorine.
- The water supply facilities install water pump and piping system to the necessary building.



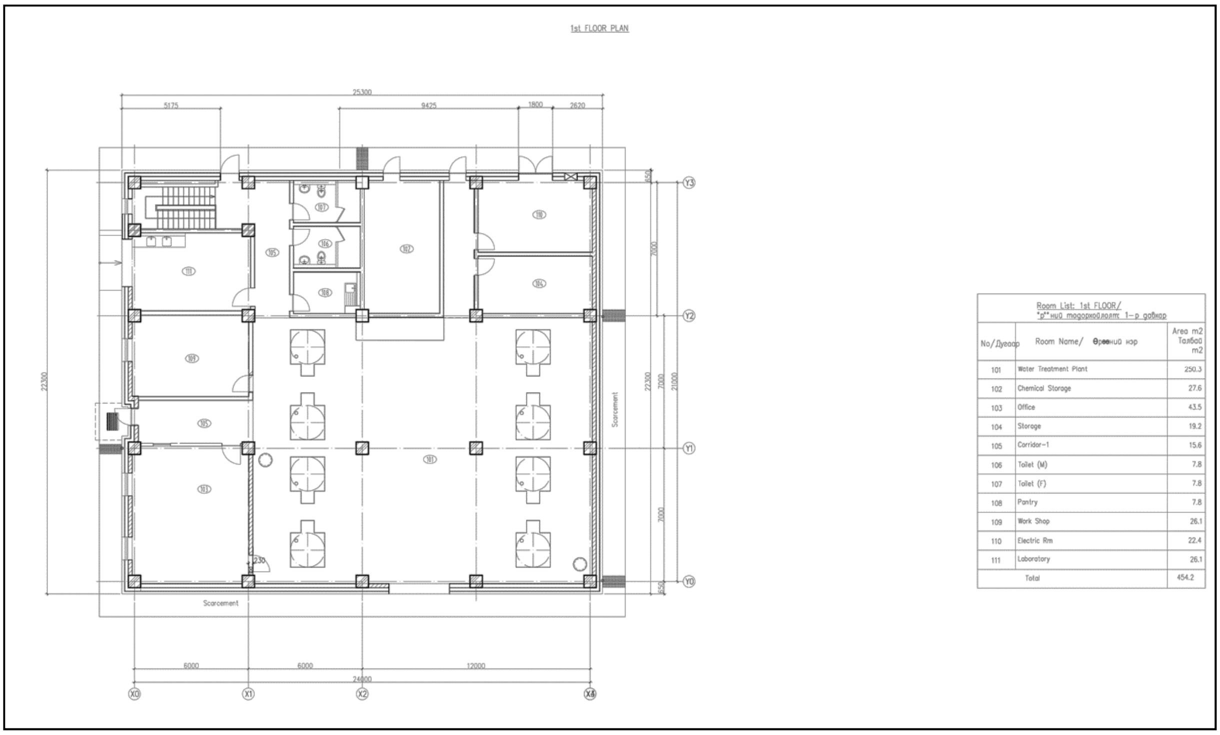
Source: JICA Study Team

Figure 10-48 Water Flow Diagram

Table 10-19 Design of Water Supply Amount

No.	Building Name	Description	Parameter	Numbers of Persons or Meals	Unit		Water Volume
					ℓ/person/day	ℓ/meals	(m3/day)
1	T3 Passenger Terminal Building	Passenger	Year 2025, Peak Daily Passenger	40,138	40		1,605.5
		Meeter and Greeter	Year 2025, Peak Daily Meeter and Greeter	21,822	40		872.9
		Office	Total Floor Area : 8,338m2 Occupant: 0.1 person/m2 8,338m2 x 0.1 x 2 shifts = 1,668	1,668	100		166.8
		Retail Shop	Total Floor Area : 7,842m2 Staff: 0.05 person/m2 7,842m2 x 0.05 x 3 shift=1,176	1,176	100		117.6
		Restaurants	Total Floor Area : 4,761m2 Staff: 0.05 person/m2 4,761m2 x 0.05 x 2 shift (avg.) = 476	476	100		47.6
			For Meal: Seating area: 60% of floor area No. of seat: 2m2/seat Turn-over: 3 times 4,761 x 0.6/2 x 3 = 4,285 meals	4,285		40	171.4
		Aircraft					67.0
		Sub Total					3,048.8
2	VVIP Terminal	Staff :	Office Floor Area : Total Floor Area 5% Occupant: 0.2 person/m2 5,000m2x0.05x0.2 = 50	50	100		5.0
		VIP & User	Toilet & Others	100	30		3.0
			Meal	100		40	4.0
3	Car Park	Staff :	Day Time : 6 Person, Night Shift : 3x2 Person	12	100		1.2
		User	Meeter & Greeter : 5% 21822x0.05 =	1,091	20		21.8
4	Cargo Building	Staff :	Office Floor Area : Total Floor Area 2% Occupant: 0.2 person/m2 50,000m2x0.02x0.2 = 200	200	100		20.0
		Forwarder :		1,000	20		20.0
5	Fire Station	Staff :	Day Time : 50 Person, Night Shift : 30x2 Person	110	100		11.0
6	Power Station	Staff :	Day Time : 10 Person, Night Shift : 5x2 Person	20	100		2.0
7	STP (Sewage Treatment Plant)	Staff :	Day Time : 8 Person, Night Shift : 3x2 Person	14	100		1.4
		Plant :	Chemical Feeder & Others				10.0
8	WTP (Water Treatment Plant)	Staff :	Day Time : 6 Person, Night Shift : 3x2 Person	12	100		1.2
		Plant :	Back-wash water & Others: 100 m3/day				100.0
		Total					3,249.4

Source: JICA Study Team



Source: JICA Study Team

Figure 10-49 Water Supply Equipment Layout

10.11 Sewage Treatment Plant

The sewage treatment plant is made based on the specifications in the basic design but considering the target processing material, there are many matters which need confirmation.

In the discussion with CAAB, the following matters are confirmed and assumed that the facilities will reflect these.

In addition, because the existing sewage treatment plant is reported to not operate smoothly, the sewage treatment plant for the whole airport was requested. However, it was decided to set the target facilities on the original scope because the request deviated from the conventional scope of JICA projects.

Since phosphorus and nitrogen are not prescribed as materials targeted under wastewater regulations, depending on the need, it is suggested to consider facilities which cope with these two materials in following recent trends in sewage treatment.

After confirming the existing sewage treatment plant from outside the facility, aeration processing space for the disposal of sludge was observed and a similar space will be secured for the new sewage treatment plant.

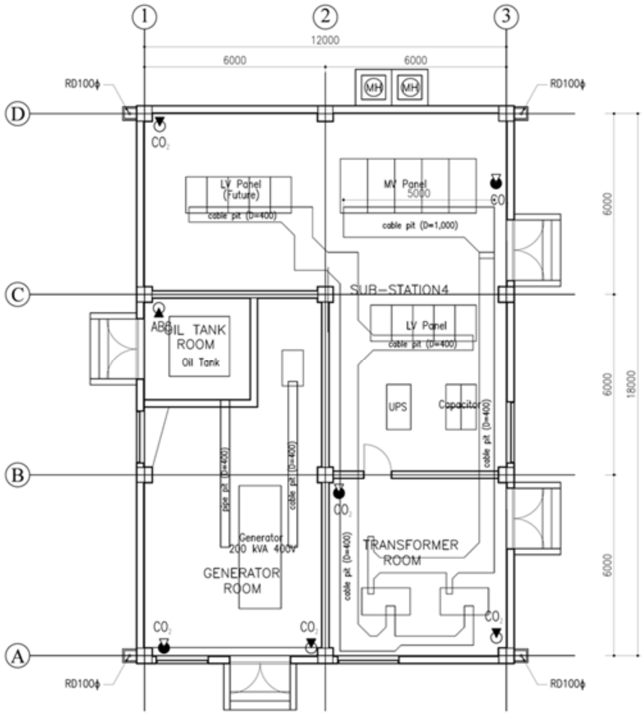
After the water supply capacity of the above was calculated, the necessary processing capacity was reduced for the make-up water or other water supply of the cooling tower for the air conditioning.

Based on the specifications of the CAAB, black water is the filthy water which is discharged from toilet, and grey water is wastage discharged from kitchen and canteen. Grey water shall be provided with oil and grease trap to remove oils and fats prior to connection to the septic tank facilities. The expansion will only handle grey water in the future.

Table 10-20 Design of Sewage Treatment Amount

No.	Building Name	Description	Parameter	Numbers of Persons or Meals	Unit		Water Volume
					ℓ/person/day	ℓ/meals	(m3/day)
1	T3 Passenger Terminal Building	Passenger	Year 2025, Peak Daily Passenger	40,138	40		1,605.5
		Meeter and Greeter	Year 2025, Peak Daily Meeter and Greeter	21,822	40		872.9
		Office	Total Floor Area : 8,338m2 Occupant: 0.1 person/m2 8,338m2 x 0.1 x 2 shifts = 1,668	1,668	100		166.8
		Retail Shop	Total Floor Area : 7,842m2 Staff: 0.05 person/m2 7,842m2 x 0.05 x 3 shift=1,176	1,176	100		117.6
		Restaurants	Total Floor Area : 4,761m2 Staff: 0.05 person/m2 4,761m2 x 0.05 x 2 shift (avg.) = 476	476	100		47.6
			For Meal: Seating area: 60% of floor area No. of seat: 2m2/seat Turn-over: 3 times 4,761 x 0.6/2 x 3 = 4,285 meals	4,285		40	171.4
		Aircraft					67.0
		Sub Total					3,048.8
2	VVIP Terminal	Staff :	Office Floor Area : Total Floor Area 5% Occupant: 0.2 person/m2 5,000m2x0.05x0.2 = 50	50	100		5.0
		VIP & User	Toilet & Others	100	30		3.0
			Meal	100		40	4.0
3	Car Park	Staff :	Day Time : 6 Person, Night Shift : 3x2 Person	12	100		1.2
		User	Meeter & Greeter : 5% 21822x0.05 =	1,091	20		21.8
4	Cargo Building	Staff :	Office Floor Area : Total Floor Area 2% Occupant: 0.2 person/m2 50,000m2x0.02x0.2 = 200	200	100		20.0
		Forwarder :		1,000	20		20.0
5	Fire Station	Staff :	Day Time : 50 Person, Night Shift : 30x2 Person	110	100		11.0
6	Power Station	Staff :	Day Time : 10 Person, Night Shift : 5x2 Person	20	100		2.0
7	STP (Sewage Treatment Plant)	Staff :	Day Time : 8 Person, Night Shift : 3x2 Person	14	100		1.4
		Plant :	Chemical Feeder & Others				10.0
8	WTP (Water Treatment Plant)	Staff :	Day Time : 6 Person, Night Shift : 3x2 Person	12	100		1.2
		Plant :	Back-wash water & Others: 100 m3/day				100.0
		Total					3,249.4

Source: JICA Study Team



Source: JICA Study Team

Figure 10-50 STP Layout

Source: JICA Study Team

Figure 10-51 Sewage Treatment Facilities Aeration Space (Existing Facilities)

10.12 Power Intake Station

(1) Existing Electricity Facilities

The power demand of the existing HSIA is estimated to be 8 MVA. It is supported by two intake power substations, namely, the CAAB DESCO Service Station in the north and ADA DESCO Service Station in the south. From these DESCO service stations, the 11 kV power cables are laid to the CAAB's Main Power Plant Service Substation in the north and Euro Tech Bangladesh (ETB) Service Substation in the south of the existing terminal building. From CAAB's Main Power Plant Service Substation and ETB Service Substation, power supply is further distributed to other service substations via the 11 kV cable infrastructure. The existing outgoing 11 kV cable infrastructure is designed with redundancy, providing flexibility to tap power from either one of the DESCO power sources.

(2) New Power Intake Station

In this "Dhaka International Airport Expansion Project" plan, the expansion is planned with the new passenger terminal building, new cargo terminal building, and the VVIP building, so existing power receiving facilities and distribution lines do not have enough capacity.

Therefore, a new intake power station and HT distribution are to be installed.

The power station confirmed by CAAB to be planned to receive power supply from both ADA Power Station in the south side and CAAB Power Station in the north side, with an electric voltage of 11 kV.

In addition, in the meeting between CAAB and the Dhaka Power Supply Public Corporation, it wais confirmed that at least five years are required in the preparation of power station in the master plan of CAAB. This is a significant risk factor for planning of the construction schedule.

Therefore, reconfirmation by CAAB is requested, and it will be necessary to arrange countermeasures, such as temporary power supply, prior to commencement of construction if substation schedule does not meet the main construction schedule.

1) New Electric Equipment Capacity

Taking into consideration the plan of this "Dhaka International Airport Expansion Project" and future expansion plan, the total electric power capacity will be 57,520 kVA.Total power demand will be about 50,000 kVA (Intake power: minimum of 50,000 kVA required). Also, the generator is installed at each substation, and 100% backup excluding airconditioning, and refrigerator (chiller) demand is scheduled for power outage and accident. Total generator capacity is 64,000 kVA.

Table 10-21 Power Demand Estimate for HSIA Airport

HT CIRCUIT	FACILITIES	TRANSFORMER (KVA)	LOADING DEMAND(KVA)	SUB TOTAL (KVA)	BACK UP GENERATER(KVA)
1	HT SUB STATION 1 – FINGER	3000KVA x 2	3050	3050	2500 x 2 Total: 5000
2	HT SUB STATION 2 – PTB	3000KVA x 7	9890	9890	2500 x 5 Total: 12500
3	HT SUB STATION 3 – PTB	3000KVA x 7	9710	9710	2500 x 5 Total: 12500
4	HT SUB STATION 4 – FINGER	3000KVA x 2	3020	3020	2500 x 2 Total: 5000
5	HT SUB–STATION 5 – CHILLER	2000KVA x 7	8700	8700	2000 x 2 Total: 4000
6	HT SUB–STATION 6 – CHILLER	2000KVA x 7	8700	8700	2000 x 2 Total: 4000
7 – 1	FUTURE FIRE STATION	750KVA x 1	370	1570	500 x 1 Total: 500
7 – 2	WIP COMPLEX	1600KVA x 1	1200		1500 x 1 Total: 1500
8 – 1	HT SUB STATION 8– CAR PARK	2000KVA x 2	2950	5510	2000 x 2 Total: 4000
8 – 2	HT SUB STATION 7– LINK–WAY	2000KVA x 2	1560		2000 x 2 Total: 4000
8 – 3	CONTROL TOWER	1000KVA x 2	1000		1500 x 1 Total: 1500
9 – 1	FUTURE DOMESTIC TERMINAL	1600KVA x 2	1700	5870	FUTURE 2000 x 1
9 – 2	FUTURE HANGER	750KVA x 1	330		FUTURE 500 x 1
9 – 3	FUTURE CARGO BUILDING	1600KVA x 2	1870		FUTURE 2500 x 1
9 – 4	2ND RUNWAY	1600KVA x 1	820		FUTURE 1000 x 1
9 – 5	FUTURE FLIGHT KITCHEN	1000KVA x 2	1150		FUTURE 1500 x 1
10	FUTURE FUEL FARM EXPANSTION FUTURE SEWERAGE TREATMENT PLANT & WASTE WATER TREATMENT PLANT	1000KVA x 2	1000 500	1500	2000 x 1
	TOTAL	107100		57520	64000

Source: JICA Study Team

2) New Distribution System（HT Distribution Schematic Diagram）

The new power intake station assumes a two system retreat from an electric power company and plans four system pulls in the future so that it is possible for including it (future HT loop).

Figure 10-52 HT Distribution Schematic Diagram

Confidential due to security reasons.

Source: JICA Study Team

3) New Power Intake Station

Confidential due to security reasons.

Confidential due to security reasons.

Figure 10-53 Assumed Device Arrangement Drawing

Source: JICA Study Team

4) New Supply of Electric Power Line (HT Distribution)

Confidential due to security reasons.

Confidential due to security reasons.

Figure 10-54 Substation and Power Cable Routing Layout No. 1

Source: JICA Study Team

Confidential due to security reasons.

Source: JICA Study Team

Figure 10-55 Substation and Power Cable Routing Layout No. 2

Confidential due to security reasons.

Source: JICA Study Team

Figure 10-56 Substation and Power Cable Routing Layout No. 3

10.13 Fuel Supply Facilities

10.13.1 Fuel supply Facilities for Terminal 3

(1) Work Demarcation of Fuel Supply Facility

The fuel depot and hydrant facility are all in one system as a fuel supply system and it cannot be segregated individually. Therefore, the implementation of fuel supply system (Fuel depot and hydrant facility) for Terminal 3 must be done all in one system.

Further discussion for the work demarcation of fuel supply facility at Terminal 3 with Padma Oil Co., Ltd. will be required. However, we understand that fuel depot facilities will be provided by Padma Oil Co., Ltd and hydrant facility will be provided by CAAB.

Confidential due to security reasons.

Figure 10-57 Outline of Fuel Supply Facilities

(2) Premises

- Facility Capacity: Described in Article 7 Fuel Supply Facilities
- Annual Fuel Demand Forecast for Terminal 3: Phase 1-1, 811kl/day, Phase 2-2, 429kl/day
- Storage Tanks: Phase 1 - 4,500kl x 3 nos., Phase 2 - 4,500 x 1 no.
- Hydrant Delivery Volume: Phase 1 - 817kl/h (3,600gpm), Phase 2 - 1,362kl/h (6,000gpm)
- Delivery Pump Discharge Pressure : 1.3MPa (Maxium)

(3) Design codes and standards

- Bangladesh local codes and standards
- ICAO Doc 9977 "Manual on Civil Aviation Jet Fuel Supply"
- Design, construction, commissioning, maintenance and testing of aviation fuelling facilities (EI 1540 5th edition ENERGY INSTITUTE)
- Japanese Fire Service Law

(4) Standards, etc.,

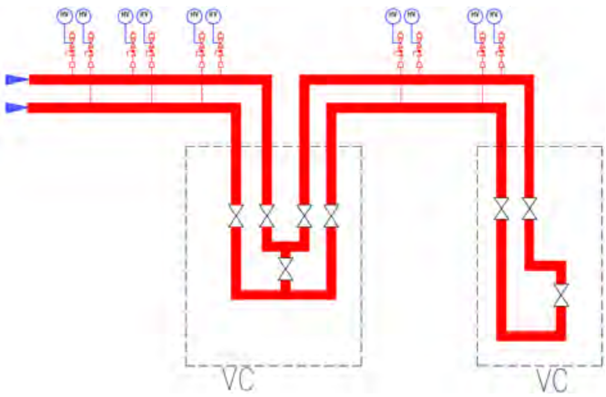
- IATA、ANSI、ASTM、JIS、JIG、SII、API、IEC、IEEE
- Jet fuel standard: ASTM D-1655
- Hydrant pit valve standards: API/IP Bulletin 1584

10.13.2 Hydrant Pipelines at Apron

Underground hydrant pipelines at apron shall be redundant system (installation of dual pipelines) for inspection, repairing and reinstallation purpose. The valve chambers are installed for each 5 to 6 aircraft parking spots and install valves in valve chamber to block problem area and minimize closing of aircraft parking spots.

Typical layout of hydrant pipelines and valve changers is shown in Figure 10-58.

Figure 10-58 is also shown normal operation condition and all valves are open status and it is able to supply jet fuel to all hydrant valves.

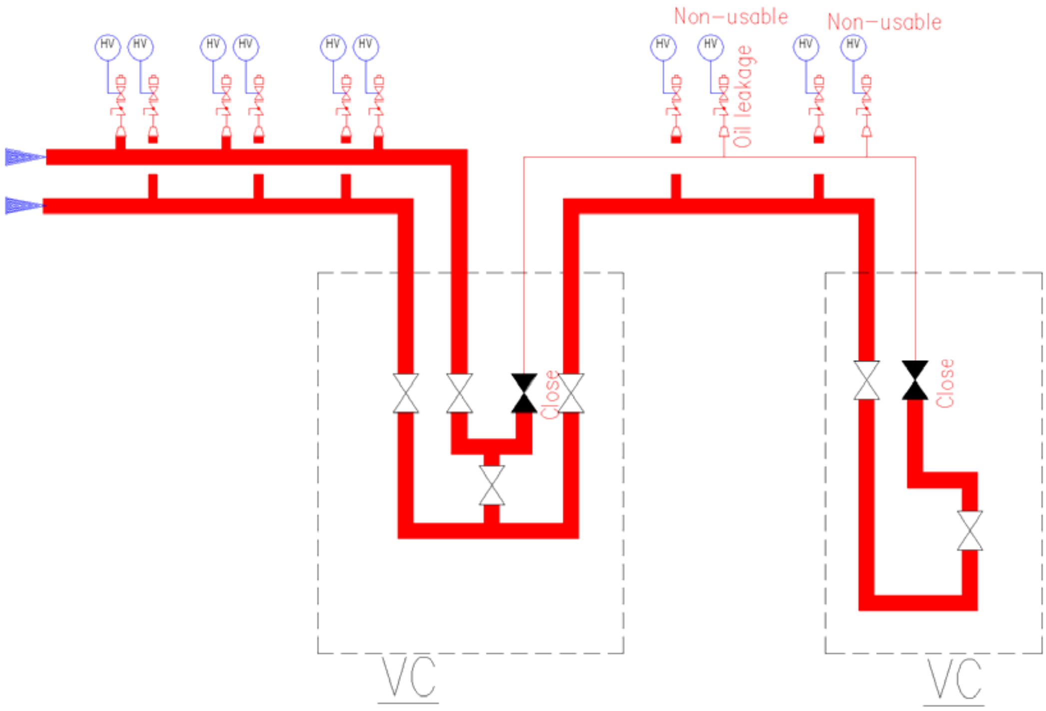


VC: Valve Chamber HV: Hydrant Valve

Source: JICA Study Team

Figure 10-58 Apron Pipeline – Function of Dual Pipelines and Valve Chambers (1)

Reference to Figure 10-58, in case oil leakage is occurred at one hydrant valve, 2 valves are closed in valve chamber (Refer to the status of Figure 10-59). Then the oil leakage point and another hydrant valve cannot be used. However other hydrant valves can be used and it is possible to repair the oil leakage point under operation condition.



Source: JICA Study Team

Figure 10-59 Apron Pipeline – Function of Dual Pipelines and Valve Chambers (2)

Process flow diagram for hydrant pipelines at terminal 3 apron is shown in

Confidential due to security reasons.

Figure 10-60.

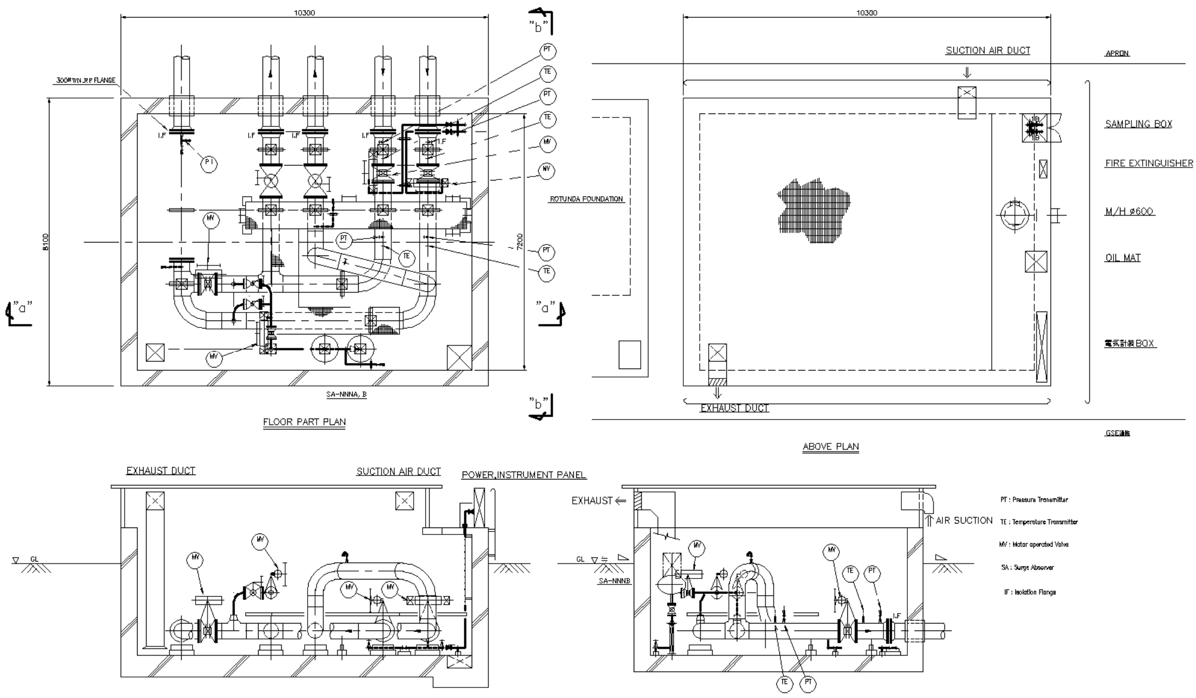
Confidential due to security reasons.

Figure 10-60 Process Flow Diagram for Hydrant Pipelines at Terminal 3 Apron

Reference drawing for valve chamber is shown in Figure 10-61 and reference drawing for hydrant pipelines is shown in

Confidential due to security reasons.

Figure 10-62.

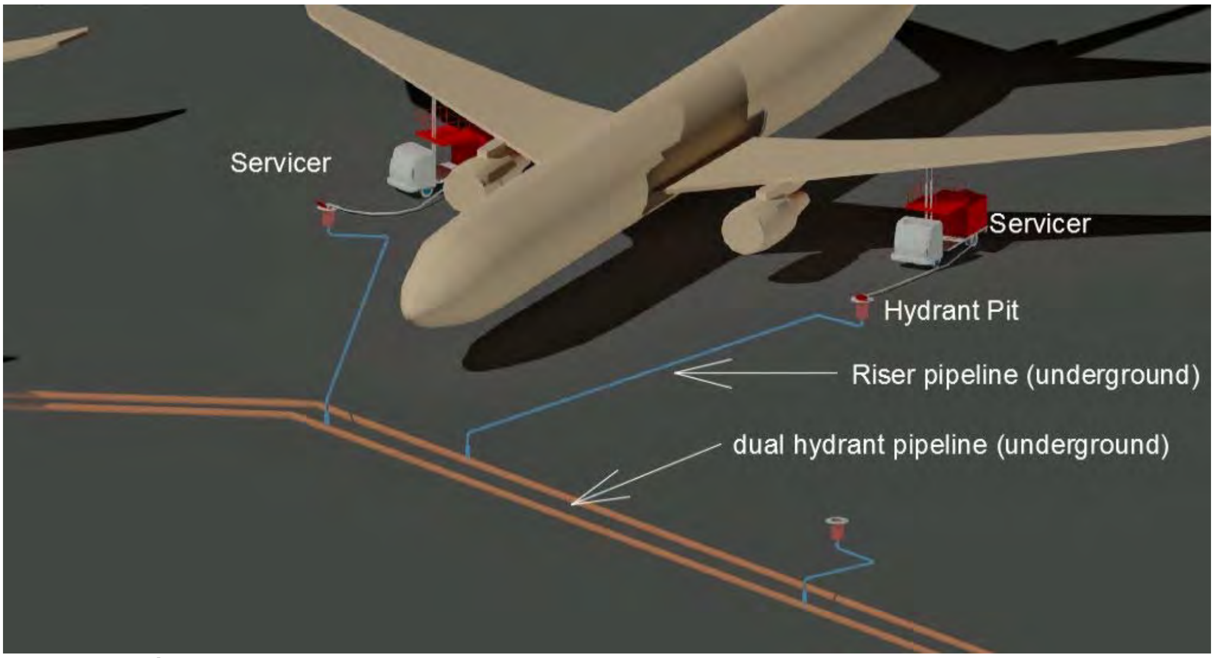


Source: JICA Study Team

Figure 10-61 Reference Drawing for Valve Chamber

Confidential due to security reasons.

Figure 10-62 Reference Drawing for Hydrant Pipelines



Source: JICA Study Team

Figure 10-63 Reference Drawing for Hydrant Valves and Hydrant Pits

10.13.3 Fuel Depot (Receiving, Storage and Delivery Facilities)

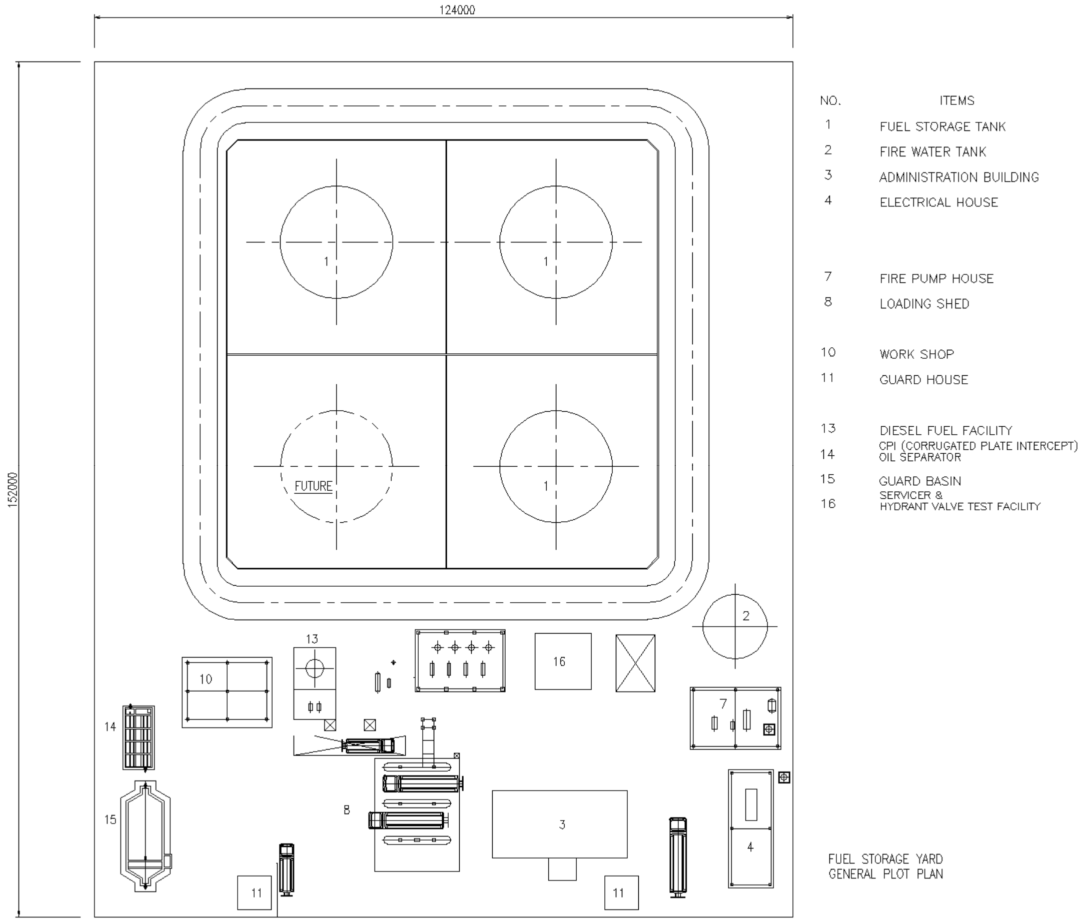
The hydrant pump control system, automatic hydrant oil leakage system and cathodic protection for the hydrant facility shall be installed at the fuel depot.

Required area for the fuel depot with storage tanks, hydrant pumps and other ancillary facilities is approx. 20,000m^2 (2.0ha).

The following items shall be considered for the fuel depot design.

- The facilities where flammable material is being handled, so it shall be satisfied the requirement of law and regulation for the safety distance.
- The location of fuel depot shall be refered to the law and regulation of airport.
- The fuel depot shall be accessible from the public area (outside) of airport.
- The Fuel Depot shall be accessible from the internal airport road.

For reference, Layout Plan for the Fuel Depot is shown in the Figure 10-64.



Source: JICA Study Team

Figure 10-64 Layout Plan for the Airport Fuel Depot

10.13.4 Future Tasks

- Further discussion for the responsibility of new fuel depot facilities for Terminal 3 with Padma Oil Co., Ltd. will be required.
- It is necessary to harmonize the design of new fuel depot facilities and fuel hydrant facilities in the detailed design stage of this project

10.14 Communication Facility

In the HSIA Expansion Project Phase-1, significant extension, including the new terminal building, new cargo terminal, and VVIP terminal is scheduled. Therefore, the existing communication network will be utilized and the new communication network for expansion area will be newly built. The new network will be connected to the existing network to complete the whole built out network.

(1) Structure of New Communication Network

Confidential due to security reasons.

Confidential due to security reasons.

Figure 10-65 Telecommunication and Structured Cabling Network Architecture

(2) Communication Cable Routing Layout

New communication network cable will be buried piping of PVC pipe duct. Figure 10-66 to Figure 10-68 show the communication cable routing layout.

Confidential due to security reasons.

Source: JICA Study Team

Figure 10-66 Communication Cable Routing Layout No.1

Confidential due to security reasons.

Source: JICA Study Team

Figure 10-67 Communication Cable Routing Layout No.2

Confidential due to security reasons.

Source: JICA Study Team

Figure 10-68 Communication Cable Routing Layout No.3

10.15 Security Equipment

Confidential due to security reasons.

- HSB will follow the regulation of TSA and ECAC.
- HSB will comply with EU STD3 that will be operational at the time of Terminal3 opening
- HSB shall have a separate image inspection for handguns, etc. in addition to EDS evaluation functions on all baggage.
- The inspection of the carry-on is also based on regulation of TSA and ECAC.
- The regulation of ECAC in the carry-on will comply with the EU STD3 (C1 - C3) operation.
- The security check point will be provided with a smart security lane.
- In the inspection for passenger, will install ATI(MWD).
- The inspection machine of the customs excludes the installation of CAAB.

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Figure 10-69 HBS Inspection Flow

CHAPTER 11 STUDY ON APPLICABILITY OF JAPANESE TECHNOLOGIES

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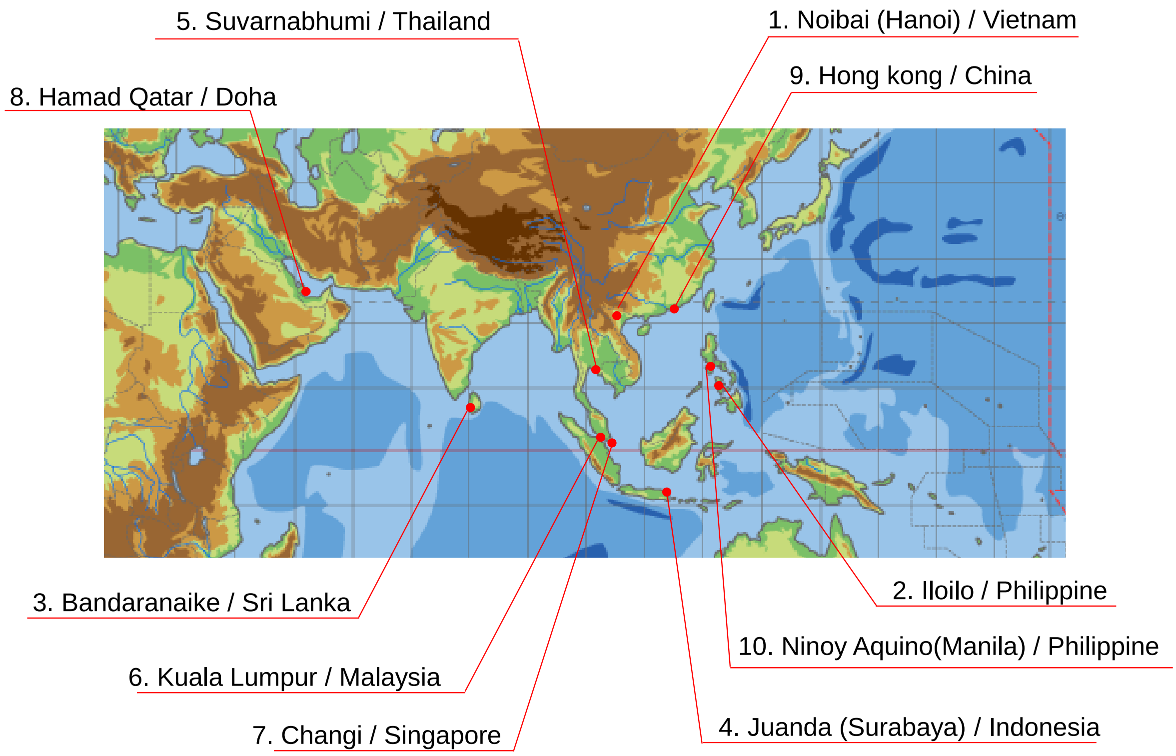
Chapter 11 STUDY ON APPLICABILITY OF JAPANESE TECHNOLOGIES

11.1 Collection and Compilation of Examples

Figure 11-1 shows the airports constructed by Japanese companies in the past 20 years. Also, the Japanese technologies applied in these airports are listed in Table 11-1 to Table 11-4

There are various technical problems in each airport and various Japanese advanced technologies were used tin their solutions. Major problems of the Dhaka International Airport Expansion Project are airport construction under operation and soil improvement.



Source: JICA Study Team

Figure 11-1 Map of Airports Constructed by Japanese Companies

Table 11-1 Construction Technology of Japanese Contractors (1)

No.	Country/City	Airport Name	Contractor	Project Duration/Cost (JPY)	Feature	Major Work Item	Particular Feature (Technical, Constrained Condition)	Others
1	Vietnam	Noibai	Taisei, Vinaconex (Vietnam) JV	March 2010 to December 2014	Package Type Infrastructure Overseas Expansion	Passenger Terminal Building	Operational Airport	
	Hanoi			Yen loan: 12.6 billion(I), 20.5 billion (II), 26.0 billion (III), Construction cost: 44.7 billion	Airport operation underpublic and private cooperation Japanese high technical system for operation and maintenance (O&M) Fuel hydrant system, BHS, Data system	Four stories, one basement building and associated facilities, parking, viaduct, special equipment, sewerage disposal, andfuel hydrant		Hard: annual passenger: 10 million; terminal building and associated facility Soft: Support for airport operation and management
2	Philippines	Iloilo	Taisei, Shimizu JV	August 2000 to March 2007	Greenfield airport	Civil, Building, Air Navigation, Utilities		
	Iloilo			Yen loan: 14.3 billion	Fourth airport traffic activity of the Philippines	- Runway (2,500 m) - Passenger Terminal Building (12,000 m^2) - Cargo Terminal Building (1,300 m^2) - Taxiway, Apron (48,000 m^2) - Admin Building, Control Tower - Radar, Lighting facility - Utility (power, water, sewer, andsolid waste)	Resettlement	Annual passenger: 10 million Cargo handling: 10,000 ton
3	Sri Lanka	Bandaran aike	Taisei, Mitsubishi Corp. JV	August 1999 to February 2007	JICA－JBIC cooperation project	Civil, Building, Air Navigation, Utilities		
	Colombo			Yen loan: 12.0 billion Construction cost: 44.7 billion	Brownfield airport development	- Taxiway, Apron (60,000 m^2) - New Passenger Terminal (18,000 m^2) - Radar, Meteorological, High Frequency facility - Utility (power, water, sewer, and solid waste)	Operational Airport	Annual passenger: 9 million;Terminal and associated facility Phase II (next stage） is ongoing around JPY 28.9 billion

Source: The Survey on the Japanese Latest Technologies for Overseas Expansion of Airport Infrastructure

Table 11-2 Construction Technology of Japanese Contractors (2)

No.	Country/City	Airport Name	Contractor	Project Duration/Cost (JPY)	Feature	Major Work Item	Particular Feature (Technical, Constrained Condition)	Others
4	Indonesia	Juanda	Kajima, Mitsubishi Corp. with three Indonesian contractors JV	December 1996 to April 2010	New terminal development	Civil, Building, Air Navigation, Utilities		
	Surabaya			Yen loan: 12.8 billion (I), 14.5 billion (II)	New terminal development at the opposite side of existing runway	- Passenger terminal building (52,100 m^2) - Cargo terminal building (10,000 m^2) - Taxiway, apron (130,000 m^2) - Admin building, control tower - Radar, MET, HF facility - Utility (power water, sewer, and solid waste)	Resettlement	Annual passenger: 6 million, 120,000-ton cargo handling
5	Thailand	Suvarna-bhumi	Japan-Thailand JV nine groups	September 1996 to September 2007	Capital greenfield airport	Civil, Building, Air Navigation, Utilities		
	Bangkok		Japanese contractors (5) Obayashi, Takenaka, Shimizu Corp., Nishimatsu, Nippon Road	Yen loan: 194.4 billion	Greenfield airport at the center of ASEAN supply-chain	- Earthworks, ground improvement (3,100 ha) - Passenger terminal building (540,000 m^2) - Runway(3,700 m, 4,000 m) - Admin building, control tower - Air navigation facility - Utility (power, water, sewer, and solid waste)	Resettlement, Ground Improvement	Annual passenger: 45 million, 2.12 million ton cargo handling for the new airport
			Takenaka, Obayashi, Italian Thai JC	Around 100 billion	Steel structure, reinforced concrete, seven stories, one basement	New passenger terminal building (610,851 m^2)		

Source: The Survey on the Japanese Latest Technologies for Overseas Expansion of Airport Infrastructure

Table 11-3　Construction Technology of Japanese Contractors (3)

No.	Country/ City	Airport Name	Contractor	Project Duration/Cost (JPY)	Feature	Major Work Item	Particular Feature (Technical, Constrained Condition)	Others
6	Malaysia	Kuala Lumpur	Taisei, Takenaka JV	April1994 to June 1998	Capital greenfield airport (Terminal only)	Passenger terminal building	Design-build	
	Kuala Lumpur			Yen loan: 50.3 billion	Scope of Yen loan portion: Passenger Terminal Complex	- Building (457,000m^2) - Special equipment (BHS: Baggage Handling System, TTS: Track Transit System BAS: Building Automation System)	- Importance of project management (PM) due to several packages and projects - Detailed design (DD) and constructionbased on basic design (BD) and specifications - High technique of steel structure and roofing due to huge open space of main terminal building	Annual passenger: 25 million; The symbiotic relationship between nature and architecture is realized through the concentric garden in the airport. Architecture: Kisho Kurokawa. Main terminal by Taisei, satellite by Takenaka
7	Singapore	Changi				Building and associated facility		
			Takenaka	January 2014 to 2017 Around 80.0 billion (CAG）	No. 4 Terminal	- Passenger terminal building (490,000 m^2) - Parking（1,500 vehicle capacity） - Ramp Tower (H=68 m)		DD：SAA Architect, Benoy, Takenaka JV
			Takenaka	March 2015 to 2019 28.0 billion （CAG）	Expansion of No. 1 Terminal	- No. 1 terminal departure lobby - Check-in area - BHS		DD：RSP, Squire Mech
			Penta Ocean, Koon (Sin) JV	Nov. 2014 to 2020 95.3 billion (Singapore MOT）	Ground improvement for airport expansion area (No. 3 R/W, No. 5 Terminal Area)	- Ground improvement area 700 ha (whole area 1,080ha)	Airside construction under operational airport	

Source: The Survey on the Japanese Latest Technologies for Overseas Expansion of Airport Infrastructure

Table 11-4　Construction Technology of Japanese Contractors (4)

No.	Country/City	Airport Name	Contractor	Project Duration/Cost	Feature	Major Work Item	Particular Feature (Technical, Constrained Condition)	Others
8	Qatar	Hamad			Green field airport	Building and associated facility		
	Doha		Taisei, TAV（Turkey）JV	March 2006 to December 2012 USD 825 million (Qatar Government)	Passenger Terminal (24 million PAX) and associated facilities	- Passenger terminal building (490,000 m^2) - Special equipment (elevator, escalator, BHS)		Design and Supervision : Overseas Bechtel
			Takenaka, CDC（Qatar）JV	May 2006 to May 2008 Around JPY 27 billion (Qatar Government)	Emiri Terminal, Parking, and Mosque	- Emiri terminal building (9,100m^2) - Mosque, minaret (H=37 m） - Parking (1,409 vehicle capacity）		Design and Supervision : Overseas Bechtel
9	United Arab Emirates	Abu Dhabi			District Heating and Cooling Plant			
	Abu Dhabi		Shinryo	December 2013 to July 2017	EPC Contract	60,000 refrigeration ton capacity		
10	China							
	Hong Kong	Hong Kong		December 1992 to July 1998 Around JPY 1,500 billion (Government of Hong Kong)	Earthworks (CLK island area reclamation)	Land Reclamation Area: around 1,300 ha Offshore Artificial Island	- Huge Earthworks（Total volume: around 300 million m^3） - Reclamation Works	Construction period: around 3.5 years
					Passenger Terminal (3.5 million passengers)	Building Structure: 498,000 ㎡		Annual passenger: 35 million, 1.3 million-ton cargo handling

Source: The Survey on the Japanese Latest Technologies for Overseas Expansion of Airport Infrastructure

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CHAPTER 12 CONSTRUCTION PLANNING

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Chapter 12 CONSTRUCTION PLANNING

12.1 Procurement Situation

The local procurement situation for the procurement of materials for civil engineering facilities works and building facilities works, which shall be the main works in the construction of HSIA Expansion Project, are summarized below.

However, based on the applicable standards and specifications, special equipment and plant, such as baggage handling system, passenger boarding bridge, aeronautical navigation radio facility, and lighting facilities, will have to be imported.

12.1.1 Construction Materials

Basically, general materials are available within Bangladesh. However, VAT of country’s tax is levied upon purchase.

(1) Earthworks

Earth filling material for pond is also available locally. This soil is carried from a site located 5km away from HSIA. Carrying in/out these materials to/from the site using dump truck requires a permit from the related department.

(2) Building Works

For building work, the cast-in-place pile and the screwed steel pile are used. It is easy to procure the cast-in-place pile in the country. Also, the screwed steel pile can shorten the construction period. Steel products used for reinforcement works are also available in the country. However, large materials such as I-beams and structural pipes are to be imported from abroad.

Although it is necessary to survey the situation of manufacturing, industry and quality in Bangladesh, in general, most products are considered to be procured from overseas except for bricks and tiles.

(3) Pavement Works

Materials for asphalt and concrete pavement are available in the country. For base course material, sand is available in Dhaka City and stone is available in the north area of Bangladesh.

(4) Drainage Facilities Works

On the drainage facilities works, secondary product such as pipes, U-shape gutter, concrete used for inlets, and reinforcement bars are available, except for special materials.

(5) Structure Works

Steel products used for reinforcement works are also available in the country. However, large materials such as I-beams and structural pipes are to be imported from abroad.

12.2 Scope of Construction Work

(1) Earthworks

1) Removal of Topsoil

Removal of topsoil will be done in the section of pavement area and building area. The removed soil will be carried to the other area of pavement area and building area.

2) Sand Filling in Pond

Sand filling in pond will be done after relocating existing drainage and draining stored water and removal of soft soil deposited on the bottom of the pond. The surplus soil will be carried to the site outside the pavement in the airport area and building construction area.

3) Soil Improvement Work

Soil improvement work will be done in the areas where liquefaction and uneven settlement at the time of earthquake are expected in the taxiway area, new apron area, and new access road.

4) Earth Cut

The generated soil during earth cut will be divided into good-quality soil and expansive clay; good-quality soil will be used for the subgrade of the pavement. The surplus clay will be used for earthwork except for the pavement and building works.

(2) Building Works

The building work will be done in each area listed in Table 12-1.

Table 12-1 Building Works

Facilities	2018	2019	2020	2021
International Terminal (Terminal 3)	preparation work, earthwork, piling work, foundation work, concrete work, steel frame work	earthwork, piling work, foundation work, concrete work, steel frame work, roof work, outer wall, interior, M&E work	steel frame work, roof work, outer wall, interior, M&E work	interior, M&E work
Cargo Terminal	preparation work, earthwork, piling work, foundation work, concrete work	concrete work, steel frame work, roof work, outer wall, interior, M&E work	interior, M&E work	
VVIP	preparation	earthwork, foundation, concrete work, steel frame work, roof work, outer wall, interior, M&E work		
Fire Station		earthwork, foundation, concrete work, steel frame work, roof work, outer wall, interior, M&E work	interior, M&E work	
Parking	preparation work, earthwork, piling work, foundation work, concrete work	earthwork, piling work, foundation, concrete work, roof work, outer wall, interior, M&E work	roof work, outer wall, interior, M&E work	interior, M&E work

Source: JICA Study Team

(3) Pavement Works

The pavement works are listed below.

Table 12-2 Pavement Works

Facilities	2018	2019	2020	2021
Taxiway	Connecting taxiway: 2 Main area: 13,200m^2 Shoulder area: 16,000m^2	Connecting taxiway: 4 Rapid exit taxiway: 2 Main area: 70,000m^2 Shoulder area: 88,300m^2	Connecting taxiway: 3 Rapid exit taxiway: 1 Main area: 37,900m^2 Shoulder area: 37,600m^2	
Apron	Existing apron side: 38,400m^2	Front of VVIP apron: 201,600m^2	Front of VVIP apron and Terminal 3 apron: 201,600m^2	Front of existing VVIP apron and Terminal 3 apron: 38,400m^2
Service road	Apron area	Apron area	Apron area	Apron area
Security road	VVIP area	VVIP area	VVIP area	VVIP area
GSE Road	Apron area	Apron area	Apron area	Apron area
Access road	Up to the supply and treatment facility andsewage treatment facility	-	-	-

Source: JICA Study Team

(4) Drainage Facility

Drainage facilities in the terminal and car parking area, and regulating reservoir to pool water from the runway strip and taxiway strip and apron drainage facility will be constructed.

(5) Utility Facility (Supply and Treatment Facility, Sewage Treatment Facility, Electric Power Supply Facility, Fuel Facility, Community Facility)

Utility facilities around the terminal will be constructed.

12.3 Construction Planning

The following are the important points in the construction planning of the HSIA Expansion Project:

- The construction planning has taken into consideration the schedule of piling work.
- The onsite construction work as well as related planning would take into consideration the bad nature of the site soil.
- The timing of infrastructure connection, such as mechanical, electrical and fuel should be coordinated.

12.4 Study on Construction Works Progress

(1) Preconditions

1) Working Ratio

a) Rainfall

In Dhaka area of Bangladesh, as stated in Section 4.2.1, there are rainfalls of 50 mm/h or more concentrated during the four months of June through September; there is a dry season with almost no rainfall during the six months of October through March. 70% of the rain will fall in the rainy season. The weather data of 2014 measured in HSIA is shown in Table 12-3. The table shows the relation of rainy date classed by rainfall per day.

Work suspension day is 0.5 day in case of 1-10 mm rainfall per day, and work suspension day is 1.0day in case of more than 10 mm rainfall per day. In that case, total work suspension days of rainy season is 55 days and the days of other season is 22.5 days.

Table 12-3 Rainy Date Divided in Rainfall per day and Work Suspension Days

Rainfall per day (mm)	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1-10	1	2	1	3	3	6	4	11	7	5	0	0	43
More than 10	0	1	0	6	7	8	17	7	9	1	0	0	56
Work suspension days	0.5	2	0.5	7.5	8.5	11	19	12.5	12.5	3.5	0	0	77.5

Source: JICA Study Team

b) Holidays

There are 22 holidays in Bangladesh for 2017, as listed in Table 12-4; excluding for the disability period during the rainy season, 11 days per year can be considered as official holidays. Islamic holidays move against the western calender due to progression of the Islamic calender, but the annual holidays can be considered 22 for the period under study. Also, the holidays during the rainy season can be considered 11 days same as 2017.

Table 12-4 Holidays in Bangladesh

Holidays	Holiday Days	Rainy Season	Holiday Name
2017/2/21	1		Shaheed Dibash
2017/3/17	1		Birth Day od Sheikh M. Rahman>
2017/3/26	1		Independence Day
2017/4/14	1		Bangla New Year's Day
2017/5/1	1		May Day
2017/5/10	1		Buddha Purnima
2017/5/12	1		Shab-E-Barat
2017/6/23		1	Shab-E-Qudar
2017/6/23		1	Jumatul Bida
2017/6/25～2017/6/27		3	Eid-Ul-Fitr
2017/8/14		1	Janmastami
2017/8/15		1	National Mourning Day
2017/9/1～2017/9/3		3	Eid-Ul-Azha
2017/9/30		1	Durgapuza
2017/10/1	1		Moharram (Asura)
2017/12/1	1		Eid-e-milad-un-Nabi
2017/12/16	1		Victory Day
2017/12/25	1		Christmas Day
Total	11days	11days	Total Holiday Days: 22

Source: JICA Study Team

c) Working Ratio

Working ratio is determined at 75.7% (1.32), as shown in Table 12-5, omitting rainy days as disability period and holidays.

Table 12-5 Calculation of Operating Rate

Year (days)	Work Inability Date			Working Days	Operating Rate	
	Rainfall Date	Holidays	Total			
365	77.5	11	88.5	276.5	75.7%	1.32

Source: JICA Study Team

2) Working Period

a) Civil Work

Working period of main work of civil facilities is calculated based on the construction capacity by the standard construction machine.

For earthwork, the dump truck to be used is a maximum of 11t class, since it is necessary to use general road for transportation of landfill earth. In that case, the number of work days of the earthwork is determined from the number of 11t class dump trucks rather than the capacity of compaction or leveling. The work capacity when the number of dump trucks is 50 or 100 is shown in Table 12-6.

- Soil quantity in one loading: C = 7.2 (m^3)
- Soil quantity conversion factor: f = 0.77
- Work efficiency: E = 0.9
- Cycle time: Cm = 75 (min)
- Workload per driving time: Q = 60・C・f・E/Cm = 4.0 (m^3 / h)
- Work time per day: 8 (hour)

Table 12-6 Work Capacity

Number of Dump Truck	Transport Volume per day (m^3)	Annual Amount of Earthwork (m^3)
50	1,600	442,800
100	3,200	884,000

Source: JICA Study Team

For pavement works, a dedicated plant will be constructed on site to manufacture concrete. The number of work days of the pavement work is determined from the capacity of the concrete plant. The volume of plant mixer and standard capacity per hour in large-scale construction are shown in Table 12-7.

Table 12-7 Relationship between Mixer Volume and Mixing Capacity of Plant (2-axis Forced Type)

Volume of Mixer	Number of Mixer	Continuous Mixing Capacity (m^3/h)
1.0	1	40
	2	60
1.5	1	60
	2	90

Source: JICA Study Team

Althoughthe continuous mixing capacity will be changed according to the volume and the number of mixer, the capacity is set to 60 (m^3/h)in this report. Assuming that the daily work time is 8 hours, the daily work volume is 480 (m^3/day). Assuming that the thickness of pavement is 50 (cm), the annual construction area of concrete pavement is 960 (m^2/day). Considering the working ratio, the monthly construction volume will be 21,800 (m^2/month).

Main work volume and working days are shown below.

Table 12-8 Working Period

Engineering Work	Classification	Quantity	Working Days (days)	Working Months (months)	Remark
Earthwork	Removal of Topsoil	760,000 m^3	270	12	
	Sand Filling in pond	425,000 m^3			
	Soil Improvement Work	200,000 m^3			
	EarthCut	—			
Pavement work	Taxiway	108,000 m^2			
	Apron	498,500 m^2	500	22	
	Facilities Road	1 Lot	520	23	
Drainage work	Main Drainage	1 Lot	630	28	
	Reservoir	1 Lot	770	34	
Miscellaneous work	Security Fence	1 Lot	200	9	

Source: JICA Study Team

b) Building Work

For constructing an airport on new land, the following are the main types of construction work that have been taken into consideration:

Table 12-9 Main Types of Construction

Facility	Work Item
Construction of Terminal 3, Cargo Terminal and VVIP Terminal	Earthwork, piling work, foundation work, concrete work, steel frame work, roof work, outer wall, interior, M&E work, special equipment and elevator work, exterior
Construction of the Kerbside Road and Car Parking Areas	Earthwork, piling work, foundation work, concrete work, roof waterproofing work, outer wall, interior, M&E work, elevator work, exterior
Construction of the Supply and Treatment Facilities	

Source: JICA Study Team

It is necessary to have an efficient and reliable overall construction plan which takes into account the abovementioned construction works along with their respective construction schedules, airport opening, and trial and testing period.

(2) Work Progress Plans

3) Civil Engineering Facilities Works

The progress plans were made based on the following conditions:

- Preparation period for works: two months
- Earthworks will start after one month of preparation period for works.
- Pavement works, considering preparation period for works after start of the earthworks, will start after four months of the start of the works. Meanwhile, works on apron pavement will start early since this work takes the longest time and is related to the soft opening and start of the VVIP terminal building.
- Other pavement works will start at different times of completion of the main works in order to disperse pavement machinery usage.

- Works on pipes for drainage facilities will start a month after the start of earthworks since the works will be done underneath the pavement.
- Security fences will be installed a month after the start of earthworks.

12.5 Project Implementation Schedule

12.5.1 Conditions

(1) Precondition

Based on the intention of the Bangladeshi government of early completion, the procurement procedure shall be of a minimum period.

- Consulting service will start in April 2017.
- The period of detailed design is shortened to six months by utilizing existing drawings as much as possible.
- Construction will start in April 2018 based on the above condition.
- Construction period for international terminal (Terminal 3) is 37 months.
- Construction period for apron is 34 months.
- At the time of the soft opening planned in January 2019, the service of the new VVIP building shall start.

(2) Project Implementation Schedule

Confidential

Confidential

Figure 12-1 Step Drawing in December 2018 (9 months elapsed)

Confidential

Figure 12-2 Step Drawing in December 2019 (21 months elapsed)

Confidential

Figure 12-3 Step Drawing in December 2020 (33 months elapsed)

Confidential

Figure 12-4 Step Drawing in April 2021 (37 months elapsed)

Table 12-10 Project Implementation Schedule

Confidential

Source: JICA Study Team

CHAPTER 13 ENVIRONMENTAL CONSIDERATIONS

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Chapter 13 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

Based on the JICA Guidelines for environmental and social considerations (Hearinafter called JICA Guidelines), this Project is classified under Category B. This Project is an expansion project involving construction of new buildings, among others, within the current airport area. There is no land acquisition involved. There is no new runway construction or extension. Thus, expected impacts are site specific, are reversible, and normal mitigation measures can be applied.

For this Project, as it is classified as Category B project, environmental and social consideration studies require the IEE level including examination of the potential positive and negative environmental impacts, mitigation measures to avoid, minimize, mitigate or compensate for adverse impacts, as well as measures to promote positive impacts, if any such measures are available.

13.1 Proposed Project Components Subject to ESC

Proper environmental and social protection against any adverse impact from a development project is the key to the project's sustainability. To ensure that, environmental and social analysis and assessment is to be carried out, and if required, proper mitigation plan is to be prepared. The environmental and social examination under this Survey is aimed at analysis of environmental and social considerations base on both JICA guidelines Bangladesh regulations, confirming the current status of environmental and social assessment, and formulating further tasks to be carried out before the Project can enter into the implementation stage.

The physical components of the proposed Project subject to environmental and social considerations are as follows:

Table 13-1 Details of Scope of Works (Phase - 1)

Works	Division	Facilities
Building	New Passenger Terminal Building (Terminal 3)	3 story building with area of approximately 220,000 m^2 including supply of related equipment capacity of 12.0 mppa
	New Cargo Complex	Area of approximately 42,200 m^2
	VVIP Complex	Area of approximately 5,000 m^2
	Rescue and Fire Fighting Facilities	
	Multi-Level Car Parking with Tunnel	Area of approximately 62,000 m^2
Civil	Parking Apron (Terminal 3 Area)	Approximately 520,000 m^2
	Taxiways (two rapid exit and one connecting taxiway for the runway 14 threshold)	Approximately 60,000 m^2
	Taxiways Landside Service Road with Elevated Road	9 connecting taxiways connecting to the T3 apron: approximately 35,000 m^2
	Improvement of Drainage System	
Utility	Water Supply System	
	Sewage Treatment Plant	Area of approximately 3,000 m^2
	Intake Power Plant with Distribution System	Area of approximately 7,000 m^2
	Hydrant Fuel Supply System	

Works	Division	Facilities
	Communication System	
	Security and Terminal Equipment	

Source: JICA Study Team

The following are the scope of analysis under this Survey:

1. To confirm baseline of environmental and social conditions;
2. To confirm environmental and social system of Bangladesh;
3. To prepare item scoping of EIA study;
4. To predict future environmental and social situation with this project;
5. To assess effect of this project and to execute comparative consideration of altenative plans;
6. To consider mitigation measures;
7. To prepare draft environmental management plan and draft environmental monitoring plan;
8. To clarify budjet, financial resource and implementing organization of EMP and EMoP and
9. To support stakeholders' consultations.

As the Project does not need any land acquisition and as all the Project-related construction and operation activities are expected to be confined within the HSIA area, no adverse social impact is expected. However, there are some former leaseholders, who still have facilities within the proposed work site and still occupying the land. Details of the issue are explained in Section 13.3.

13.2 Present Conditions of the Project Area

A detail description of the environmental setting of the Project area has been elaborated in the Project IEE Report (August, 2016). A brief summary is given here.

(1) Land Use

1) Land use Planning

Dhaka Metropolitan Development Plan (DMDP) was prepared in 1995 with support from UNDP under Rajdhani Unnayan Kartripakkha (RAJUK) (Capital Development Authority). The plan covers the Dhaka Metropolitan development area, an area of over 1,500 km^2. Height restrictions are enforced by RAJUK for the airport overlay zone. The usual practice is that RAJUK consults with CAAB in connection with high rise constructions within the airport surroundings, and particularly along the runway approach.

It may be mentioned that RAJUK recently updated the 1995 Land Use Plan in 2015 for next 20 years period of 2016 to 2035. However, the plan has not been approved yet.

2) Existing Land Use

The existing land use in the airport environment is illustrated in Figure 13-1.

Figure 13-1 Spatial View of Existing Land Use Features (Airport, Residential Areas, Wetland-Swamp, Restricted Military Zone, Army Golf Club, Govt. Offices, Trees etc.)

There are some wetland areas in north-west side of the runway. Residential area in the north-northeast side is mostly single storey buildings, and some are semi-permanent buildings. Military area is located in south-southwest of the runway.

All the infrastructures under the proposed Project will be located inside the airport boundary.

(2) Physical Environment

1) Geology, Topography, and Soils

Dhaka is basically flat low-lying land. The airport and the surroundings are at levels between 4 and 10m with only very gentle slope. The major feature of the geology is sedimentary deposit with compact soil, mainly clay, with poor porosity and percolation capacity.

2) Climate and Meteorology

The climate of Bangladesh is sub-tropical with little variation across the country. The project area lies in the South-central climate zone of the country. Gentle north/north-westerly winds with occasional violent thunderstorms called northwester during summer and southerly wind with occasional cyclonic storm during monsoon are prominent wind characteristics of the region.

Winter is from November to February; while pre-monsoon summer usually starts in March and ends in May. Monsoon (rainy) season is from June to October. This period accounts for 80 % of total rainfall. Annual rainfall in Dhaka varies from 1169 mm to 2850 mm.

3) Extreme Weather Events

Monthly rainfall in May, June and July is usually 400 - 500 mm that may concentrate over 4 - 6 days. The airport is surrounded by a dike to prevent flooding from surrounding areas. The drainage system carries water from the airport area through ditches and via a number of ponds to outlet at the Southeast and Northwest corners of the airport. The area of the airport within the airport boundary is roughly 5 km^2 (500 ha) of which roughly 4 km^2(400 ha) area is within the dike area.

4) Water Supply

The airport is supplied with water from three numbers of groundwater wells in the airport area. The water is pumped from the wells to three elevated water reservoirs having storage capacity of 760 m^3, 190 m^3, and 40 m^3. The water consumption is roughly 4,000 m^3 per day. Water is used for CAAB airport operation, offices, living areas for airport personnel, etc.

5) Sewerage

Sewage water from the airport is collected through sewerage system to the airports own sewage treatment plant located east of the cargo centre in the northern part of the airport area and subsequently discharge to a point north of the airport. The treatment plant is currently not operational, but rehabilitation of this plant is planned by CAAB.

(3) Biological Environment

1) Flora within Airport Boundary

Different types of flora such as grasses, herbs, and trees are visible within the airport area. Inside the airport boundary (concrete wall fence), the vegetation is dominated by different grass species. At the boundary and to the South/North of the airport area there are also several species of herbs. The grasses inside the airport area include sun-grass (Imperata Aurandinaceae), Durbaghas (Cynadon Dactylon), Lajjabati (Mimosa pudica), Ulu grass (Imperara cylindrica), and Lantana (Lantana camara). Along the airport boundary and along the runway to the West, the vegetation is of fast growing tree species, predominantly Akashmoni (Acacia auriculiformis) (90%) and K orai (Al-beHazratShahjalalprocera).

2) Fauna within Airport Boundary

It is likely that rodent, rabbit, hare, tortoise, lizard, snakes, and frog, may stay in the area, but no wild animals was reported. Some birds are seen within the boundary, but this is not their sole natural habitat.

(4) Socio-Cultural Environment

1) Nearby Community

Three localities are located near the airport, namely, Uttara in north and east, Cantonment in south, and Mirpur in west and north.

2) Employment

The CAAB has employed close to 2,000 people in Hazrat Shahjalal Airport. The Airport further provides direct employment to around 1,500 people in customs services, immigration, postal services and airlines. Indirectly between 5,000 and 7,000 people are employed with transport services, customs clearance services, and contractors for works and services in the airport. Roughly 10 % of the CAAB employees are women, mainly occupied as security personnel, office clerks, and cleaning personnel.

3) Community Attitudes

The airport is believed to be well accepted in community. Complaints about the airport have not been reported.

4) Natural Protected Areas near Airport Boundary/ Cultural Heritage

There are no internationally or nationally protected nature reserves, or nature parks within the close vicinity of the airport. Nearest one is Bhawal National Park at a distance of about 25 km from the airport.

There is no cultural heritage within the airport area or its immediate vicinity.

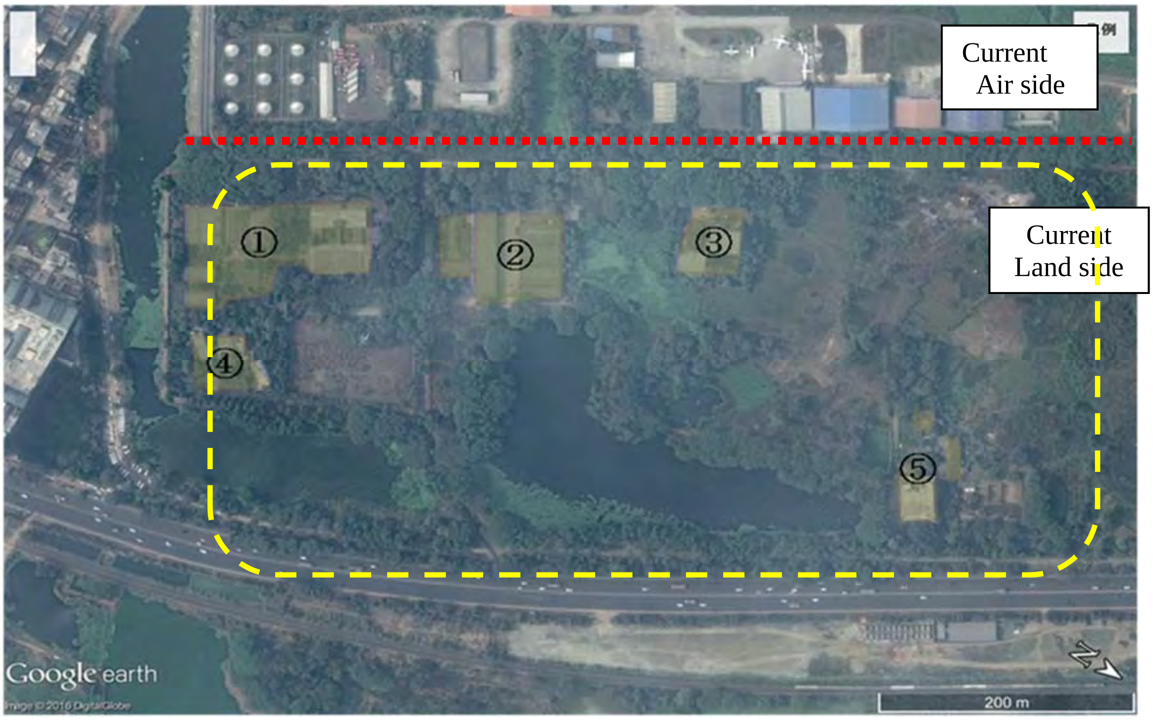
13.3 Investigation of Existing Structures/Facilities at the Proposed Work Site (Within Current Landside)

The proposed location of the Terminal 3 building, its entrance facility, and new apron will occupy some portion within the current airside area and some portion within the current landside area. The map in Figure 13-2 shows the outline of the proposed Terminal 3 and its related constructions. The structures/ facilities within the current airside area are well defined and CAAB has definite plan for their relocation. The Study Team investigated the existing structures/facilities located within the current landside portion earmarked for the proposed T3 terminal.

Source: The Study Team

Figure 13-2 Future Plan Layout on the Current HSIA Map

It can be seen that there are no existing structures/facilities at the northern part of the landside area. On the contrary, there are some structures/facilities at the southern side of the plot. A close up of the yellow box marked on Figure 13-2 is shown in Figure 13-3.



Source: The Study Team

Figure 13-3 Structures/Facilities at the Southern Side

Five structures/facilities are identified during the investigation as marked in Figure 13-3. Brief descriptions of each structure/facility are given below.

Location # 1: This is where CAAB’s Central Engineering, Maintenance and Stores Unit (CEMSU) compound is located. There are one administrative building, one workshop just behind that, one warehouse in the south, and two smaller stores. There are powerhouse and water tank located just north of the administrative building. Some pictures of this location are given below.

Confidential due to security reasons.

Figure 13-4 Existing CEMSU Compound

Location # 2: Airport Armed Police Battalion. This area is now used by the Airport Police for their barrack and office. About 300 personnel are stationed at this barrack. All the facilities in this barrack are owned by CAAB. Some pictures of this location are given below.

Confidential due to security reasons.

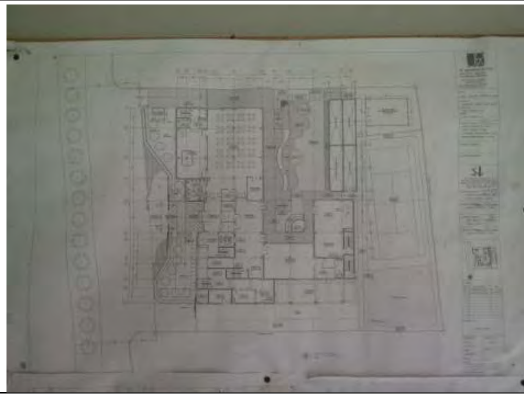
Figure 13-5 Existing Airport Armed Police Battalion

Location # 3: Flying Club Complex. This area was leased out by CAAB to Flying Club, which later sub-leased the area to R&R Aviation, a subsidiary of Shikdar Group. There is an under construction building; five stories were completed out of the proposed 6-storey building. Construction is now suspended, and there is no business activities going on. The total lease area is 0.81 acre, and the 20-year lease expired in 2013. Some pictures of this location are given below.

Inauguration Stone

Building Under Construction

Inside View



Planned Layout

Source: The Study Team

Figure 13-6 Existing Flying Club Complex

Location # 4: Civil Aviation Training Center (CATC) of CAAB. There are three interconnected buildings, namely: male hostel, female hostel, and diving area. A part of the female hostel is now used by female police staffs. Some pictures of this location are given below.This facility will be relocated to the CAAB Residential Area until the end of 2017.

Confidential due to security reasons.

Figure 13-7 Existing CATC

<u>Location # 5:</u> This area was leased to Builders and Design, a subsidiary of Bengal Group. There is a 5-storey building which houses a number of Bengal Group's publications companies, a semi-pacca (brick wall with corrugated iron roof) prayer area, a restaurant named Munmun Kebab, a semi-pacca car garage, and some storage sheds. Total area is 1.5 acre. The 30-year lease expired in 2012. As the lease expired, CAAB asked for their eviction. But litigation has been filed at the judicial court, which gave a verdict in favour of CAAB in 2015. However, the Bengal Group appealed to the High Court and got a stay order. The lawsuit is now pending. The court trial were held in January and February 2017. The veridict will be given at March of 2017. Some pictures of this location are given in Figure 13-8.

Full View

Signboard Showing List of Companies

Munmun Kebab

Garage and Store Area

Praying Area

Inside the Praying Area

Source: The Study Team

Figure 13-8 Existing Buildings near Bengal Group

Analysis: For the implementation of the Project, all these facilities/ buildings/ structures mentioned above must be removed. Facilities at Location #1 are owned by CAAB; thus their relocation can be done with CAAB internal arrangements. Similarly, all the facilities at Location #4 are owned and operated by CAAB, thus their relocation can be managed easily by CAAB. Though the facilities at Location #2 are used by Police, the facilities are owned by CAAB. The policemen are staying there “at the request” of CAAB, and CAAB is "paying" for their duty and arranging accommodation. CAAB has already finished accommodation arrangement and request Police to move to new location. So there are no social issues.

On the one hand, facilities at Locations #3 and #5 are occupied by private entity. As lease tenures have been expired for both the cases, technically there is no bar on CAAB to re-possess the land. After the issue of the verdict, these area will be vacated in accordance with government law.

13.4 Legal and Administrative Framework

(1) Environmental Policy and Regulation of GoB

For the protection, conservation, and management of the biophysical (natural) and social environment from damaging development pressures, if any, the Government of Bangladesh has developed a legal framework, including laws, regulations, decrees, and standards addressing environmental and social safeguards. These legislations also provide the principal mechanism for assessing and mitigating the environmental impacts of projects, both existing and proposed. The relevant national legislative, regulatory, and policy requirements are listed as follows:

- National Conservation Strategy (NCS), 1992 (Updated 2013)
- National Environmental Policy, 1992
- National Environmental Management Action Plan (NEMAP), 1995
- Environment Conservation Act (ECA), 1995 (Amended 2000, 2002, and 2010)
- Environment Conservation Rules (ECR), 1997 (Amended 2002, 2003)
- Environmental Quality Standards (for air, water, discharge, etc.) under ECR 1997
- National Water Policy, 1999
- National Land Utilization Policy, 1991
- National Forest Policy, 1994 (Amended 2010)
- Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2008 (revised 2009)
- Standing Orders on Disaster, 2010
- National Biodiversity Strategy and Action Plan (NBSAP), 2007
- National Adaptation Programme of Action (NAPA), 2005
- National Fisheries Policy, 1996
- Bangladesh Wildlife (Conservation and Security) Act, 2012
- Civil Aviation Ordinance, 1960 and Civil Aviation Rules, 1984 (Amended 2009)

The Environment Conservation Act (ECA), 1995 is currently the main legislation related to environmental protection in Bangladesh. The Act is applied by the Department of Environment (DOE), under the Ministry of Environment and Forest (MOEF). The Act forms the basis of the country’s environmental safeguard system.

Among other things, ECR 1997 rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust, etc., (ii) the requirement for and procedures to obtain environmental clearance, and (iii) the requirement for IEE/EIA according to categories of industrial and other development interventions. The noise from mosuqu and airport are exempted from Environmental Quality Standards for ambient noise on ECR 1997.

Before any new project can go ahead, as stipulated under the rules, the project promoter must obtain clearance from the DOE. This is a two-step approval process. First, DOE issues a “site clearance” and then “environmental clearance”. An appeal procedure does exist for those promoters who fail to obtain clearance. Failure to comply with any part of this Act may result to punishment.

As specified in Clause 7 of the Environmental Conservation Rules 1997, all new industries and projects must apply for an Environmental Clearance Certificate (ECC). Industries/ development activities are classified according to their potential impact on the environment into four categories, namely: Green, Orange-A, Orange-B, and Red. Details of these procedures are explained below.

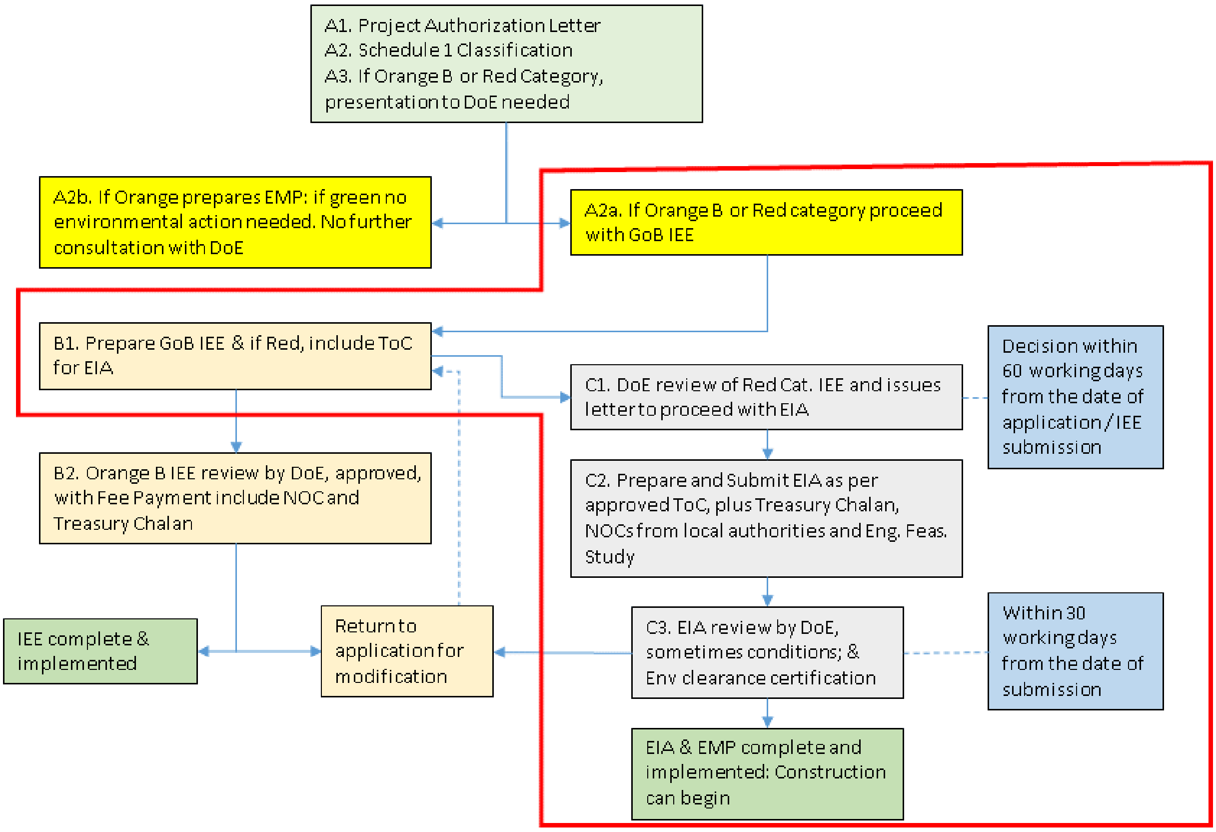
(2) Application Procedure of Environmental Clearance

As explained above, any proposed project must obtain an ECC from the DOE before its implementation. The clearance process varies depending on the project classification.

A schedule attached to the ECR 1997 defines the categories into which various types of projects fall. The Rules also set out differing requirements to be fulfilled in applying for an ECC under each of the four categories of project, identifying the level of environmental impact assessment required in each case.

As per ECR 1997, this proposed Project is classified under the “Red Category” as per item 60, Schedule I, which mentions “Engineering works: capital above 10 (ten) hundred thousand Taka”. Rule 7 of ECR 1997 states that the proponent of such projects must obtain a Location Clearance Certificate (LCC, or known as site clearance) and an ECC from the DOE.

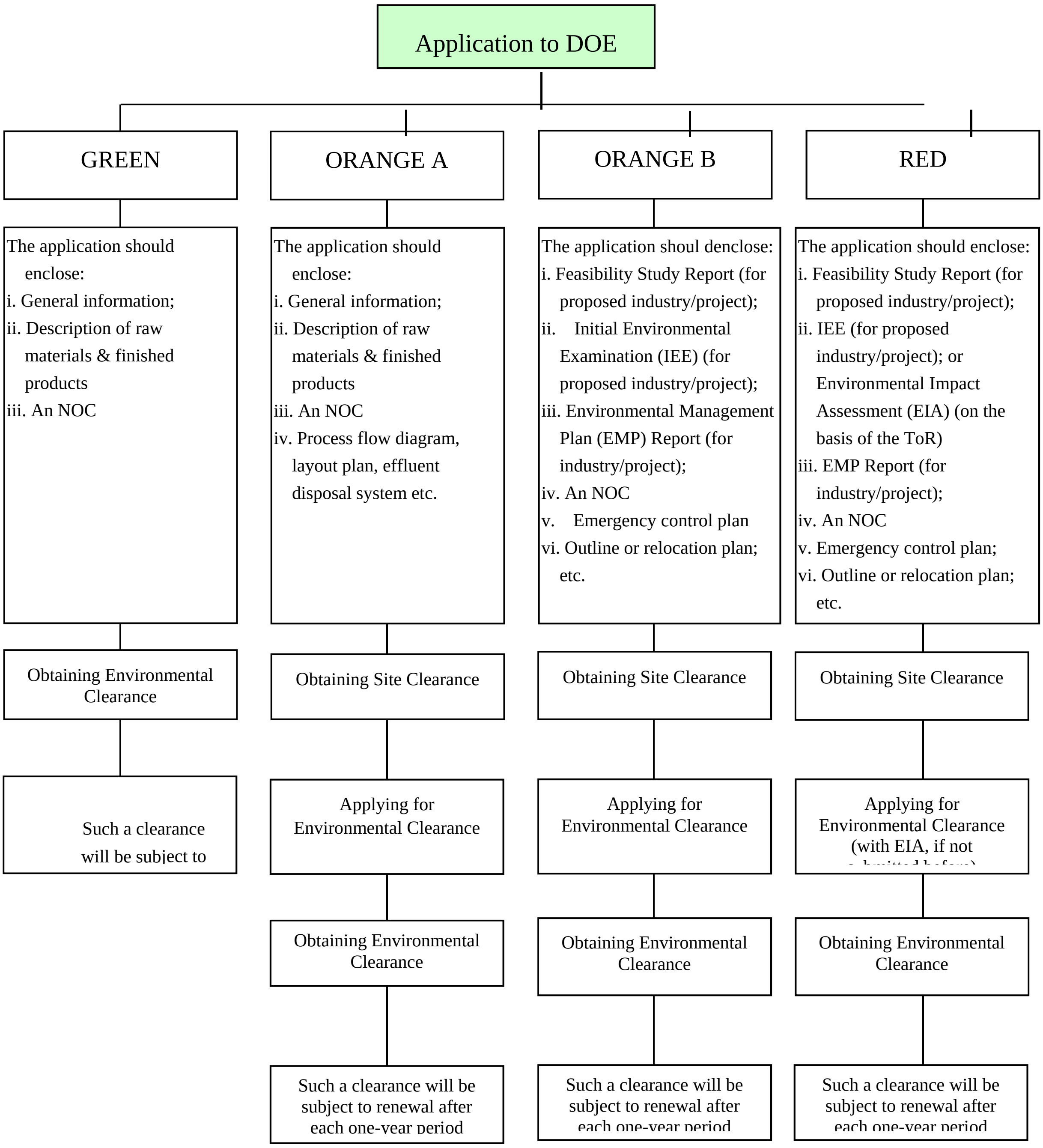
Flow diagram for the environmental clearance procedure is shown in Figure 13-9 (as this airport expansion project falls under Red Category, only red colour marked steps need to be followed).



Source: Adopted from the Environmental Guidelines (DOE, 1997)

Figure 13-9 Diagram for DOE Environmental Assessment Process

Steps involved in the environmental clearance process are shown in Figure 13-10.



Note:

1. NOC = No Objection Certificate, usually obtained from the local government.
2. Time to obtain Environmental Clearance:

for Green Category Projects, the gestation period for granting Environmental Clearance has been fixed within 15 days; while for Orange A, Orange B, and Red Category projects, at first, site clearance and thereafter Environmental Clearance will be granted. The gestation period for site clearance is within 30days for Orange A, and within 60days for Orange B and Red Category projects.

Source: from the Environmental Guidelines (DOE, 1997)

Figure 13-10 Steps Involved in Environmental Clearance Following DOE Guidelines

As explained in the figure above, as part of the clearance process, first an IEE with Terms of Reference (TOR) for EIA is to be prepared satisfactorily and submitted to the DOE. After obtaining the first step clearance as LCC and approval of EIA TOR, the proponent then has to prepare an EIA, which will be examined by DOE prior to issuing the ECC. The ECC has to be renewed on yearly basis until the completion of the Project.

(3) Policy Gap between the Government and JICA

As explained in the previous sections, this Project is classified as Category B as per JICA guidelines requiring only IEE level environmental assessment. On the other hand, this Project is classified as Red Category as per ECR 1997 requiring EIA level of environmental assessment. For this particular Project, there is difference in categorization between GOB and JICA regulation. However, JICA guidelines also mentions that if an EIA procedure has been conducted to satisfy national requirement, JICA may refer to the EIA report, but this is not a mandatory requirement.

The Gap between the government law and JICA Guidelines are shown following Table.

Table 13-2 Comparison between JICA Guidelines and GOB law

Item	JICA Guidelines for Environmental and Social considerations 2010	Relevant law in Bangladesh	Gap between JICA Guidelines and GovernmentLaw/ Actions to be taken
1. Underlying Principles	1. Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan. 2. Such examinations must be endeavored to include an analysis of environmental and social costs and benefits in the most quantitative terms possible, as well as a qualitative analysis; these must be conducted in close harmony with the economic, financial, institutional, social, and technical analyses of projects. 3. The findings of the examination of environmental and social considerations must include alternatives and mitigation measures, and must be recorded as separate documents or as a part of other documents. EIA reports must be produced for projects in which there is a reasonable expectation of particularly large adverse environmental impacts. 4. For projects that have a particularly high potential for adverse impacts or that are highly contentious, a committee of experts may be formed so that JICA may seek their opinions, in order to increase accountability.	1. Article 18A of the constitution states "The State shall endeavor to protect and improve the environment and to preserve and safeguard the natural resources, bio-diversity, wetlands, forests and wild life for the present and future citizens." 2. As per ECA 1995, "No industrial unit or project shall be established or undertaken without obtaining, in the manner prescribed by rules, an Environmental Clearance Certificate from the Director General." 3. As per ECR 1997, "Environmental Clearance Certificate shall be issued to all existing industrial units and projects and to all proposed industrial units and projects falling in the Green Category."	Though ECA 1995 and ECR 1997 does not explain in detail regarding basic principle of environmental safeguard, by virtue of requiring IEE/ EIA (depending on intervention type), in principle the target and objectives are siilar to JICA guideline. No gap.

Item	JICA Guidelines for Environmental and Social considerations 2010	Relevant law in Bangladesh	Gap between JICA Guidelines and GovernmentLaw/ Actions to be taken
2. Examination of measures	1. Multiple alternatives must be examined in order to avoid or minimize adverse impacts and to choose better project options in terms of environmental and social considerations. In the examination of measures, priority is to be given to avoidance of environmental impacts; when this is not possible, minimization and reduction of impacts must be considered next. Compensation measures must be examined only when impacts cannot be avoided by any of the aforementioned measures. 2. Appropriate follow-up plans and systems, such as monitoring plans and environmental management plans, must be prepared; the costs of implementing such plans and systems, and the financial methods to fund such costs, must be determined. Plans for projects with particularly large potential adverse impacts must be accompanied by detailed environmental management plans.	As per ECR 1997, the required examination items for Red Category: (i) report on the feasibility; (ii) Environmental Impact Assessment report prepared on the basis of terms of reference previously approved by the Department of Environment, along with the Layout Plan (showing location of Effluent Treatment Plant), Process Flow Diagram, design and time schedule of the Effluent Treatment Plant of the unit or project, (these are applicable only for a proposed industrial unit or project) (iii) Report on the Environmental Management Plan (EMP) for the industrial unit or project, and also the Process Flow Diagram, Layout Plan (showing location of Effluent Treatment Plant), design and information about the effectiveness of the Effluent Treatment Plan of the unit or project (these are applicable only for an existing industrial unit or project) (iv) emergency plan relating adverse environmental impact and plan for mitigation of the effect of pollution (v) outline of relocation, rehabilitation plan (where applicable)	Mostly similar. However, alternate analysis is not a requirement in Bangladesh law. /The alternative study should be executed.

Item	JICA Guidelines for Environmental and Social considerations 2010	Relevant law in Bangladesh	Gap between JICA Guidelines and GovernmentLaw/ Actions to be taken
3. Scope of Impacts to Be Assessed	1. The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. 2. In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project.	Scope of impacts are not mentioned in ECA or ECR. But Impact assessment and management plan is a requirement. Also, during the first step approval of DOE, usually the approval letter includes conditions to be fulfilled and scope of special impact assessment during EIA preparation	There is a gap because of no spelling out the scope of imapct in the act or rules. (Generally resettlement and social aspects are less focused.) / The consideration of impact items based on JICA Guidelines should be needed.

Item	JICA Guidelines for Environmental and Social considerations 2010	Relevant law in Bangladesh	Gap between JICA Guidelines and GovernmentLaw/ Actions to be taken
4. Compliance with Laws, Standards, and Plans	1. Projects must comply with the laws, ordinances, and standards related to environmental and social considerations established by the governments that have jurisdiction over project sites (including both national and local governments). They must also conform to the environmental and social consideration policies and plans of the governments that have such jurisdiction. 2. Projects must, in principle, be undertaken outside of protected areas that are specifically designated by laws or ordinances for the conservation of nature or cultural heritage (excluding projects whose primary objectives are to promote the protection or restoration of such areas). Projects are also not to impose significant adverse impacts on designated conservation areas.	1. Projects must follow all government laws/ 2. Projects must be outside of "Ecologically Critical Areas".	No Gap
5. Social Acceptability	1. Projects must be adequately coordinated so that they are accepted in a manner that is socially appropriate to the country and locality in which they are planned. For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans. 2. Appropriate consideration must be given to vulnerable social groups, such as women, children, the elderly, the poor, and ethnic minorities, all members of which are susceptible to environmental and social impacts and may have little access to decision-making processes within society.	Not properly spelled out.	Thought Stakeholders consultation is not spelled out in ECR, usually DOE requires this. Though ECR mentions about resettlement plan preparation, there is no legal elaboration. However, for any ODA project, it is a requirement to follow respective agencies guideline as part o loan agreement (but not part of environmental law). Major Gap exists. /Consideration should be executed as needed.

Item	JICA Guidelines for Environmental and Social considerations 2010	Relevant law in Bangladesh	Gap between JICA Guidelines and GovernmentLaw/ Actions to be taken
6. Ecosystem and Biota	1. Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests. 2. Illegal logging of forests must be avoided. Project proponents etc. are encouraged to obtain certification by forest certification systems as a way to ensure the prevention of illegal logging.	Not directly spelled out. But usually DOE requires such considerations.	There is a gap because of no spelling out the scope of impact in the act or rules.(DOE require the consideration for this item, so in fact there is no gap.) / Consideration should be executed as needed.

7. Involuntary Resettlement	1. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected. 2. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by project proponents etc. in a timely manner. Prior compensation, at full replacement cost, must be provided as much as possible. Host countries must make efforts to enable people affected by projects and to improve their standard of living, income opportunities, and production levels, or at least to restore these to pre-project levels. Measures to achieve this may include: providing land and monetary compensation for losses (to cover land and property losses), supporting means for an alternative sustainable livelihood, and providing the expenses necessary for the relocation and re-establishment of communities at resettlement sites. 3. Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood. In addition, appropriate and accessible grievance mechanisms must be established for the affected people and their communities. 4. For projects that will result in large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. It is desirable that the	There is no national law for RAP. All acquisition is based on 1982 law which does not entitle anybody without legal title.	Major GAP exists. However, all ODA projects follows that respective agencies guideline. So in fact, there is no gap in practice. /Consideration should be executed as needed.

Item	JICA Guidelines for Environmental and Social considerations 2010	Relevant law in Bangladesh	Gap between JICA Guidelines and GovernmentLaw/ Actions to be taken
	resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A		
8. Indigenous Peoples	1. Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses. 2. When projects may have adverse impacts on indigenous peoples, all of their rights in relation to land and resources must be respected in accordance with the spirit of relevant international declarations and treaties, including the United Nations Declaration on the Rights of Indigenous Peoples. Efforts must be made to obtain the consent of indigenous peoples in a process of free, prior, and informed consultation. 3. Measures for the affected indigenous peoples must be prepared as an indigenous peoples plan (which may constitute a part of other documents for environmental and social consideration) and must be made public in compliance with the relevant laws and ordinances of the host country. In preparing the indigenous peoples plan, consultations must be made with the affected indigenous peoples based on sufficient information made available to them in advance. When consultations are held, it is desirable that explanations be given in a form, manner, and language that are understandable to the people concerned. It is desirable that the indigenous peoples plan include the elements laid out in the World Bank Safeguard Policy, OP4.10, Annex B.	No legal basis.	Major GAP exists. However, all ODA projects follows that respective agencies guideline. So in fact, there is no gap in practice. /Consideration should be executed as needed.

Source: The Study Team

(4) International Civil Aviation Organization (ICAO) Recommended Practices

It may be noted that airport noise is exempted in the Bangladesh Noise regulation of 2006. Since this Project will be funded by JICA, proper noise management is required, and this Project should follow

ICAO guidelines for noise.

International design code, manual, standards, and guidelines that are relevant to the proposed project include the following: International Civil Aviation Organization (ICAO), International Air Transport Association (IATA), and U.S. Federal Aviation Administration (FAA). The relevant documents and their relevance to the Project are given below:

Table 13-3 Outline of the international standard

Guidelines	Relevance to this Project
Annex 16 to the Convention on International Civil Aviation, Volume I: Aircraft Noise, Sixth Edition, July 2011	Gives the maximum allowable noise levels depending on aircraft types, at lateral point, approach point and flyby measurement point.
ICAO Doc. 9184 - Airport Planning Manual, Part 2: Land Use and Environmental Control, 2nd Edition, 2002	Airport and runway noise and its remedial measures
FAA Advisory Circular 150/5020-1-Noise Control and Compatibility Planning for Airports, 1983	Noise measurement methods, preparation of noise contour, prediction of noise exposure, and airport noise control planning

Source: The Study Team

13.5 Alternative study

Since it is expected that the passenger of HSIA will be exceed the capacity of the existing facilities, the countermeasures of this issue had considered. The result of alternative study is shown below table.The Plan-0 will obstruct the economic development for rising up from Least Development Countries. The Plan-1 is able to meet the expected demand after 2030, but the benefit per cost is low. And the negative effect to environment and social is large. Plan-2 is able to meet the expected demand until 2030, the benefit per cost is high and the negative impact to socio environmental aspect is small. Therefore, the Plan-2 is selected on this project. On the Plan-3, the cost is high and the negative impact to socio environmental aspect is significant and tne plan-2 will be acceptable until 2030.

Table 13-4 Result of the alternative study

item	Plan-0	Plan-1	Plan-2	Plan-3
Outline of planning	Non installing new facility	Introducing 2nd runway and new terminal building (To meet the increase of passenger after 2030)	Introducing new terminal building (To meet the increase of passenger until 2030)	Constructing new airport on other site
Land use	No change of land use	Land acquisition around airport will be needed, so the land use will change	No change of land use	Land use will change significantly on the candidate site of new airport
Technology & Economy	This plan don’t meet the increase of passenger ,so the number of landing and takeoff will not be increased in future. Therefore, economic development will be obstructed.	The benefit of the 2nd runway is small because of locating close to existing runway. The number of landing & takeoff is not expected large rising up. The specific consideration and	The plan-2 is able to meet the increase of passenger until 2030 by less investment than the Plan-1. This plan don’t need specific construction technology.	The construction of new airport is needed huge investment. There will be possibility of technological issue of flooding in rainy season because of drainage conditions.

		technology will be needed for construction of new runway near the existing one.		
Environmental & Social consideration	The current socio-environmental condition will be maintained.	The land acquisition and involuntary resettlement will be needed around existing airport. The negative environmental impact is large because of construction work out of the airport area. The negative impact from increasing the number of landing and takeoff will be occure.	The land acquisition and involuntary resettlement will not be occure. The negative environmental impact is small because of construction works in the airport area. The negative impact from increasing the number of landing and takeoff will be occure.	The huge land acquisition and involuntary resettlement will be occur. The negative environmental impact will be significant during construction and after construction.
Comparative Conclusion	Socio-Environmental impact is the lowest. But this plan cannot meet to increasing of passenger in future and will obstruct economic development for rising up from LDC.	The negative Socio-Environmental impact is large.The benefit per cost is low.	Socio-Environmental impact is the lowest except the Plan-0. This plan can meet the increasing of passenger for a while. This plan is selected in this project because of advantage on economic aspect and lower negative impacts.	This plan has largest Socio-Environmental negative impact. And it need the largest cost. But this plan will be needed for future demand after 2030.

Source: JICA Study Team

13.6 Scoping

The project was reviewed in light of the JICA Guideline for environmental and social considerations. The scoping result is summarized in Table 13-5.

Table 13-5 Scoping Matrix

No.	Impacts	Ratings		Brief Description
		Pre-construction/ Construction	Operation	
Pollution				
1	Air Pollution	B-	B-	Construction: Limited air pollution is expected due to heavy machinery and construction activities Operation: With the increase of flights, emission of air pollutant generated from airplanes and ground operation vehicles, as well as from commuting vehicles will increase. The impact is in range of normal activity.
2	Water Pollution	B-	B-	Construction: Temporary water pollution due to construction activity is expected. In addition, temporary water pollution from contractor’s labour camp is expected. Operation: With the increase of flights and terminal users, amount of generated waste water will increase. But it would be acceptable for treatment.

No.	Impacts	Ratings		Brief Description
		Pre-construction/ Construction	Operation	
3	Waste	B-	B-	Construction: Construction and demolition materials will be generated. Also, waste soil will be generated. Operation: With the increase of flights and terminal users, amount of generated waste will increase. But it would be acceptable for treatment.
4	Soil Contamination	D	C-	Construction: Although oil leakages from construction machineries and trucks are expected, the amount, so as the impact, is negligibly small. Operation: With the increase of flight, risk of fuel leakage will increase. But it would not be expected to spread out.
5	Noise and Vibration	B-	C-	Construction: Limited noise and vibration resulting from construction activities and construction vehicle movement are predicted. Operation: With the increase of flights, degree of noise from airplane will increase. Needs further investigation.
6	Ground Subsidence	D	D	Construction/Operation: No activity that will cause ground subsidence is expected.
7	Offensive Odor	D	D	Construction: There is no plan which causes offensive odour during construction. Operation: There is no plan which causes offensive odour during operation.
8	Bottom Sediment	D	D	Construction/Operation: No activity that will affect the bottom sediment is expected.
Natural Environment				
9	Protected Area	D	D	No protected area within the Project area.
10	Flora, Fauna and Biodiversity	D	D	Effect on flora, fauna, or biodiversity is not expected since the Project will be implemented within the existing airport facilities which is not sole habitat of any endangered species.
11	Hydrology	D	D	Construction/Operation: No activity that will adversely affect the hydrological situation is expected.
12	Topography and Geology	D	D	Construction/Operation: No activity that will adversely affect the topography and geographical features is expected.
Social Environment				
13	Involuntary resettlement	C-	D	Construction/Operation: No resettlement is needed since the Project will be implemented within the existing airport facilities.
14	Vulnerable group	D	D	No direct impact on vulnerable group is predicted since the Project will be implemented within the existing airport facilities.
15	Indigenous and Ethnic Minority	D	D	No direct impact on indigenous and ethnic minorities is predicted since the Project will be implemented in the existing airport facilities.
16	Local Economy, Employment,	B+	B+	Construction: Positive impacts such as creation of local employment are predicted. Operation: Increase of flights will ultimately contribute to the local economy.
17	Land Use and Local Resources	A+	A+	Significant positive impact on use of local resources is predicted.
18	Water Use/ Water right	D	D	No activity that will adversely affect the water usage or water rights is predicted.

No.	Impacts	Ratings		Brief Description
		Pre-construction/ Construction	Operation	
19	Social infrastructures and services	B-	B-	Construction: Due to construction activities, decrease in the convenience of the airport users is expected, but very minimum. Operation: Increase in airport users will affect traffic circulation near the airport area, but impact in minimum.
20	Community Organization	D	D	No negative impact on social institutions / community organizations is predicted.
21	Unequal Distribution of Social Costs and Benefits	D	D	No negative impact on social institutions / community organizations is predicted.
22	Social Conflict	B-	D	There are some former lease holders located within the proposed Project area. CAAB is now negotiating for their relocation. Other than this, no other local conflict of interests is predicted.
23	Historical/Cultural Heritage	D	D	No cultural heritage is located within the Project area.
24	Landscape	B-	B+	Construction: Due to the construction activities, the disturbance to the scenery is expected, but impact is minimal. Operation: Renovation of the international terminal and VVIP terminal will enhance the landscape.
25	Gender	B+	B+	Construction: Construction will create female job opportunity. Operation: Operation will create female job opportunity.
26	Children's Rights	D	D	No issues on children's rights are predicted.
27	Communicable Diseases such as HIV/AIDS	B-	D	Construction: Inflow of construction workers may increase the risks on communicable diseases. Operation: No activities that will increase the risk of communicable diseases in the local communities around airport are expected.
28	Working Environment (includes work safety)	B-	D	Construction: Inappropriate management of working environment will raise the risk of accident and casualty. Operation: No activities that will increase the risk of the working environment are expected.
Others				
29	Accidents	B-	B-	Construction: The effect of construction vehicles to the local community is predicted. Operation: With the increase of airport users, the risk of traffic accidents near the airport will also increase.
30	Global Warming	D	C-	Construction: Impacts on trans-boundary effects and global warming are negligible, since the construction works of this project is limited in time, volume, and the area. Operating: CO2 emission will increase with the increase of flights and ground operation vehicles. Needs further investigation.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
Source: JICA Study Team

The Terms Of Refarence for the environmental items selected on scoping matrix is shown below table.

Table 13-6 Terms of reference on environmental and social consideration study

Category	Survey Item	Method of survey
Alternative study	1.Forecast demand of Aviation and passenger 2.Hnadling capacity of airport 3.Expansion plan of the HSIA	1.Exisiting document survey 2.Exisiting document survey 3.Master plan for expansion of HSIA
Air pollution	1.National standard of air quality 2.Current situation of air quality 3.Environmental Mitigation plan during CP 4. Environmental Mitigation pla during OP	1. Exisiting document survey 2. Exisiting document survey 3. Exisiting document survey, interview survey 4. Exisiting document survey, interview survey
Water Pollution	1.National standard of water quality 2.Current situation of water quality 3.Environmental Mitigation plan during CP 4. Environmental Mitigation pla during OP	1. Exisiting document survey 2. Exisiting document survey 3. Exisiting document survey, interview survey 4. Exisiting document survey, interview survey
Solid Waste	1.Environmental Mitigation plan during CP 2. Environmental Mitigation pla during OP	1. Exisiting document survey, interview survey 2. Exisiting document survey, interview survey
Soil Contamination	1.Current situation of soil contaminatiuon 2.Environmental Mitigation plan during CP 3. Environmental Mitigation pla during OP	1. Exisiting document survey 2. Exisiting document survey, interview survey 3. Exisiting document survey, interview survey
Noise/ Vibration	1.National standard of Noise & Vibration 2.Current situation of Noise & Vibration 3.Environmental Mitigation plan during CP 4. Environmental Mitigation pla during OP	1. Exisiting document survey 2. Exisiting document survey 3. Exisiting document survey, interview survey 4. Exisiting document survey, interview survey
Local economies, such as employment, livelihood	1.Construction plan of HSIA 2.Operation plan of HSIA	1. Exisiting document survey 2. Exisiting document survey
Land use and utilization of local resources	1.Construction plan of HSIA 2.Operation plan of HSIA	1. Exisiting document survey 2. Exisiting document survey
Exisiting social infrastructuresand services	1.Construction plan of HSIA 2.Operation plan of HSIA	1. Exisiting document survey 2. Exisiting document survey
Local conflicts of interest	1.Current situation of arrangemnet for tenant moving	1. Exisiting document survey
Landscape	1.Construction plan of HSIA 2.Operation plan of HSIA	1. Exisiting document survey 2. Exisiting document survey
Gender	1.Construction plan of HSIA 2.Operation plan of HSIA	1. Exisiting document survey 2. Exisiting document survey
Infectious disease such as HIV/AIDS	1.Construction plan of HSIA	1. Exisiting document survey
Working Environment (includes work safety)	1.Construction plan of HSIA	1. Exisiting document survey
Accidents	1. Exisiting document survey	1. Exisiting document survey
Global Warming	1.Operation plan of HSIA	1. Exisiting document survey
Stake holder meeting	1.Meetings of IEE process	1. Exisiting document survey

Category	Survey Item	Method of survey
	2.Meetings of Draft EIA process	2. Exisiting document survey, Record of Metting (Dec,2016 – Jan.2017)

Source: JICA Study Team

13.7 The result of Environmental and Social Consideration Survey

The result of survey and prediction for environmental and social consideration is shown following table.

Table 13-7 The result of Environmental and Social Consideration Survey

Environmental Item	Result of survey and prediction
Air pollution	The baseline of air quality in Airport area： SO2 8.12 – 9.01 μ g/m^3 ,NOx 55.10 – 58.12 μ g/m^3, PM2.5 71.54 – 76.68 μ g/m^3, PM10 142.50 – 148.52 μ g/m^3, CO 2-3 μ g/m^3 Construction: The dust and resuspended soil will not result in significant impact on ambient air quality because dust control such as water sprinkling will be done. Operation： Current situation of air pollutant such as nitrogen oxides(NOx) and sulfate oxides(SOx) in airport is same as other monitoring point in Dhaka city. The concentration of these substances are lower than air quality standard value of Bangladesh. That means that future concentration of NOx and SOx will not become significant level because current aircraft emission do not affect to air quality in the airport area. On the other hand, the concentration of particulate matter (PM10, PM2.5) is above the environmental quality standard. According to the ADB report “Country Synthesis Report on Urban Air Quality Management”, 55% of PM10 comes from soil and 32% comes from vehicles in Dhaka city. Likewise, 46% of PM2.5 comes from Natural gas/diesel burning, and 29% comes from vehicles. That means aircraft is not main source of particulate matter. It seems that reason of high concentration of particulate matter in Dhaka city is soil, air pollutant from stationary source such as gas engine/ diesel engine and gas emission from vehicles. Therefore, the concentration of PM10 and PM2.5 will not become high only because of increasing of taking off and landing of aircraft and the impact of this project is small. The impact from vehicles travelling inside of the airport is expected. As a countermeasure of this, muliti stories car parking will be implemented with adequate parking number for reduction of gas emission from waiting cars. Therefore, this impact will be mitigated.
Water Pollution	The baseline of water quality in Airport area： Turbidity 8.77 – 69.4 NTU, TSS 16 – 155mg/L, COD 31 – 54 mg/L, BOD 7.2 – 19.2 mg/L Construction: Turbid water treatment will be done such as sedimentation tank/ pool before discharge to the canals in the airport. Operation： Waste water will be treated in installed treatment plant conforming to the regulations. The methods of treatment would be determined at D/D. Meanwhile oil separator will be installed for avoiding oil contamination into waste water.
Solid waste	Construction: Proper disposal of solid waste is responsibility of contractor and that will be ensured by appropriate clauses in the bidding document, for example, separation of waste based on category, storage and disposal based on category, inventory control, etc. Therefore, the impact will be insignificant. Operation： CAAB will be responsible to proper collect and dispose all internally generated solid waste. That activity will be done correctly, so the impact of waste will not be significant.

Environmental Item	Result of survey and prediction
Soil conta	Construction: Contaminated soil will be kept isolated from non contaminated soil, and deposited separately. Operation： Soil contamination may happen due to fuel leak, but that will be minimaized by appropriate measures, for example, oil seperator at fuel farm and drainage system.
Noise/Vibration	The baseline of water quality in Airport area： LAeq(Average) 54.8 – 58.6 dB Aircraft Noise (Ousside of the airport) Lden 75dB Construction: The impact of noise around the airport will be insignificant because propagation distance of the noise will be ensured from construction site to boundary of the airport. Additionally, perodic maintenance of construction machinery will be done. Operation：Airport operation is exempted from country's noise regulation. However, the noise survey of current situation is done for comparing with the aircraft noise standard of Japan and the aircraft noise prediction is also executed based on the future landing and takeoff. The area in where aircraft noise is over Japanese standard will distribute around the airport. As a countermeasure of this, CAAB will promote the using of low nosie aircraft recommended by ICAO by giving insentives. It is difficult to give subsidy for anti-noise works likewise Japan because the aircraft nosie is exempted from standards on government law. Thus, complaint section for noise will be implemented by CAAB. The impact from vehicles travelling inside of the airport is expected. The impact of noise around the airport will be insignificant because propagation distance of the noise will be ensured from construction site to boundary of the airport.
Local economies, such as employment, livelihood	Construction: The positive impact will be occured by local job creating effect from this project. Operation：The increasing of landing and takeoff will contribute to the local economy.
Land use and utilization of local resources	Construction /Operation：There will be significant positive impact on using of local resource.
Exisiting social infrastructuresand services	Construction: Due to construction activities, decrease in the convenience of the airport users is expected, but very minimum. And the carrying road will be implemented in the airport area so, negative impact around the airport will be mitigated. Operation： Due to increasing users of the airport, road traffic will be affected. However, the impact will be mitigated because, the new road inflastrucures will be implemented.
Local conflicts of interest	Construction: There are some former lease holders located within the proposed Project area. CAAB is now negotiating for their relocation.
Landscape	Construction: Due to the construction activities, the disturbance to the scenery is expected, but impact is minimal. Operation: Renovation of the international terminal and VVIP terminal will enhance the landscape.
Gender	Construction: Construction will create female job opportunity. Operation: Operation will create female job opportunity.
Infectious disease such as HIV/AIDS	Construction: Inflow of construction workers may increase the risks on communicable diseases. There will be a clause of contract documents on HIV/AIDS prevention measures.
Working Environment (includes work safety)	Construction: The impact will be insignificant because of using Personal Protective Equipment (PPE), hearing protection for workers on demolition of concrete.
Accidents	Construction: The contractor will prepare a traffic management plan and road safety plan for prevebnting road accident around the airport.

Environmental Item	Result of survey and prediction
	Operation: Due to the increasing of users and road traffic, there is a possibility the road accident will be occurred. The impact will be mitigated because of implementing road infrastructures.
Global Warming	Operation: The emission of GHG will be increased because of energy consumption in new terminal building. The impact will be mitigated because of implementing energy reduction equipment for lighting or air conditioning.

13.8 The assessment of project effect for environmental and social conditions

The assessment of project effect for environmental and social conditions is shown below table. The negative impact of this project is considered small.

Table 13-8 Draft scoping and result of the assessment

分類	No.	Environmental Item	**Ratings At Scoping**		**Ratings After Surveying**		**Brief Description**
			Pre-construction/ Construction	Pre-construction/ Construction	Pre-construction/ Construction	Pre-construction/ Construction	
Pollution control	1	Air pollution	B−	B−	B−	B−	Pre Construction/ Construction: The dust and resuspended soil will not result in significant impact on ambient air quality because dust control such as water sprinkling will be done. Operation: The impact of airquality is small because, current concentration of nitrogen oxides(NOx) and sulfate oxides(SOx) in airport are low level. Furthermore, concentration of particulate matter(PM) is mainly affected from many sources except aircraft. The impact from vehicles travelling inside of the airport is expected. As a countermeasure of this, multi storey car parking will be implemented with adequate parking number for reduction of gas emission from waiting cars. Therefore, this impact will be mitigated.
	2	Water Pollution	B−	B−	B−	B−	Pre Construction/ Construction: Temporary water pollution due to construction activity is expected. The Impact will be mitigated because turbid water treatment will be done such as sedimentation and collection before discharge to the canals in the airport. Operation: It is expected to impact of water quality around project site from generated waste water. However, this impact will be mitigated because of waste water treatment and installation of oil separator.
	3	Solid waste	B−	B−	B−	B−	Pre Construction/ Construction: It is expected to impact of solid waste from construction work. However, this impact will be mitigated because of proper disposal of solid waste by contractor. Operation: It is expected to impact of solid waste from new terminal building. However,

分類	No.	Environmental Item	**Ratings At Scoping**		**Ratings After Surveying**		**Brief Description**
			Pre-construction/ Construction	Pre-construction/ Construction	Pre-construction/ Construction	Pre-construction/ Construction	
							this impact will be mitigated because of proper collect and dispose all internally generated solid waste as a responsibility of CAAB.
	4	Soil contamination	D	B−	B−	B−	Pre Construction/ Construction: It is expected to impact of soil contamination. However, this impact will be mitigated because contaminated soil will be kept isolated from non contaminated soil, and deposited separately. Operation: It is expected to impact of soil contamination due to fuel leak. However, this impact will be mitigated because of installation of oil separator.
	5	Noise/Vibration	B−	C−	B−	B−	Pre Construction/ Construction: Limited noise and vibration resulting from construction activities and construction vehicle movement are predicted. The impact of noise around the airport will be mitigated because propagation distance of the noise will be ensured from construction site to boundary of the airport. And, perodic maintenance of construction machinery will be done Operation: The area in where aircraft noise is over Japanese standard will distribute around the airport. As a countermeasure of this issue, CAAB will promote the using of low nosie aircraft recommended by ICAO by giving insentives. It is difficult to give subsidy for anti-noise works likewise Japan because the aircraft nosie is exempted from standards on government law. Thus, complaint section for noise will be implemented by CAAB. The above countermeasures will mitigate the impact. The impact from vehicles travelling inside of the airport is expected. The impact of noise around the airport will be insignificant because propagation distance of the noise will be ensured from construction site to boundary of the airport.
Social Environment	6	Local economies, such as employment, livelihood	B+	B+	B+	B+	Pre Construction/ Construction: Positive impacts such as creation of local employment are predicted. Operation: Increase of flights will ultimately contribute to the local economy.
	7	Land use and utilization of local resources	A+	A+	A+	A+	Pre Construction/ Construction/ Operation: Significant positive impact on use of local resources is predicted.
	8	Exisiting social infrastructuresand services	B−	B−	B−	B−	Pre Construction/ Construction: Due to construction activities, decrease in the

分類	No.	Environmental Item	Ratings At Scoping		Ratings After Surveying		Brief Description
			Pre-construction/ Construction	Pre-construction/ Construction	Pre-construction/ Construction	Pre-construction/ Construction	
							convenience of the airport users is expected, but very minimum. And the carrying road will be implemented in the airport area so, negative impact around the airport will be mitigated. Operation: Due to increasing users of the airport, road traffic will be affected. However, the impact will be mitigated because the new road inflastrucures will be implemented.
	9	Local conflicts of interest	B−	D	B−	D	Pre Construction/ Construction: There are some former lease holders located within the proposed Project area. CAAB is now negotiating for their relocation. Operation: Other local conflict of interests is not predicted.
	10	Landscape	B−	B+	B−	B+	Pre Construction/ Construction: Due to the construction activities, the disturbance to the scenery is expected. However, this impact will be mitigated because of cleanup activity in construction site. Operation: Renovation of the international terminal and VVIP terminal will enhance the landscape.
	11	Gender	B+	B+	B+	B+	Pre Construction/ Construction: Construction will create female job opportunity. Operation: Operation will create female job opportunity.
	12	Infectious disease such as HIV/AIDS	B−	D	B−	D	Pre Construction/ Construction: Inflow of construction workers may increase the risks on communicable diseases. However, this impact will be mitigated because of clause of contract documents on HIV/AIDS prevention measures. Operation: No activities that will increase the risk of communicable diseases in the local communities around airport are expected.
	13	Working Environment (includes work safety)	B−	D	B−	D	Pre Construction/ Construction: Inappropriate management of working environment will raise the risk of accident and casualty. However, this impact will be mitigated because of using Personal Protective Equipment (PPE), hearing protection for workers on demolition of concrete. Operation: No activities that will increase the risk of the working environment are expected.
Others	14	Accidents	B−	B−	B−	B−	Pre Construction/ Construction: The effect of construction vehicles to the local community is predicted. However, this impact will be mitigated because of traffic management plan

分類	No.	Environmental Item	**Ratings At Scoping**		**Ratings After Surveying**		**Brief Description**
			Pre-construction/ Construction	Pre-construction/ Construction	Pre-construction/ Construction	Pre-construction/ Construction	
							and road safety plan for prevebnting road accident around the airport. Operation: With the increase of airport users, the risk of traffic accidents near the airport will also increase. However, this impact will be mitigated because of mplementing road infrastructures.
	15	Global Warming	D	C-	D	B-	Pre Construction/ Construction: Impacts on trans-boundary effects and global warming are negligible, since the construction works of this project is limited in time, volume, and the area. Operation: The emission of GHG will be increased because of energy consumption in new terminal building. The impact will be mitigated because of implementing energy reduction equipment for lighting or air conditioning.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
Source: JICA Study Team

13.9 Mitigation measures

It is needed to consider mitigation measures for avoiding or reducing environmental and social impact regardless the scale of the impact. The study on mitigation measures is conducted with consideration of technological feasibility and legislative system. The result of study is shown following table.

Table 13-9 Mitigation Measures

No.	Environmental Items	EMP	Implementing agency	Responsible Agency	Rough cost estimation (Million JPY)
Construction					
1.	Air pollution	• Water sprinkling for preventing resuspende soil • Cleaning activity of inside hauling road and entrance of the airport • Using of low air pollutant emission type machinery for construction	Contractor	CAAB	Confidential
2.	Water Pollution	• Using wastewater treatment such as sedimentation tank for discharge to the canals	Contractor	CAAB	
3.	Solid waste	• Segregation and sorting of the	Contractor	CAAB	

No.	Environmental Items	EMP	Implementing agency	Responsible Agency	Rough cost estimation (Million JPY)
		waste for appropriate reusing and recycling			Confidential
4.	Soil contamination	• Securing that contaminated soil will be isolated from clean soil.	Contractor	CAAB	
5.	Noise/Vibration	• Using of low noise type machinery for construction	Contractor	CAAB	
6.	Exisiting social infrastructuresand services	• Installation of inside hauling road for reducing imact to outside road.	Contractor	CAAB	
7.	Local conflicts of interest	• Nogotiating for relocatin	CAAB	CAAB	
8.	Landscape	• Cleanup activity in construction site for impact mitigation of scenery to the airport users and residents	Contractor		
9.	Infectious disease such as HIV/AIDS	• Complying with craus of HIV/AIDS prevention measures.	Contractor	CAAB	
10.	Working Environment (includes work safety)	• Installing Personal Protective Equipment (PPE), hearing protection for workers on demolition of concrete.	Contractor	CAAB	
11.	Accidents	• Preparing traffic management plan and road safety plan for prevebnting road accident around the airport.	Contractor	CAAB	
Operation					
1.	Air pollution	• Installing multi storey car parking with adequate parking number for reduction of gas emission from waiting cars.	CAAB	CAAB	
2.	Water Pollution	• Installing wastewater treatment facility for complying with the standards mentioned in Schedule 10 of the ECR 1997 for inland water discharge	CAAB	CAAB	
3.	Solid waste	• Proper collection and disposing all internally generated solid waste	CAAB	CAAB	
4.	Soil contamination	• Installing Oil separator for drainage in oil farm	CAAB	CAAB	
5.	Noise/Vibration	• Establishing complaint section for issue of airport activity including aircraft noise	CAAB	CAAB	
6.	Exisiting social infrastructuresand services	• Installing road infrastructure for smooth traffic and human movement near airport.	CAAB	CAAB	
7.	Accidents	• Installing road infrastructure for smooth traffic and human movement near airport.	CAAB	CAAB	
8.	Global Warming	• implementing energy reduction equipment for lighting or air conditioning.	CAAB	CAAB	

Source: JICA Study Team

13.10 Environmental Monitorig Plan

The environmental monitoring plan during construction and operation is shown below table.

Table 13-10 Monitoring Plan

No.	Monitoring Item	Parameter	Monitoring area/ point	Term / Frequency	Responsible Agency
Construction					
1.	Air pollution	1. The number of times of water sprinkling to the carrying road and entrance of the airport 2. The number of times of cleaning of the equipment and work site	Carrying road and entrance of the airport Equipment and work site	During the construction/ reporting for once in 3 months	CAAB
2.	Water Pollution	pH, Temp, Turbidity, EC	Discharging point to the canal	During the construction/ Every 3-month survey at typical day	CAAB
3.	Solid waste	1.Types of waste 2.Monthly quantity of waste	Whole of the project site	During the construction/ Reporting for once in 3 months	CAAB
4.	Noise/Vibration	Construction Noise	Around the construction area	During the construction/ Every 3-month survey at a.m. and p.m. of typical day	CAAB
5.	Working Environment (includes work safety)	1.W=The number of workers on demolition site 2.I=The number of installation of hearing protections on demolition site 3. Ratio (IR)=I/W 4. Number of PPE must be equal or more than W	Whole of the project site	During the demolition of concrete/ Reporting for once in 3 months	CAAB
Operation					
1.	1	NO x 、SO x 、PM10、PM2.5	Project site	During operation/ Annual report	CAAB
2.	Water Pollution	pH, Temp, SS, EC, TDS, NH3, COD, BOD, Coli, Oil&Grease	Discharging point of the treated water	During operation/ Annual report	CAAB
3.	Land contamination	1.Quantity of contaminated soil 2.Method of the storing and managing contaminated soil	Whole of the project site	During operation/ Annual report	CAAB
4.	Noise/Vibration	1.The status of implementation complaint section 2.Ambient noise level(Leq) 3. Aircraft noise (Lden)	1. Project site 2. Bboudary of the project area 3. At the point of near residential area	1,2. During operation/ Annual report 3. During operation/ Once	CAAB

Source: JICA Study Team

13.11 Next Activities Required for Obtaining ECC

As stated earlier, the DOE first step clearance (which is the site clearance) together with the approval of IEE and EIA TOR has been obtained. It may be noted here that as per JICA guidelines (2010), as this Project is of Category B, IEE approval by DOE can fulfil minimum JICA requirement. However, as this Project is classified as Red category as per Bangladesh law, EIA approval by DOE is required before the start of construction activities.

Based on the approved EIA TOR, the EIA document is to be prepared. The EIA document must include EMP, Environmental Monitoring Plan (EMoP), EMP implementation budget, and EMP implementation arrangement, in addition to expected impacts and their remedial measures. The EIA document should also include result of public consultant meetings/ information disclosure meetings should be conducted.

The Report is to be submitted to DOE for its approval leading to the issuance of ECC. It is rather difficult to estimate the time required for such approval process.,it can be assumed that two months will be required for EIA approval. A tentative timeline is given in Table 13-11.

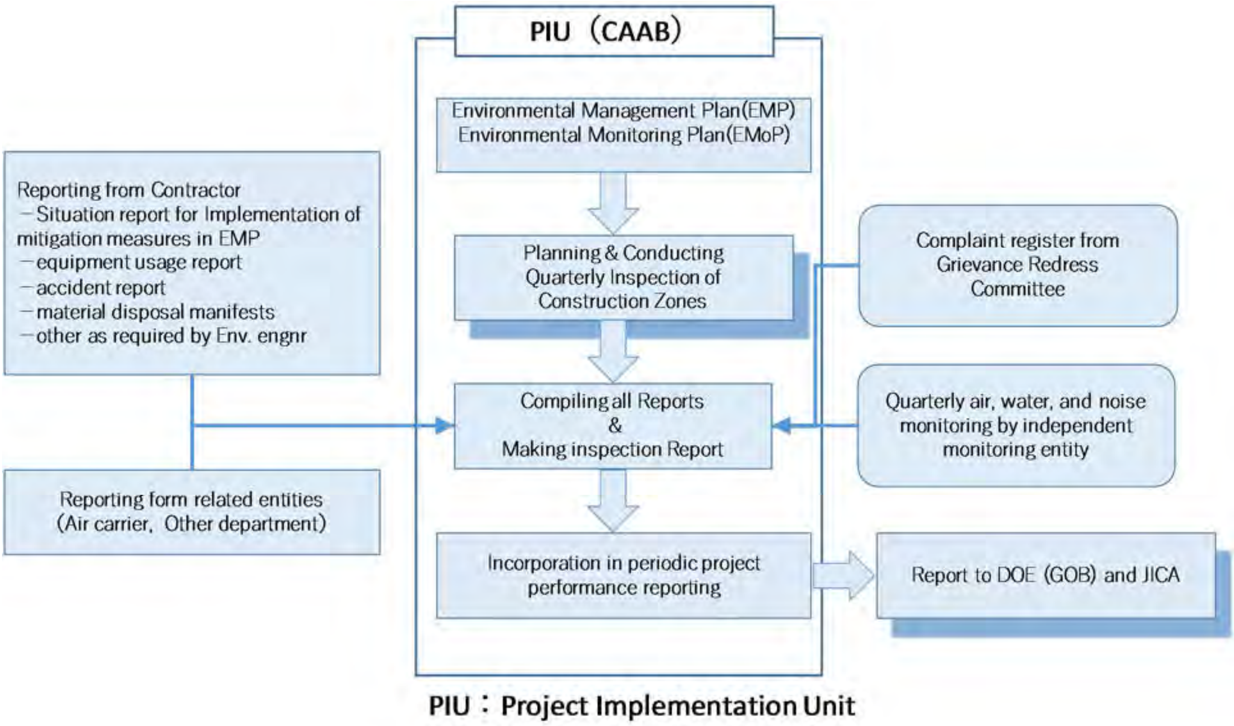
Table 13-11 Tentative Timeline

Activity	Q2, 16	Q3, 16	Q4, 16	Q1, 17	Q2, 17
IEE Approval / EIA TOR Approval by DOE					
EIA Preparation by CAAB					
EIA Approval/ ECC Issuance by DOE					

Source: The Study Team

13.12 JICA Environmental Checklist, Environmental Management Plan, Monitoring Plan

As the Project is a candidate for JICA loan financing, JICA Environmental Checklist for Airport (Template Number 9) have been prepared to facilitate project appraisal by JICA. These can be found in Annex 13.1. Environmental Management Plan (EMP) are shown in Annex 13.2, Environmental Monitoring Plan (EMoP) are shown in Annex 13.3 and Environmental Monitoring Form are shown in Annex 13.4. The frameworks of Environmental monitoring is shown below figure.The project Implementation Unit (PIU) would be organazied in CAAB and PIU would execute EMP and conduct EMoP during construction and operation. It has better to propose to the CAAB to establish the special sector or personnel for conducting EMP and EMoP of this project.



Source: JICA Study Team

Figure 13-11 Tentative Environmental Monitoring Framework

13.13 Stakeholder Meeting

During the IEE study, stakeholder meeting was held.

Table 13-12 Stakeholder Meetings

The date of meeting		The name of meeting
A	25th August 2014	Stakeholders meeting during IEE Preparation
B	21st November 2016	Focus Group Discussion (FGD)
C	10th January 2017	Focus Group Discussion (FGD)
D	11th – 24th January 2017	Key Informal Interview (KII)
E	27th – 30 th December 2016	Individual Consultation
F	26th January 2017	Information Disclosure Meeting (IDM)
A. Stakeholders meeting during IEE Preparation		
Outline	Stakeholders meeting during IEE Preparation: During the IEE study, stakeholder meeting was held on 25August 2014 involving CAAB officials, airport workers and surrounding people. Project objectives and anticipated impacts were explained. It was reported that no one objected the proposed Project. It was also reported that participants showed their willingness to cooperate whole heartedly during construction.	
	The plans reflected of stakeholders comments. ・none	
B. Focus Group Discussion (FGD)		
Outline	FGD during draft EIA preparation: An FGD type stakeholders meeting was held on 21 Nov, 2016 at CAAB (Annex 9, draft EIA report submitted to DOE, December, 2016). About forty-three (23) participants of different occupations were present at the meeting. A detail power point presentation was made to explain the objective and components of the Project, and anticipated impacts and their remedial measures. All of the participants supported the project and extended their cooperation. However, there are some concerned raised in the meeting as follows: • Some residents claim that drainage water from airport area enters into nearby Nikunja residential	

<table>
<tr><td></td><td>area causing water logging problem. It was replied that the issue would be examined.
• Similarly, people from Uttara 1 area also complained about water logging at their area. It was replied that there is no connection between airport area and Uttara 1 area, still the issue would be examined.
• Participants expressed their opinion that re-plantation must be done for any tree cutting.
Participants inquire about new building height restriction. It was replied that no addition height restriction is needed as there will be no new runway.</td></tr>
<tr><td></td><td>The plans reflected of stakeholders comments.
・Tree inventory survey was conducted for future cutting trees. About replantation, it will be studied in detailed design.</td></tr>
<tr><td colspan="2">C. Focus Group Discussion (FGD)</td></tr>
<tr><td>Outline</td><td>FGD was held on 10 Jan, 2017 at CAAB. About sixty-six (66) participants of different groups including businessmen, social workers, local elected representative (UP Member), Government officials were present at the meeting. After presentation on the Project and its environmental issues, the participants expressed their views. The participants were positively accepted the Project and appreciated that environmental issues are considered and will be addressed. Also, the approach of taking opinion from the local people was greatly appreciated. Some of their concerns are as follows:
• Many participants inquired about land acquisition. It was replied that there would ne no land acquisition as all the Project activities will be confined within the current airport premises.
• Many participants also inquired about building height restriction. They were briefed that as there would be no new runway construction, there would be no change in zone wise building heigh restriction.</td></tr>
<tr><td></td><td>The plans reflected of stakeholders comments.
・none</td></tr>
<tr><td colspan="2">D. Key Informal Interview (KII)</td></tr>
<tr><td>Outline</td><td>Key Informant Interview (KII) is a useful tool of PRA (Participatory Rapid Appraisal) that gives shared understanding of common concerns of a knowledgeable/ focal person. The KII usually takes place at a suitable place where the concerned person can discuss issues in details and express his views freely and independently. KII does not follow any fixed structured questions.
The following six persons were interviewed as part of the KII for this Project
<table>
<tr><td>S/N</td><td>Name of Key Informant</td><td>Expertise on</td><td>Identity</td></tr>
<tr><td>1</td><td>Dr. Ainun Nishat</td><td>Water resources/ ecology</td><td>Prof Emeritus, VC (Former) BRAC University
Former Chairman, IUCN-Bangladesh
Former Professor, BUET</td></tr>
<tr><td>2</td><td>Prof M. Feroze Ahmed</td><td>Environmental Expert</td><td>VC, Stamford University
Former Professor, BUET</td></tr>
<tr><td>3</td><td>Prof A. I. Mabub Uddin Ahmed</td><td>Sociologist</td><td>Past Chair, Sociology,
Dhaka University</td></tr>
<tr><td>4</td><td>Mr. Mahfuz Ullah</td><td>Environmental Journalist</td><td>Secretary General, Center for Sustainable Development (CFSD),
Former Chairman IUCN-Bangladesh</td></tr>
</table></td></tr>
</table>

<table>
<tr><td rowspan="4"></td><td>5</td><td>Mr. Iqbal Habib</td><td>Architecture</td><td>Director, Vitti Sthapati Brindo LTD
Environmental Activist</td></tr>
<tr><td>6</td><td>Dr. Ashan Uddin Ahmed</td><td>Climate Change</td><td>Executive Director, Centre for Global Change</td></tr>
<tr><td colspan="4">All these eminent scholars were highly supportive to the expansion project. Summary of KII is given below:
<Aiprot planning>
• Expansion should be comprehensive & integrated
• Accessibility should be enhanced
• A National Symbol should decorate the HSIA outlook
• Interconnected water channel should surround the HSIA
• Entrance overcrowding by malls & hotels should be eliminated
• Lounge, escalator, and other internal facilities should be improved
• An emergency runway additional to the existing one is required
<Environment>
• Promote greenbelt by native timber, fruits & herbal trees
• An emergency runway additional to the existing one is required
• Improved safety and security should be ensured
• Impact of noise pollution on the nearby residents should be minimized.
• Occupational Health and Safety (OHS) should be maintained during construction
• Special attention needs to be taken about fuel storage and handling
• Water reuse and use of rain water should be considered.
• Birds should be regulated for aircraft safety.
• Tree cuttings should be property compensated by re plantation.</td></tr>
<tr><td colspan="4">The plans reflected of stakeholders comments.
・Tree inventory survey was conducted for future cutting trees. About replantation, it will be studied in detailed design.
・Complaints section will be prepared for countermeasure of noise issue.
・Personal Protective Equipment should be prepared for construction workers.
・Implementation of Waste water treatment facility.</td></tr>
<tr><td colspan="5">E. Individual Consultation</td></tr>
<tr><td>Outline</td><td colspan="4">Conducted interview with various local people living close to the airport area for gathering their opinion on the Project and its impact. Interviewees included shopkeeper, teacher of school, college, madrasa (religious school), land owner, service holder, business man, taxi driver, rickshaw driver, van puller, Moszid Imam (religious leader), word councilor (elected representative), women leader, house wife etc, These</td></tr>
</table>

	people are from the nearby four villages (Dolipara, Ahalia, Pakuria and Baunia) of Harirampur union under Turag Thana. Summary of their opinion are as follows: • Aircraft noise is a problem especially for sick, pregnant, babies, and elderly persons, particularly at night. • Drainage from airport creates a problem. • Road communication is not good enough • Dense population live here because house rent of this area is comparative less
	The plans reflected of stakeholders comments. ・Complaints section will be prepared for countermeasure of noise issue. ・Road infrastructure will be implemented for smooth traffic and human movement near airport.
F. Information Disclosure Meeting (IDM)	
Outline	Information Disclosure Meeting was arranged on 26 January, 2017, at Dhaka Regency Hotel. The purpose of the meeting was to disclose the ouput of the EIA study along the description of the HSIA Expansion Project. Total number of participants were twenty six (26) representing various government agencies and local elites including Dept of Forest, Road and Highway, Airlines, Metereology dept., Police, RAB, RAJUK, REB, BWDB, elected councillor, businessmen, etc. All the participants expressed their support for the Project and apprciated the proposed measures against anticipated environmental impact. Important issues are mentioned below: • Importance of new metereological station at airport. It was replied that this is included in ongoing control tower construction project, but excluded from the HSIA Expansion project. • During tree re-plantation, exotic and invasion species of trees should be avioided. • There was an inquery if Resettlement Action Plan was prepared or not. It was replied that as there is no land acquisition, RAP is not needed. • Emphesis on smooth access by various mode of transport, like DEE, BRT, MRT, car, BR, Bus, etc.
	The plans reflected of stakeholders comments. ・Tree inventory survey was conducted for future cutting trees. About replantation, it will be studied in detailed design. ・Road infrastructure will be implemented for smooth traffic and human movement near airport.

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CHAPTER 14 PROJECT COST ESTIMATE

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Chapter 14 PROJECT COST ESTIMATE

14.1 Cost Estimate

Based on the construction plan mentioned in Chapter 8, the preliminary project cost was estimated.

14.1.1 Precondition for Project Cost Estimation

Confidential due to security reasons.

Confidential

Source: JICA Study Team

Table 14-1 Implementation Schedule

14.2 Project Cost

(1) Total Project Cost

Confidential.

Table 14-2 Financial Plan

Confidential.

Table 14-3 Annual Financial Plan

Confidential.

Table 14-4 Breakdown of Fund

Confidential.

14.2.2 Construction Cost

Confidential.

Table 14-5 Breakdown of the Construction Cost

Confidential.

14.3 Review of validity of project cost

Confidential.

Table 14.6 Comparison of Construction Cost

Confidential

Source: JICA Study Team

14.4 Applicability of Japanese Advanced Technology

Confidential.

Table 14-7 Increase and Decrease of Construction Cost

Confidential.

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CHAPTER 15 IMPLEMENTATION ORGANIZATION OF THE PROJECT

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Chapter 15 IMPLEMENTATION ORGANIZATION OF THE PROJECT

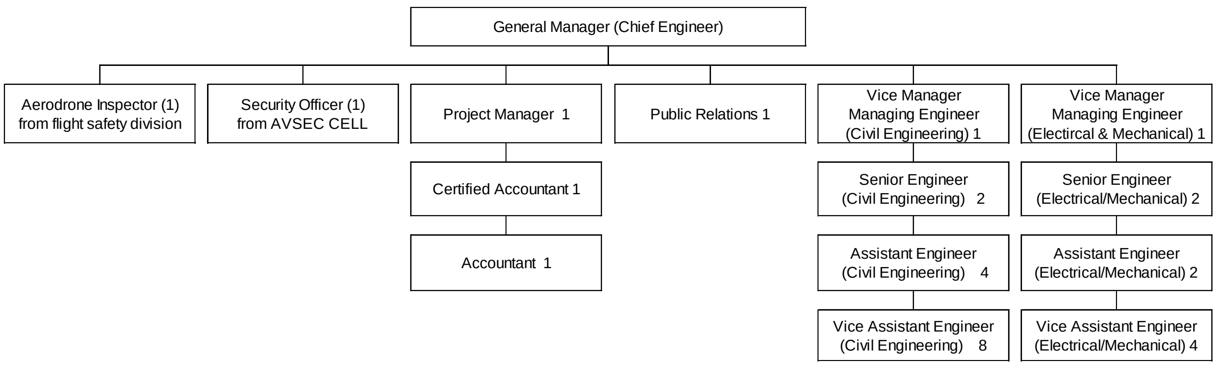
15.1 Implementation Organization

15.1.1 The Implementing Agency

The implementing agency for the terminal expansion project will be the Civil Aviation Authority, Bangladesh (CAAB), which will be responsible for the design, procurement, and construction of the project. CAAB shall establish the Project Implementation Unit (PIU) for this project, which will be an independent organization with delegated authority and specific functions.

15.2 Confirmation of Scope of PMU, Composition of the Organization and Staff

CAAB is responsible for providing air traffic control (ATC) services, securing fast and efficient flow of aviation traffic within the Bangladesh Flight Information Region (FIR), as well as the responsible agency for maintaining facilities including development and cosntruction, for all airports in Bangladesh. The organizational organization of CAAB is composed of three councilor members and the Chief Engineer under the Chairman, as shown in Figure 15-1. It has jurisdiction over operations and planning of air traffic safety and security, formulation of aviation policies, and construction of aviation infrastructure, including airports and air navigation facilities. CAAB has a total staff of 3,716 (as of 2016), of which approximately 900 are staff exclusive of the security forces such as police. Out of this number, about 754 personnel are assigned to the Chief Engineer’s Office. Their main task is responding to engineering issues at airports and they are divided into three groups, namely: 1. Electrical and mechanical, 2. Civil engineering, and 3. Planning/design/quality survey. During the implementation of the project, dedicated staff will be assigned to the PIUas shown in Figure 15-1.



Note: numbers indicate assigned staff numbers
Source: CAAB

Figure 15-1 Organization of PIU in CAAB

15.3 Finances and Budgetary Situation of the Implementation Agency

Confidential

Table 15-1 CAAB Finances

Confidential

Table 15-2 Revenue for HSIA

Confidential

15.3.1 Technical Level of the Implementation Agency

CAAB has experience in implementing projects under Japanese yen loans through the Chittagong Airport Development Project which commenced in 1995. The grant aid project for procurement of Air Navigation Equipment at Dhaka International, Chittagong, Jessore, and Saidpur airports is also presently being implemented. CAAB also has experience in constructing other international airports and domestic airports in addition to HSIA. Therefore, its technical level is considered to be high.

The contents of the guidelines for procurement of consultant's services also exhibit deep understanding of Japanese yen loan procedures gleaned from previous projects. The guidelines also show an understanding of utilizing and formulating tender and contract documents based on FIDIC standards.

15.3.2 Experience in Similar Projects by the Implementing Agency

The previous experience in similar projects by the implementing agency is shown in Table 15-3. The list includes several Japanese yen loan projects. CAAB is deemed to be well versed in the procedures and steps required for the implementation of Japanese yen loan projects.

Table 15-3 List of Similar Projects Implemented by CAAB

No.	Project Name	Project Cost (BDT in million)	Actual Cost BDT in million)	Date of Completion
1	Chittagong Airport Development Project	5,411	－	December 2000
2	Renewal of Displays (FIDS) at Dhaka International Airport	129.4	129.4	November 2006
3	Asphalt Overlay on Runway at Jessore Airport ジ	121.3	120.7	June 2007
4	Asphalt Overlay on Runway and introduction of Navigation Lighting System at Cox's Bazaar Airport	246.0	236.5	June 2007
5	Development of Sylhet Airport to enable Wide-Body Aircraft Operations	1,077.9	1,060.9	June 2008
6	Renewal of Existing DVOR and DME at Dhaka International Airport	53.8	51.3	June 2008
7	Renewal of Existing Navigation Radar facilities at Dhaka International Airport	143.0	140.7	December 2008
8	Expansion of Apron north of No. 7 Spot at Dhaka International Airport	65.7	56.0	December 2008
9	Expansion and Modernization of Terminal Bldg. at Sylhet International Airport, including ground floor staircase	562.7	532.7	June 2009
10	Refurbishment of Normal Electrical Supply Circuit and Emergency Generators at Dhaka International Airport	240.0	217.0	June 2011
11	Procurement of Security Equipment for Cargo Facilities at Dhaka International Airport	287.8	－	June 2011
12	Consulting Services for Renewal of Dhaka International Airport	186.7	－	June 2014 (planned)
13	Renewal of Dhaka International Airport	4,140.5 (approved) 5,312.0 (revised)	－	June 2013 (planned)
14	Asphalt Concrete Overlay on Runway at Dhaka International Airport	878.0	－	June 2011 (planned)
15	Cox Bazaar Airport Development (Phase 1)	3,026.5 (original) 5,496.4 (revised)	－	December 2013 (planned)
16	Expansion of Apron wets of Taxiway F and north of existing Export Cargo Terminal at Dhaka International Airport	444.0	－	June 2013 (planned)
17	Construction of CAAB HQ	614.2 (approved) 1,098.5 (revised)	－	June 2014 (planned)

Source: CAAB

15.3.3 Evaluation and Recommendations on the Implementing Agency (Required Staffing, Human Resource Development)

The staff required for PIU to carry out the implementation of the Japanese yen loan project will be selected from the CAAB staff with previous experience of airport development projects. In addition to DSIA, since CAAB is responsible for operation and management and development of international airports in Chittagong and Sylhet and five other domestic airports, experience of construction projects is abundant. There are no difficulties envisioned in the implementation of the project since the PIU will be appropriately established and manned mainly by experienced CAAB staff. However, the scale of the proposed Terminal 3 is extremely large and also the first passenger terminal with capacity of ten million passengers, which exceeds the annual handling capacity of the existing terminal building for CAAB. Moreover, the construction period is only three years from commencement of construction to commencment of operations requiring highly difficult construction management.

Furthermore, security management over the whole large construction site must also be firmly addressed following the terrorist attack of July 2016.

Therefore, it will be necessary to employ staff who have the capability to manage large projects in short construction schedules and are also capable of cooperation with the security management entity. At the same time, it will also be necessary to train CAAB staff in order to acquire capabilities to carry out similar difficult projects. Therefore, on-the-job training (OJT) programs must be implemented for CAAB staff as well as appropriate off-the-job training as required.

CHAPTER 16 MAINTENANCE AND OPERATION ORGANIZATION

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Chapter 16 MAINTENANCE AND OPERATION ORGANIZATION

The area inside the restricted airspace must be operated and maintained under international rules. CAAB has a responsibility to take care and protect the value of passenger’s life, property, and cargo passing through for compensation and receives revenue in return.

When the airport is secure and comfortable, and the country can provide value, passengers and cargo will increase at a high rate. Bangladesh has highly valued assets in its labor forces and resources, but the passenger and cargo handling services at the international airport, one of its gateway facilities, are inferior to global standard levels. Visitors to the airport are guests of all the people who work at the airport and cargo is valued property. Airport authorities must ensure the safety and comfort of passengers and the value of property. In addition, people and cargo that use the airport and foreign airlines that undertake flight operations also value time. The airport urgently needs to provide comfortable and appropriate services to all comers and raise credibility in their services.

It is also necessary to gain the trust from foreign airline operators. The airport operations must adhere to the rules governing their execution. They should also maintain and improve the quality of the matters within their scope in order to maintain orderly functions throughout the airport.

16.1 Confirmation of Maintenance and Operation Organization

The operations, maintenance, and administration of airports in Bangladesh at present are under the jurisdiction of CAAB. The maintenance of runways, taxiways, aprons, landing strips, radio navigation facilities, and navigation aids are also their responsibility. The ground handling services are operated by Biman Bangladesh Airlines and cargo handling is operated by Biman Cargo.

Table-16-1 Organization of Operations and Management at HSIA

Category of Operation	Responsible entity	notes
Operation of passenger terminal	CAAB	
Operation of cargo terminal	Biman Cargo	
Safety management	CAAB	
Fire fighting and emergency services	CAAB	
Disaster prevention	CAAB	
Security Services (security inspections, police)	CAAB, airlines, Bangladesh Police (Airport Armed Police), Bangladesh Ansar & VDP	
Facility Management & Maintenance	CAAB	
Ground Handling Services	Biman Bangladesh Airline	
Immigration/Emigration/Quanrantine	Bangladesh Police, Bnagladesh Customs, Department of Agricultural Extension	
Air Traffic Control Services	CAAB	

Source: JICA Study Team

This system is expected to remain during the construction period and after commencement of operations. The project encompasses not only the expansion of the airport facilities, but also includes the continued operations of the existing terminal during construction. Therefore, the existing maintenance operations must also be continued same as before.

16.2 Confirmation of Scope, Organization, and Staffing of Maintenance and Operation Organization

The present situation of CAAB concerning its scope, organization, and staff are described in Chapter 15. In summary, approximately 900 airport staff exclusive of the security guard corps are deployed as operations and maintenance staff to each domestic airport as of 2016. The increase of approximately 700 staff by the end of phase 1 has been approved by Ministry of Finance. There are also plans to increase the staff after completion of T3 during phase 2.

Confidential due to security reasons.

Since CAAB has appropriately managed the operations of the passenger terminal up until now, it is expected that CAAB will continue its appropriate airport operations, maintenance, and administrations after commencement of services at Terminal 3.

16.3 Finance and Budgetary Conditions of Maintenance and Operation Organization

The project budget for maintenance and operations is secured within the CAAB budget which is independent from government budget. The budget and expenditures for 2010 to 2016 is shown in Table 16-2. It has been confirmed that over 90% of requested budget has been secured for maintenance and operations and review of current revenues and expenditures reveal no financial issues. However, while terminal floor space will increase and passenger revenues will also increase, in order to handle the increased passengers and airport visitors with a high level of service, the number of staff must be increased and new equipment procured. This will require careful attention to balancing revenue and expenditures in project planning for maintenance and operations.

Table 16-1 Maintenance and Operation Cost

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16.4 Technical Level of Maintenance and Operation Organization

The maintenance at airports in Bangladesh is conducted following a maintenance manual prepared by CAAB based on the airport services manual published by ICAO. The maintenance division of CAAB conducts maintenance activities of basic facilities and navigation aid facilities based on these manuals. Observation of actual maintenance activities has shown that the rules are followed reliably and the technical level is not an issue. The operation procedures of various airport facilities and the basic procedures for maintenance and inspection of equipment are also provided with manuals prepared by CAAB and are carried with attention paid to the items listed below. Following the commencement of operations at Terminal 3, the facilities requiring maintenance will increase and it is assumed that CAAB recognizes that an increase in staffing is necessary. Incorporation into project planning and implementation of staff employment and training should be confirmed at appropriate times.

- Attention to conformance with procedures in manuals and guidelines in the performance of maintenance services by operation and maintenance staff.
- Improvement of equipment and technical skills and increase in efficiency
- Thorough familiarization with composition and functions of each equipment and responses prepared in advance for various accidents.
- Maintain close vigilance over the condition of each equipment and immediately report any abnormality or accident to responsible person
- Strict observance of all safety related rules.

16.5 Experience of Operation and Maintenance Organization

CAAB is responsible for operations and maintenance of HSIA at present.

CAAB carries out maintenance of basic facilities such as passenger terminal, parking facilities and the runways, taxiways and aprons, radio navigation, and aviation lighting facilities at HSIA. It also has experience in maintenance and operations of two other international airports and five domestic airports in Bangladesh. The maintenance and operations after completion of the project facilities are judged to be without issue as the organization to utilize these experiences is in place.

16.6 Evaluation and Recommendations on Maintenance and Operations (Required Staff Deployment, Human Resource Training)

CAAB has prepared manuals (Aerodrome Maintenance manual, 2013 CAAB) for operations and maintenance for airports in Bangladesh based on the airport services manual published by ICAO. The maintenance division of CAAB conducts maintenance activities of basic facilities and navigation aid facilities based on these manuals.

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Evaluation and recommendations on the present conditions are reiterated below.

16.6.1 Passenger Terminal Operation Services

The primary mission of the passenger terminal is to provide safe and comfortable environment to the users of the passenger terminal and a similar level of respect for their luggage should be shown as well. However, at present, the luggage is taken out of aircraft, piled on to ULD dollies and handled roughly before being handed back at the terminal. The same applies to departures. This handling leads to damage of the luggage and betrayal of the trust of the passengers. The conditions are even worse during the rainy season. A shining new building is impressive, but provision of high quality services to the passengers is highly desired.

16.6.2 Cargo Terminal Operation Services

Biman Cargo carries out air cargo and the ground handling as mentioned previously. The income and expenditure situation is shown in Table 16-2. The revenue of cargo handling from 2010-2014 is estimated to be about 1.0 to 1.5 billion BDT, of these, the income and expenditure situation about grand handling was not able to do data acquisition. On the other hand, about the expenditure, the payment to CAAB which is an airport owner does not occur. It is assumed that Biman Cargo have monopolistic rights and interests about the freight handling in the airport. As for this, it is assumed that it occurs because it is the national enterprise where is equal with CAAB in an organization in MoCAT.

Table 16-2 Income Statement of Biman Cargo

Confidential.

As mentioned in previously in Section 3.3.4, although issues with cargo handling are recognized, there are no sign of improvement. The lack of a competitive mindset due to the monopoly in handling seems to be the main reason for the slow advance of improvement.

The cargo handled at the cargo terminal are valued products and goods of the customers and their valuable assets. The main mission is to make timely deliveries to consignees of goods accepted from abroad or from domestic sources, without causing damage. However, at present, cargo with lost identification tags overwhelm not only the terminal building, but also spill out onto the apron area. This is an unacceptable situation leading to losing valuable customers and defeating the motivation of prospective new customers as well.

Each cargo has a consignor who expects smooth acceptance and delivery in exchange for their money. Utmost efforts must be expended to eliminate damage and loss and to take clear countermeasures when damage does occur to regain the trust of the consignor.

The future operations at the cargo terminal must establish upgraded services by introducing appropriate equipment to improve work efficiency. Especially, imported cargo must have clear structural delineation of airside/landside areas to limit entry of unauthorized personnel. The internal handling should be regulated to be carried out only by professionally trained personnel and a system for quick discharge to landside areas should be in place. The customs services should also take into account that they are an incidental service of an airport with 24 hour operations.

16.6.3 Safety Management Services

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16.6.4 Fire Fighting and Evacuation Services

This service is divided into two types: fires onboard aircraft or boarding ramp and fires in the terminal building.

The main mission of the Airport Fire Station is to combat fires onboard the aircraft. They must be on 24 hour alert to respond to onboard fires that can occur at any time. They must also keep in mind that they are responsible for the evacuation of many passengers in the event of aircraft fires and they must procure and maintain equipment in peak condition. Fire engines will be at the forefront in any fire response situation and they should be possessed in sufficient numbers to allow a reliable level of service under any conditions. Considerations should be made to reduce mobilization time to a minimum.

In the event that an aircraft catches fire on the single runway now in use, the matter of secondary importance will be the removal of the damaged aircraft off the runway. Aircraft recovery equipment is provided by providers of the area, but it will be required to procure the minimum amount of equipment to remove the aircraft from the runway to allow early reopening of the runway at Dhaka International Airport. Reopening the runway will also allow easier acceptance of assistance from other countries during emergencies.

Each department must organize a self-defense fire fighting unit to coordinate with the airport fire station and prepare against emergencies. Fire extinguishers should be placed at strategic locations and kept in working order. All airport employees should be trained in the correct operation of the extinguishers.

16.6.5 Disaster Prevention

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16.6.6 Security Services (Security Check, Implementation)

Confidential due to security reasons.

16.6.7 Facility Maintenance and Administration

It is important to maintain pristine conditions of the facilities. Periodic inspections and checks on functionality are required to obtain an objective understanding of conditions and make appropriate responses to maintain the initial conditions. In addition to continuous maintenance by professionally trained and experienced maintenance crews, it will be necessary to listen to users complaints and conduct reviews by auditory committees to confirm actual implementation of services. Furthermore, maintenance records should be kept for extended periods. This will allow early discovery of defects and formulation of appropriate responses or resolution of issues.

16.6.8 Ground Handling Services

Ground handling services are the provision of various services to operational aircraft when they are on the ground at airports. The most important matter is to provide the requested services within the parking time without damaging the aircraft. The operational aircraft are the customers and provision of appropriate handling services utilizing appropriate ground service equipment (GSE) to support the safety of aircraft operations is an important service.

Some instances were observed where GSE was used improperly or inadequately maintained. GSE are expensive and securing their efficient use under appropriate maintenance over the long term will require a thorough review of procurement contents. Furthermore, it is important to conduct periodic maintenance service for each GSE at appropriate intervals and maintain proper records in order to achieve reliable service and lower maintenance costs.

Old and obsolete GSE should be removed from the ramp area to allow efficient use of the limited ramp spaces.

Aircraft from overseas demand the provision of ground handling service according to international standards and the provision of a clean and safe airport. The introduction of the latest equipment and improvement of the service level will be required.

16.6.9 Immigration/Emigration Management, Customs, Quarantine

Confidential due to security reasons.

16.6.10 Air Traffic Control Services

Confidential due to security reasons.

CHAPTER 17 FINANCIAL AND ECONOMIC EVALUATION AND EFFECT INDICATORS

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Chapter 17 FINANCIAL AND ECONOMIC EVALUATION AND MONITORING INDICATORS

17.1 Financial Analysis

The financial analysis of the proposed Dhaka International Airport Expansion Project was carried out by comparing the costs and revenues between the 'with project' and 'without project' cases. Based on the assumptions below, the cash flow of an 'incremental' case was prepared in order to measure the net financial impact of implementing the proposed project. The financial internal rate of return (FIRR) of the incremental case was calculated to evaluate the feasibility of the proposed project.

17.1.1 Basic Assumptions

The following are the basic assumptions applied to both with project and without project cases unless otherwise mentioned:

(1) Definition of With Project Case, Without Project Case, and Incremental Case

1) With Project Case

The proposed project will be implemented in order to meet the traffic demand in 2019-2030. The both domestic and international traffic handled at Hazrat Shahjalal International Airport (HSIA) for the period of 2031-2045 will remain constant at the same level of 2030.

2) Without Project Case

The proposed project will not be implemented. The domestic and international traffic handled in HSIA will remain constant from 2021 to 2045.

3) Incremental Case

The incremental case is for the difference between with project and without project case to measure the net financial impact of the proposed project.

(2) Project Period

The project period is 25 years from 2021 to 2045, including the initial construction period from 2017 to 2022 and evaluation period from 2017 to 2045.

(3) Price Base and Exchange Rates

The prices shown in BDT are expressed as the net price escalation using the constant price level in January 2017. Real exchange rates, net of price escalation of Bangladesh, Japan, and the US are estimated at USD 1 = JPY 108.2 = BDT 78.4 during the project period.

(4) Contingencies

A physical contingency of 5% for investment costs excluding administration costs and 5% for consulting fees is included in the investment costs. Price contingency is not included.

(5) Target Project FIRR

Investments incurred between 2017 and 2022 will be met by the Japanese yen loan except for administration costs, value added tax (VAT), and import tax. The yield curve of Bangladesh T-Bond will be utilized for the investments from 2021 to 2045. The cut-off yield of accepted government T-Bond (15 years) as of January 11, 2017 was 7.64%.

The weighted average cost of capital (WACC) was calculated at 1.983%, which was used as the target FIRR of the project.

Table 17-1 Capital Cost of the Project

Confidential.

Source: JICA Study Team

Figure 17-1 Cut-off Yield of Accepted Government T-Bond

17.1.2 Costs

Project costs are comprised of investment costs and operation and maintenance (O&M) costs.

(1) Investment Costs (Initial and Replacement)

The total costs of initial investment is shown in Table 17-2. The total of replacement investment costs is shown in Table 17-3.

Table 17-2 Total Cost of Initial Investment

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Table 17-3 Total Cost of Replacement Investment

Confidential.

(2) O&M Costs

The O&M costs was estimated based on the incremental case.

1) Labour Cost in Incremental Case

The organizational plan of CAAB indicates a 52% increase of CAAB personnel by the year 2020. According to the interview with CAAB, the increase of personnel at HSIA is being discussed and the increase rate at HSIA could possibly be double that of CAAB. Therefore, the increase rate of HSIA by 2020 was conservatively assumed as 104% .

The number of personnel in the incremental case was set as 20% after 2020.

Table 17-4 Labour Cost of Incremental Case

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2) Maintenance Cost related to Construction in Incremental Case

Confidential.

Table 17-5 Maintenance Cost of Incremental Case

Confidential.

3) Other Administrative Expenses in Incremental Case

The other administrative expenses in the incremental case was estimated based on the increase of floor area (see Table 17-6). The other administrative expenses were separated into two parts of influenced or not influenced by floor area and the former was analyzed as shown in Table 17-7.

Table 17-6 Increase of Floor Area

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Table 17-7 Other Administrative Expenses

Confidential.

17.1.3 Revenues

Revenues consist of aeronautical and non-aeronautical revenues. Both revenues were estimated to increase in line with the passenger traffic movement as explained below. Domestic and international revenue forecasts were conducted separately.

(1) Passenger Traffic Movement

Annual passenger traffic movement under with project case, without project case, and incremental case are summarized in Table 17-8.

Table 17-8 Forecast of Passenger Traffic Movement

	With Project Case			Without Project Case			Incremental Case		
	International	Domestic	Total	International	Domestic	Total	International	Domestic	Total
2021	9,304,917	1,502,326	10,807,243	8,668,579	1,029,997	9,698,575	636,338	472,329	1,108,668
2022	9,930,487	1,640,618	11,571,105	8,668,579	1,029,997	9,698,575	1,261,908	610,621	1,872,530
2023	10,593,591	1,779,648	12,373,240	8,668,579	1,029,997	9,698,575	1,925,013	749,651	2,674,664
2024	11,296,482	1,927,786	13,224,268	8,668,579	1,029,997	9,698,575	2,627,903	897,789	3,525,693
2025	12,041,546	2,085,615	14,127,161	8,668,579	1,029,997	9,698,575	3,372,967	1,055,619	4,428,586
2026	12,765,500	2,240,510	15,006,009	8,668,579	1,029,997	9,698,575	4,096,921	1,210,513	5,307,434
2027	13,529,271	2,404,730	15,934,001	8,668,579	1,029,997	9,698,575	4,860,692	1,374,734	6,235,426
2028	14,335,050	2,578,828	16,913,877	8,668,579	1,029,997	9,698,575	5,666,471	1,548,831	7,215,302
2029	15,185,146	2,763,384	17,948,530	8,668,579	1,029,997	9,698,575	6,516,567	1,733,387	8,249,954
2030	16,081,998	2,959,015	19,041,013	8,668,579	1,029,997	9,698,575	7,413,419	1,929,018	9,342,437
2031-2045	16,081,998	2,959,015	19,041,013	8,668,579	1,029,997	9,698,575	7,413,419	1,929,018	9,342,437

Source: JICA Study Team

(2) Aeronautical Revenues

Aeronautical revenues consist of the passenger service fees (PSF), aircraft landing charges, boarding bridge charges, and cargo security charges.

1) Passenger Service Fees (PSF)

Table 17-9 below compares the present PSFs of HSIA with those of some neighboring countries. Both domestic and international PSFs of HSIA are much lower than those of other airports. The hypothetical international PSF of BDT 1,200, raised to the same level as the lowest of other airports, was set in this study due to the investments for the project.

Table 17-9 Passenger Service Fees

Airport	International			Domestic			GDP Per Capita in 2014
	BDT	USD	Ratio	BDT	USD	Ratio	USD
Current PSC in HSIA	500	6.4	1.00	50	0.64	1.00	1,211.7
Phnom Penh		25.0	3.92		6.00	9.41	1,158.7
Yangon		15.0	2.35		1.68	2.63	1,161.5
Kolkatta,		17.1	2.69		6.70	10.51	1,598.3
Jakarta, Soekamo-Hatta		11.3	1.78		3.02	4.74	3,346.5
Bangkok, Suvamabhumi		20.0	3.14		2.86	4.48	5,814.8
Kuala Lumpur		16.2	2.54		2.24	3.51	9,768.3
Singapore, Changi		20.4	3.19			0.00	52,888.7
Future PSC in HSIA	1,176		2.35	132		2.63	

Source: World Bank and JICA Study Team

2) Landing Charges

The present landing charges were applied in this study. The weighted average landing charges considering composition of aircraft type in time series were analyzed as shown in Table 17-10 and Table 17-11.

Table 17-10 Average Landing Charges per Aircraft (International)

Code Letter	Weighted Average (USD)	Composition in 2015	Composition in 2020	Composition in 2025	Composition in 2030	Composition in 2035
B class	135	2%	0%	0%	0%	0%
C class						
ERJ, ATR, Dash8 Q400	192	25%	22%	15%	9%	1%
B318, B737	771	25%	30%	35%	40%	45%
D class	1,500	2%	2%	2%	2%	2%
E class	3,738	45%	45%	47%	48%	51%
F class	7,140	1%	1%	1%	1%	1%
Weighted Average (USD)		2,027	2,057	2,157	2,221	2,357

Source: CAAB

Table 17-11 Average Landing Charges per Aircraft (Domestic)

Code Letter	Weighted Average (BDT)	Composition in 2015	Composition in 2020	Composition in 2025	Composition in 2030	Composition in 2035
B class						
B class	1,023	80%	75%	60%	50%	40%
C class						
ERJ, ATR, Dash 8Q400	2,068	20%	20%	20%	20%	20%
B318, B737	11,363	0%	5%	20%	30%	40%
Weighted Average (BDT)		1,232	1,749	3,300	4,334	5,368

Source: CAAB

3) Boarding Bridge Charge

The present boarding bridge charge was applied on this study. The weighted average boarding bridge charges considering composition of aircraft type in time series was analyzed for both international and domestic flights as shown in Table 17-12.

Table 17-12 Average Boarding Bridge Charges per Aircraft (International and Domestic)

International Aircraft	Boarding Bridge Charge(USD)	Composition in 2021	Composition in 2025	Composition in 2030	Composition in 2035
Below 100 ton	100	52%	50%	49%	46%
From 100 to 200 ton	150	25%	26%	26%	28%
From 200 to 300 ton	200	23%	24%	24%	26%
Over 300 ton	250	1%	1%	1%	1%
Weighted Average		136	138	139	141
Domestic Aircraft	Boarding Bridge Charge(USD)	Composition in 2021	Composition in 2025	Composition in 2030	Composition in 2030
Below 100 ton	100	100%	100%	100%	100%
Weighted Average		100	100	100	100

Source: CAAB

4) Cargo Security Charge

HSIA started collection of the cargo security charge in 2011. The unit price is USD 0.06 per 1 kg. The revenue from cargo security charge was estimated utilizing Table 17-13 of the cargo demand forecast.

Table 17-13 Cargo Demand Forecast

Confidential.

(3) Non-aeronautical Revenues

The ratio of non-aeronautical revenues in HSIA is presently 10%, which is a very low level. The non-aeronautical revenues were assumed in this analysis to increase to 20% in the with project case due to the development of proposed new international passenger terminal.

Table 17-14 Ratio of Non-aeronautical Revenue in HSIA

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(4) Revenue Summary

The revenue summary is indicated in Table 17-15. The incremental case shows that revenue increases are mainly caused by the international PSF and non-aeronautical revenues.

Table 17-15 Revenue Summary

Confidential.

17.1.4 Financial Evaluation

(1) Project FIRR

The financial cash flow of the incremental case is attached as Appendix. The FIRR was calculated at 6.2%, higher than the target of 1.983%. Therefore, the proposed project is financially feasible.

17.2 Economic Analysis

Economic analysis of the proposed project was carried out in this section by comparing the economic costs and benefits on the incremental case. The project's economic internal rate of return (EIRR) was calculated based on the cash flow of the incremental case to evaluate the net economic impact by the proposed project on the national economy.

17.2.1 Basic Assumptions

In addition to the relevant assumptions used in the financial analysis, the following assumptions were also applied in the project's economic analysis:

(1) Conservatism Principle

The economic impact cannot be exactly measured becaused of the assumption of perfect competition. Therefore, the conservative and not optimistic assumptions and data were employed in this analysis.

(2) Economic Prices

The financial prices in the FIRR anaysis were applied as the economic prices.

1) Exclusion of Transfer Payment

The economic prices are to exclude transfer payment such as taxes and subsidies.

2) Opportunity Costs of Land and Unskilled Labour

The financial prices of non-tradable and non-competitive goods and services, if distorted, are to be converted to economic prices. For the present analysis, land and unskilled Labour costs were considered as the only non-tradable and non-competitive goods and services.

The average propotion 4.9% of “tax minus subsidy” on the gross domestic product (GDP) was employed as the conversion factor from the financial costs to the economic cost in the local costs as shown in Table 17-16.

Table 17-16 Gross Domestic Product (GDP) at the Current Market Prices (Crore Taka)

Sector/Sub-sector	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
1. Agriculture and Forestry	125,469	138,879	148,758	163,968	176,500	190,315	157,315
2. Fishing	28,482	31,827	36,995	42,308	47,581	53,076	40,045
3. Mining and Quarrying	14,208	16,650	19,461	21,080	23,876	28,578	20,642
4. Manufacturing	146,503	167,927	197,127	223,221	254,483	295,111	214,062
5. Electricity, Gas and Water Supply	11,589	14,189	16,381	18,401	19,868	23,829	17,376
6. Construction	57,072	68,304	82,432	90,834	108,484	126,353	88,913
7. Wholesale and Retail Trade	121,332	137,396	154,579	172,575	192,585	214,257	165,454
8. Hotel and Restaurants	8,228	9,755	11,263	13,035	14,928	17,058	12,378
9. Transport, Storage & Communication	94,571	112,702	124,281	134,317	150,025	169,145	130,840
10. Financial Intermediations	27,545	36,316	42,237	48,563	55,761	63,601	45,671
11. Real Estate, Renting and Business Activities	60,119	68,715	78,820	91,229	106,061	123,740	88,114
12. Public Administration and Defense	30,282	33,499	37,678	44,728	50,674	66,711	43,929
13. Education	21,392	25,048	28,429	32,767	37,624	46,512	31,962
14. Health and Social Works	17,731	20,133	23,868	26,924	30,135	34,758	25,592
15. Community, Social and Personal Services	104,608	117,293	138,952	156,552	176,402	194,248	148,009
Tax less subsidy	46,698	56,569	57,662	63,174	70,815	85,552	63,412
% of tax les subsidy	5.1%	5.4%	4.8%	4.7%	4.7%	4.9%	4.9%
GPD at current market price	915,829	1,055,202	1,198,923	1,343,676	1,515,802	1,732,844	1,293,713
Growth rate	1,483	1,522	1,362	1,207	1,281	1,432	1,381

Source: Bangladesh Economic Review 2016, originally from BBS

3) Target Economic Internal Rate of Return (EIRR)

The EIRR indicates the average rate of annual returns on the national economy by the proposed project. International financial institutions such as the World Bank and Asian Development Bank apply a 10% to 12% economic discount rate for infrastructure projects in developing countries.

The target EIRR was set at 12% in this analysis.

17.2.2 Economic Costs

The conversion factor was applied on the local portion of initial investments and the other financial costs were directly used as the economic costs.

17.2.3 Economic Benefits

(1) Economic Benefit Items

Table 17-17 shows the list of quantitative economic benefit items generated by the proposed project. The economic benefits by foreign passengers were not considered.

Table 17-17 Economic Benefit Items

	Existing Passengers	Incremental Passengers
Domestic flights	-	Consumer surplus
International flights	Time saving	Consumer surplus

Source: JICA Study Team

1) Share of Bangladesh and Foreign Passengers

The share of Bangladesh and foreign passengers was calculated based on data provided by CAAB as shown in Table 17-18.

Table 17-18 Share of Bangladesh and Foreign Passengers

	Bangladesh	Foreigner
Domestic	90%	10%
International	82%	18%

Source: JICA Study Team based on the interview survey to CAAB

(2) Economic Benefits

1) Domestic Flights

Benefits from Incremental Bangladesh Passengers

The net economic benefits from the incremental Bangladesh passengers on the domestic flights were estimated with consumer surplus.

Consumer Surplus

Passengers that choose to fly and are willing to pay for airfare benefit from their service in one way or another. Net economic benefits (difference between gross benefits and costs) of passengers are called 'consumer surplus'. Consumer Surplus of passengers is defined by the following formula and assumptions:

Net Economic Benefit (Consumer Surplus) of Passengers =
Gross Economic Benefit (Willingness to Pay Amount) – Economic Cost

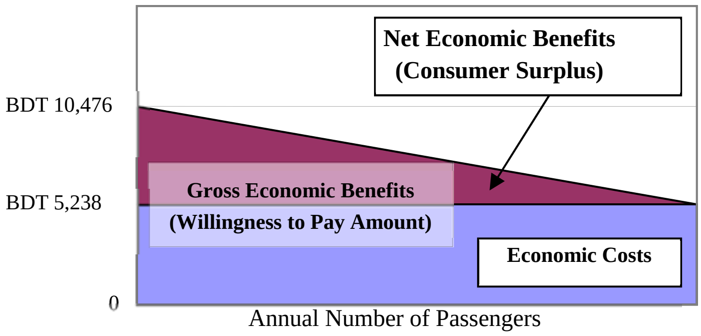
- Gross economic benefit or willingness to pay amount is defined by ticket prices (inclusive of PSF and insurance costs). It is assumed that the maximum gross benefit of passengers is equal to twice the ticket price while the minimum gross benefit is equal to the air ticket price.
- Economic costs are equal to the ticket prices paid by passengers.
- Gross economic benefit is distributed evenly among all passengers.

The total consumer surplus of Bangladesh passengers on domestic routes in a year, for instance, is exemplified by the area generated by the right triangle of the graph in Figure 17-2.The round-trip ticket price was assumed to be at BDT 5,238 for domestic flights, which is the weighted average round-trip ticket price of typical domestic routes. The ticket price of BDT 5,238 on the y-axis indicates economic cost and minimum gross economic benefit while

BDT 10,476 is equal to the maximum gross economic benefit of passengers. The x-axis indicates the number of Bangladesh passengers on domestic routes each year.

From the above explanation, the net economic benefits of total Bangladesh passengers (consumer surplus) on domestic flights in a year were calculated using the following equation:

Annual Net Economic Benefits of Total Bangladesh Passengers on Domestic Flights =
(BDT 10,476 – BDT 5,238) x annual number of Bangladesh passengers x 1/2



Source: JICA Study Team

Figure 17-2 Consumer Surplus as Net Economic Benefits of Bangladesh Passengers on Domestic Flights

2) International Flights

Benefits of Incremental Bangladesh Passengers

The net economic benefits of incremental Bangladesh passengers on international flights were estimated with consumer surplus.

The cost for roundtrip ticket, which was assumed to be at BDT 26,810, was expressed using the weighted average roundtrip ticket price of typical routes. The minimum gross benefit of passengers is equal to the air ticket price (BDT 26,810) and the maximum gross benefit is equal to double the amount of the ticket price.

Benefits of Existing Bangladesh Passengers

International passenger traffic will reach the capacity of international passenger terminal building in 2020. On the with project case, congestion will be eased and existing Bangladesh passengers on international flights will save time at the airport in comparison to the without project case.

The study estimated that passenger waiting time would be reduced by 50 minutes on average. Based on the assumption of annual income of Bangladesh passenger on international flight at BDT 1,000,000, the time cost saved per hour per person was estimated at BDT 473. Time cost saved is BDT 197 per existing Bangladesh passenger on international flights.

Table 17-19 Time Cost Saved at Airport for Each Existing Bangladesh Passenger

	Without	With	Saved Time
Departure	40	20	20
Arraival	65	35	30
Total			50
Saved Time Value=		473	**BDT/hour**

Source: JICA Study Team

3) Summary of Economic Benefit Amount

Table 17-20 below summarizes the project's economic benefits during the project period. The largest item is consumer surplus of incremental Bangladesh passengers on international flights, followed by Bangladesh passengers on domestic flights.

Table 17-20 Economic Benefits (2021-2045)

Confidential.

17.2.4 Economic Evaluation

(1) Economic Internal Rate of Return (EIRR)

The incremental economic cash flow is attached as Appendix. The EIRR was determined at 22.5%, above the target of 12%. Therefore, the proposed project is economically feasible.

17.3 Sensitivity Analysis

Table 17-21 below summarizes the results of the sensitivity test of the project FIRR and EIRR to key variables, i.e., investment cost and passenger traffic.

Table 17-21 Sensitivity Test

	Project FIRR (%)	Project EIRR (%)
Target Rate	1.983	12.000
0. Base	6.225	22.511
1. Investment Costs (+30%)	3.924	19.121
2. International Passengers (-30%)	5.077	19.347
3. Domestic Passengers (-30%)	6.215	22.297
4. Total Passengers (-30%)	5.067	19.132
5. Investment Costs (+30%) and Total Passengers (-30%)	2.938	16.255

Source: JICA Study Team

The FIRR and EIRR are higher than the respective target rates of 1.983% and 12.000% under all cases.

17.4 Conclusion

The project FIRR and EIRR were calculated at 6.2%, and 22.5%, respectively, achieving the respective targets of 1.983%, and 12.000%. The sensitivity analysis also showed higher FIRR and EIRR than the targets even on the case of +30% investment costs and -30% total passengers.

From the above discussion, it was concluded that the proposed project would bring sufficient net benefits to both HSIA and the Bangladeshi economy.

17.5 Operation and Effect Indicators

17.5.1 Quantitative Indicators

(1) Traffic volume

Passenger traffic is generally considered as both operation and effect indicators for airport development projects. Traffic movement, or the indicators, is summarized in Table 17-22. Target year of the quantitative indicators is 2023, two years after project completion.

Table 17-22 Quantitative Operation and Effect Indicators

	2015	2020	2021	2022	2023	2024	2025	2026
Passenger（Million Persons）								
International	5.569	8.669	9.305	9.930	0.594	11.296	12.042	12.765
Domestic	0.913	1.379	1.503	1.641	1.780	1.928	2.086	2.241
Total	6.482	10.047	10.808	11.571	12.373	13.224	14.127	15.006
Air Cargo （Metric ton)								
International	258,010	418,152	452,680	486,624	522,605	560,745	601,172	640,455
Domestic	1,888	3,447	4,510	4,922	5,339	5,783	6,257	7,842
Total	259,898	421,599	457,191	491,546	527,944	566,528	607,429	648,297
Aircraft movements (Number)								
International	37,192	56,289	58,156	62,066	6,210	70,603	75,260	76,901
Domestic	32,212	47,540	45,557	49,716	53,929	58,418	63,200	50,921
Total	69,404	103,830	103,713	111,781	120,139	129,021	138,460	127,821

Source: JICA STUDY TEAM

(2) The annual revenue of HSIA.

The annual revenue of CAAB, the airport administrator, is used as an effect indicator of the Project. Table 17-23 is the amount of annual revenue in HSIA after 2011.

Table 17-23 Annual revenue of HSIA

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17.5.2 Qualitative Effect Indicators

Qualitative effect indicators in 2023, two years after the completion of the Project, were considered in the following items:

(1) Upgrade of Service Levels

Currently, congestion was observed in the check-in lobby when conducting departure procedures. This results to longer waiting time.

Based on the demand forecast, due to the lack of capacity, congestion and waiting time at each facility are expected to increase. This will eventually result in the inability to maintain an acceptable standard in service levels by 2018 in the international passenger terminal building

After completion of this Project, congestion and waiting time will be reduced. Also, service level will be improved. Meanwhile, restaurants and retail shops will be expanded and service levels will be improved.

Reference indicators are shown in Table 17-24, as previously mentioned in Clause 7.2.4.

Table 17-24 Service Level Related Data

Item	Processing Time (sec./ Person)	Maximum Waiting Time (min.)
Departure Check-in	150	10
Embarkation control	20	5
Security	20	5
Arrival Immigration	50	5

Source: JICA Survey Team

Passage time should be measured based on the following conditions:

- The processing time per person at immigration departure and arrival areas and at check-in counters is measured from stand in a line to finish;
- In case of plural passengers such as a family or group, the processing time required for all members should be measured;
- Select appropriate time zones during peak hours and measure at least 10 samples; and
- In case of electricity failure at a counter, data should be excluded.

(2) Enhancement of Flight Network

Since the current terminal facility does not have enough space, the situation requires limitations to increase the number of flights particularly during peak hour. However, with the expansion of terminal facilities by the Project, the number of flights, in the time frames desired by the airlines, will be increased. Meanwhile, at the airport terminal building restrictions are enforced limiting promotion to new airlines, because office airline spaces cannot be secured.

Therefore, after the expansion of the passenger terminal building is carried out, it is assumed that existing and new routes will be expanded and convenience will be improved.

Through the recently signed open sky agreement among members of ASEAN and west Asian countries, increased flexibility in route expansion is now possible and route expansion between member of countries is expected. Furthermore, it is expected that the entry of additional airlines on the same routes will increase competition and result in reduction in airfare and the strengthening of competitiveness.

Reference indicators of flight route and number per day are shown in Table 17-25

Table 17-25 Enhancement of Flight Network

destination	Departure	Arrival	Flights	Airlines
(AUH) Abu Dhabi	3	2	5	Etihad Airways
(BKK) Bangkok	3	3	6	Biman Bangladesh Airlines, Thai Airways, Bangkok Airways
(BOM) Mumbai	1	1	2	Jet Airways
(CAN) Guangzhou	1	1	2	China Southern Airlines
(CCU) Kolkata	5	6	1	Biman Bangladesh Airlines, Regent Airways, Etihad Airways, Air India
(CMB) Colombo	2	2	4	*Mihin Lanka*
(DEL) Delhi	1	1	2	Etihad Airways
(DMM) Dammam	2	1	3	Saudi Arabian Airlines
(DOH) Doha	3	3	6	Qatar Airways
(DXB) Dubai	6	6	12	Emirates, *flydubai*
(HKG) Hong Kong	2	2	4	Hong Kong Airlines
(HAN) Hanoi	1	1	2	Cathay Pacific
(IST) Istanbul	2	1	3	Turkish Airlines
(JED) Jeddah	2	2	4	Biman Bangladesh Airlines
(KHI) Karachi	1	1	2	Pakistan International Airlines
(KMG) Kunming	1	1	2	China Eastern Airlines
(KTM) Kathmandu	2	2	4	Biman Bangladesh Airlines, Dragonair
(KUL) Kuala Lumpur	8	8	6	Malaysia Airlines, Biman Bangladesh Airlines, Regent Airways, *Malindo Air, Air Asia*
(KWI) Kuwait	2	2	4	Kuwait Airways, Biman Bangladesh Airlines
(LHR) London	1	0	1	Biman Bangladesh Airlines

destination	Departure	Arrival	Flights	Airlines
(MAA) Chennai	1	1	2	Maldivian
(MCT) Muscat	2	2	4	Oman Air, Biman Bangladesh Airlines
(PBH) Paro	1	1	2	Royal Bhutan Airlines
(PKR) Pokhara	1	1	2	Biman Bangladesh Airlines
(RGN) Yangon	1	1	2	Biman Bangladesh Airlines
(RKT) Ras al-Khaimah	1	1	2	*Air Arabia*
(RUH) Riyadh	3	2	5	Biman Bangladesh Airlines, Saudi Arabian Airlines
(SHJ) Sharjah	3	3	6	*Air Arabia*
(WUH) Wuhan	1	1	2	Uni-Top Airlines
(SIN) Singapore	5	4	9	Biman Bangladesh Airlines, Regent Airways, Singapore Airlines, *Tigerair*
Total	69	65	134	

Note : Italic character is LCC

Source: JICA Study Team（based on the flight Schedule of Apr.27, 2016 ～ May 3, 2016 & Passenger data of Biman Airline）

CHAPTER 18 POINTS TO CONSIDER FOR PROJECT IMPLEMENTATION

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Chapter 18 POINTS TO BE CONSIDERED FOR PROJECT IMPLEMENTATION

In the case when the project is implemented under Japan's ODA loan, the points to be considered which may directly affect the smooth implementation of the project are discussed below.

18.1 Procurement Situation of Equivalent Project in Bangladesh

18.1.1 Construction Bidding and General Circumstances of Equivalent Projects

In Bangladesh, public constructions are implemented under the authorization of the Ministry of Housing and Public Works. For the bidding and selection of contractors, the contractor shall be selected under Minsitry Guidelines, which are based on World Bank guidelines, following procedures in "National Competitive Bidding Procedure".

18.1.2 General Conditions of Local Consultants (Detailed Design and Construction Supervision)

There are full service consultants in Bangladesh similar to Japanese consultants, who can provide the full range of services for design, structure, mechanical systems, electrical systems and cost estimation, but their numbers are extremely limited. Most consulting firms practice a single discipline (e.g. architecture, structure, etc.). These individual firms specializing in design, structure, building systems and cost estimation collaborate to complete large projects. In case of special projects, which require specialized technology or expertise that is not available from local consultants, foreign consultants will be required. It is expected that in projects requiring high levels of design expertise and construction supervision experience, foreign firms will form consortiums with local consultants, taking the lead in project management and incorporation of various technologies.
As a note of interest, the number of listed/registered architects is roughly 3000 (October, 2016) according to IAB (Institute of Architects, Bangladesh) records, and the number of listed/registered engineers is roughly over 50,000 according to IEB (Institute of Engineers, Bangladesh).

18.1.3 General Conditions of Local Contractors

BACI (Bangladesh Association of Construction Industry) and REHAB (Real Estate & Housing Association of Bangladesh) are the premier construction associations for construction firms in Bangladesh.

According to the annual report 2015-2016 of BACI, there is no consolidated list of listed contractors in the construction sector in Bangladesh and are listed separately by each tendering govrnment agency. Examples are Bangladesh Thikadar Shomiti (meaning Bangladesh construction contractor's association), PWD (Public Works Department), LGED (Local Government Engineering Department), RHD (Roads and Highways Department), Water Development Board and other such bodies under different categories (i.e. A, B, C/ 1st class, 2nd class and so on). This system is employed due to tendering of contractors being under the control of IMED (Implementation Monitoring Evaluation Department) under the Bangladesh Planning Commission.

There are approximately 45,000 contractors in the entire country, 700 listed by RHD, 1200 listed by LGED, over 1000 listed by REHAB, 600 listed by WDB and 80 listed by BACI. It is believed that some overlap in listing occurs.

It is deemed that these companies are able to conduct primary works for building and civil construction. However, they will encounter some difficulty in conducting specific works at especially high technical levels, such as ODA Project, some kinds of interior finishing, precise electrical-mechanical works, and other specialist works, as evidenced by the established businesses by foreign engineers and companies in Bangladesh.

18.2 Tender Documents

The Japan International Cooperation Agency (JICA) imposes on the borrowers of Japanese ODA loans that contract documents have to be drawn up in accordance with the Standard Bidding Documents under Japan's ODA Loans Procurement of Works issued by JICA in 2009. These documents are based on the Red Book, MDB version, issued by the International Federation of Consulting Engineers (FIDIC) for project construction. The basic premise for the smooth implementation of Japan's ODA loans is that both the client and the contractor should fairly bear the risk of the project. This basic premise should also be applied to the Dhaka International Airport Expansion Project.

18.3 Selection of the Consultant

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18.4 Selection of the Contractor

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18.5 Considerations for Project Implementation

18.5.1 Consultant Services

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The project components are as follows:

Table 18-1 Project Component (Phase - 1)

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Points to consider for review of the design and construction supervision are as follows:

Table 18-2 Points to Consider

Category	Item	Points to Consider
Review of the design	Building work	· Study of screwed steel pile · Verification of earthquake- resistance · Confirmation of floor plan in T3 and VVIP · Floor layout for cargo complex based on handling system and facilities
	Civil work	· Re-study of pavement thickness for landside and airside area · Design of underpground pedestrian corridor besed on the coordination with MRT projects · Soil improvement · Connection with DEE structure (Longitudinal slope, Transition, sight distance etc.)
	Electrical-Mechanical work	· Handling system in cargo complex
Tender Assistance		· Change of General Conditions of Contract · PQ criteria inclusive in tender
Construction Supervision		· Environment monitoring
Environment		· Demolition and shifting of existing structure · Mitigation plan

Source: JICA Study Team

18.5.2 Measures for Construction Safety

In Japan's ODA loan, construction close to public facilities is designated as an item requiring the attention to safety measures throughout the construction work period. This project is a construction project under airport operation and there must not be any disruption to the smooth airport operations or any damage to a third parties. In order to ensure safety in the construction, the following responses are necessary:

- The selection of the Consultant, including supervision, quality-based selection method (QBS) will be adopted in accordance with the Consultant Procurement Guideline, 2012.4, Section 3.02
- In event of serious accidents such as fatalities, accident with severe injuries, or collapse of the structure under construction, the implementing agency shall immediately report necessary information to JICA.
- The following three items shall be included in the terms of reference (TOR) of the contractor:
  - Describe clearly the requirements of measures for safety during construction on the contract with reference to laws and standards in Bangladesh and international guidelines.
  - The bidder shall be required to submit a Construction Safety Plan that complies with the above requirements in the tender bid document.
  - The bidder shall name a person to be in charge of safety measures in the tender bid document.
- The following three items shall be included in the TOR of the consultant:
  - Confirm the contents of the above and conduct tender document and review.
  - Review the Construction Safety Plan submitted by the bidders.
  - During construction, monitor the construction in accordance with the safety requirements specified in the contract and ensure that arrangement of safety personnel is being carried out. If any issues are identified, the contractor will be requested to improve the measures for safety.

18.5.3 Safety Measures in Security such as Terrorism

The terrorist incident involving private citizens that occurred in July 2016 has gravely shocked the foreign community working in Bangladesh. In view of the dangerous situation, the following safety measures will be required to be enforced on the services by the consultant and the contractor:

- Safety measures of the office
  - Arrangement of safety guard (Armed Police and /or Answar)
  - Enforcement of security checks at entry/exit to consultant/contractor offices
  - Installation of close circuit television (CCTV) in the office entrance
  - Alarm in case of emergency
  - Preparation for place of refuge shelter in the office
- Commuting vehicle
  - Attaching a dark film to vehicle windows to prevent view of interior.
  - Provision of police guard for commuting
- House
  - Lodgings in a safe district
- Safety expert
  - Conduction of safety training by the safety expert
  - Collection of information on dangerous activities by information exchange with the police, military officer, and the embassy

18.5.4 Coordination with Airport Operator

Since the project includes expansion of an existing facility under the continuous operation of the airport facilities, close coordination with airport operators should be conducted during the detailed design and construction stages. Therefore, the following items should be described in the consultant's TOR:

- To hold a meeting and coordinate with the airport operator in order to obtain the information needed to reflect the airport operator's requirements in the design.

- To coordinate with terminal users, the airlines and tenants, if necessary for the design process.
- To conduct regular monthly and weekly meetings with the contractor and airport operator to confirm each other's work plans, requests, problems, etc.
- To supervise the implementation of measures during construction and ensure the safety of airport users.

To provide information regarding the construction project in order prevent reduction in level of service for airport users, insofar as possible, during construction.

18.5.5 Measures against HIV

It is necessary to include the following items in the tender document since the project scale is quite big (Confidential., with peak number of construction workers on site over 500 and construction period of more than 37 months). In addition, the contractor shall implement countermeasures against HIV/AIDS for construction workers as well as local residents during the construction phase.

According to the World Bank, 2015, HIV is less than 1% of general population. According to NASP/GOB (National Agency of State Property) HIV/AIDS is less than 0.1% of general population and less than 1% of Sex Workers, and more than 1% in IDUs (Injection Drug User), although going as high as 11% in some hot spots.

An important point to be considered is in taking measures against HIV is the "Adult Prevalence Rate". The Adult Prevalence Rate gives an estimate of the percentage of adults (aged 15-49) living with HIV/AIDS. It is calculated by dividing the estimated number of adults living with HIV/AIDS at year end by the total adult population at year end. Change of the adult prevalence rate is as shown in Table 18-3.

Table 18-3 Change of HIV/AIDS Adults Prevalence Rate

(%)

Country	1999	2001	2009	2012
Bangladesh	0.02	0.1	0.1	0.1

Source: UNAID, 2015/ CIA World Fact Book

Based on the current activities and the sources of data, modelling exercises of the future of the HIV epidemic in Dhaka suggest that, if interventions are not enhanced further, Bangladesh is likely to start with an IDU-driven epidemic, similar to other neighboring countries, which will then move to other population groups, including sex workers, males who have sex with males, clients of sex workers, and ultimately their families according to a health publication.("HIV and AIDS in Bangladesh" by Tasnim Azim and others, September, 2008).

On site mitigation measures on this matter should include carrying out a course on basic healthcare especially on transmittable diseases for the construction workers, which shall be included in the environmental management and monitoring plan (EMMP). Accordingly, the contractor shall implement preventive measures based on the EMMP.

18.5.6 Demolition and Shifting of Existing Structure around Terminal 3 Area

In the Terminal 3 construction area, there are some properties such as Central Engineering Maintenance and Store Unit of CAAB (CEMS), Armed Police Camp, Flying Club Complex, Bengal Group Building and Civil Aviation Training Center (CATC). It is necessary to obtain the agreement of the owners of these properties on the relocation of their properties outside the project area.

Of these, in the occupation area of the Bengal group, CAAB required eviction due to the expiration of lease contract for 30 years in 2012. But CAAB filed a suit because it was not taken. The trial is held in February and March, and judgment of the High Court is planned in April.

18.5.7 Building Permit

The application method for building permit is prescribed in the city development law.

The BNBC code does not permit any building or structure to be erected, constructed, enlarged, altered, repaired, moved, improved, removed, converted or demolished (with some exceptions e.g. opening/closing up a window or a door or a ventilator; providing internal doors, providing partitions, false ceiling, painting gardening and the like) without obtaining permit for each such work from the Building official.

(1) Types of Permissions

Relevant data concerning Building permissions are given in the table below

Table 18-4 Types of permissions and validity from the date of issuance

	Stages	**Validity of permissions from the date of issuance (months)**
a	Land use certificate	24
b	Large and special project permits	24
c	Building permit	36 (unless construction up to plinth level is done)
d	Occupancy certificate	Perpetual (unless any change in use and physical properties)

Source: Dhaka Mohanagar Imarat Nirman Bidhimala (meaning: Dhaka City Construction Guideline), 2008, GoB

Permissions for all or any of the above may be necessary for a particular area/city/town/municipality. Requirements in this regards shall be incorporated in the building construction by laws/ rules/ regulations valid for that particular area/city/town/municipality.

Generally speaking, for different types of buildings such as low rise, high rise or special types, the following permits are required according to the guidelines.

- ✈ Low rise (up to 10 stories or roof level up to 33 m)
- ✈ High rise (more than 10 storied or roof level more than 33m)
- ✈ Project is Special when:
    a. Residential unit more than 40 no.s
    b. FAR (Floor Area) of more than 7500 sqm.

c. Shopping Complex of more than FAR 5000 sqm.
d. Plot adjacent to national highway
e. Brick manufacturing industries, other industries which are hazardous or tend to pollute the environment
f. Plot within 250m of heritage site, natural lake, river and forest
g. Plot within 250m of distance from naturally aesthetically beautiful site
h. Plot within 50m of cliffs, mountains or hilly area
i. Plot within 250m of any river bank

- Permits from other agencies*:

The owner shall obtain permit as may be applicable from other concerned agencies relating to building, zoning, grades, sewers, water mains, plumbing, signs, blasting, street occupancy, gas, electricity, highways and all other permits required in connection with the proposed work.

However, particularly large projects like the airport are excluded from the approval process, and the responsibility is taken by CAAB, who is supposed to apply for a permit to the MOCAT or Ministry of Housing and Public works. Since the procedure is rather unclear, it is necessary to confirm the correct procedure with the authorities.

18.5.8 Evasion of Military Use

As a fundamental principle of Japan's ODA, the avoidance of "military usage and facilitation of international disputes" are stipulated as general rules of aid implementation by the Japanese government.

- Are of HSIA is organeized by the military and civil aviation. Military control area, which is located in the west side from the runway, is shown in

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- Table 18-5. As indicated in the figure, the project area shall not include the military control area.
- Passenger terminal buildings, cargo complex, and car parks are used for civil aviation and private passengers. Rapid exit taxiway is not assumed to be operated or utilized by military aircrafts from the positional relationships of the

parking apron of military aircrafts and rapid exit taxiway. There are several airplanes such as fighter, carrier and rotor blade airplane in the military in the west of runway. The military aircraft movements were approximately 72,000 times of the total annual movements and frequency of use of runway was around 7% of the whole; it was confirmed that this ratio will not changed in the future.

The frequency of runway operation for civil aviation is more than 90% of all operations and it is recognized that the facilities in the HSIA are applied for civil aviation.

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Table 18-5 Military Area

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