CHAPTER 5 DESIGN CONCEPTION FOR HHTP DEVELOPMENT

5.1 LAND USE PLAN AND STRATEGY FOR THE HHTP DEVELOPMENT

5.1.1 Strategy for the HHTP Development

The following strategy and policy have been adopted for the Land Use and Infrastructure Development Plan based on results of an evaluation of the current condition of the HHTP development.

a) Development of the HHTP is based on the VN Revised M/P, which has been endorsed by the Prime Minister. Therefore, this JICA Feasibility Study (the Study) follows the basic concept and vision proposed in the VN Revised M/P.
b) The following strategies for remedying the land use and infrastructure development plan are proposed in order to cope with the problems and constraints:
   i) The approved land use plan will be supplemented based on the internal construction regulations to protect the landscape, natural condition of the site, ensure protection from natural disasters such as floods, and minimize construction work, thereby accelerating the development of the Project.
   ii) Coordination and adjustment shall be harmonized within the overall development plan of the HHTP and each detailed plan prepared by individual developers.
   iii) Infrastructure plans will consider the existing infrastructure and also easy operation and maintenance.
   iv) For flood protection measures, the provision of a retention pond in each development zone and options for downstream flood protection measures will be proposed to HHTP-MB and developers.
   v) The detailed land use plan and population (nighttime and daytime) to be used as the standard for formulation of the internal infrastructure plan shall be re-examined and, where required, adjustments will be proposed.
   vi) It is strongly recommended that HHTP-MB enhances its capacity and function, especially the PMU, in order to formulate the implementation plan of the HHTP smoothly and effectively, including the design of infrastructure under the assistance of international organizations. In addition, it is recommended that HHTP-MB concentrates on mobilizing the PMU and the working group consisting of MPI, MOC, MOT, MONRE, etc. for the Study.

5.1.2 Constraints on Execution of the Land Use Plan

The main problems and restrictions on execution of land use plan are as follows.

- Since investment certification is issued for individual applications, as development progresses, more land which cannot be used will be created. As a result, land is not utilized efficiently and some land cannot be developed. If disorderly development licensing is continued, it is expected that effective use of land will become difficult. Therefore, the use of lots which have not yet been developed needs to be strictly controlled.
- The detailed plan of each zone has to follow the HHTP land use plan. Consistency with the HHTP land use plan is necessary when detailed plans are prepared and implemented.

5.1.3 Proposed Land Use Plan

The land use plan has been prepared based on the following concepts.

- The land use plan in the VN Revised M/P is applied as a base upon which the land use classification and layout is adopted.

- The proposed land use plan covers 1,036ha in Hoa Lac area, and a part of the industrial zone is excluded.
- The idea for detailed plans prepared by developers should refer in the HHTP land use plan.
- The infrastructure development plan proposed in the Study is integrated with the land use plan, particularly for the calculation of areas.

The basic concept of the land use plan mentioned in the VN Revised M/P is summarized below.

- Considering market needs, ease of sales and traffic safety, the High-Tech Industrial Zone will be located in the site with the best access to the LHLE.
- Considering convenience and better accessibility by users, the Center of the High-Tech City and the Mixed Use Zone will be located in the center of the HHTP.
- To strengthen the linkage between the Research and Development and high-tech industries, the Research and Development Zone will be located adjacent to both the High-Tech Industrial Zone and the Software Park. In addition, to popularize science and technology, the location of the Research and Development zone will need to be close to the Center of the High-Tech City.
- To maximize the function and performance of the common infrastructure and facilities, the zones with similar characteristics must be located close together. For example, the Software Park and the Education and Training Zone, which both require information technology facilities.

The Proposed land use plan for the Study Area is shown in Figure 5.1.1 and the allocated areas are summarized in Table 5.1.1.

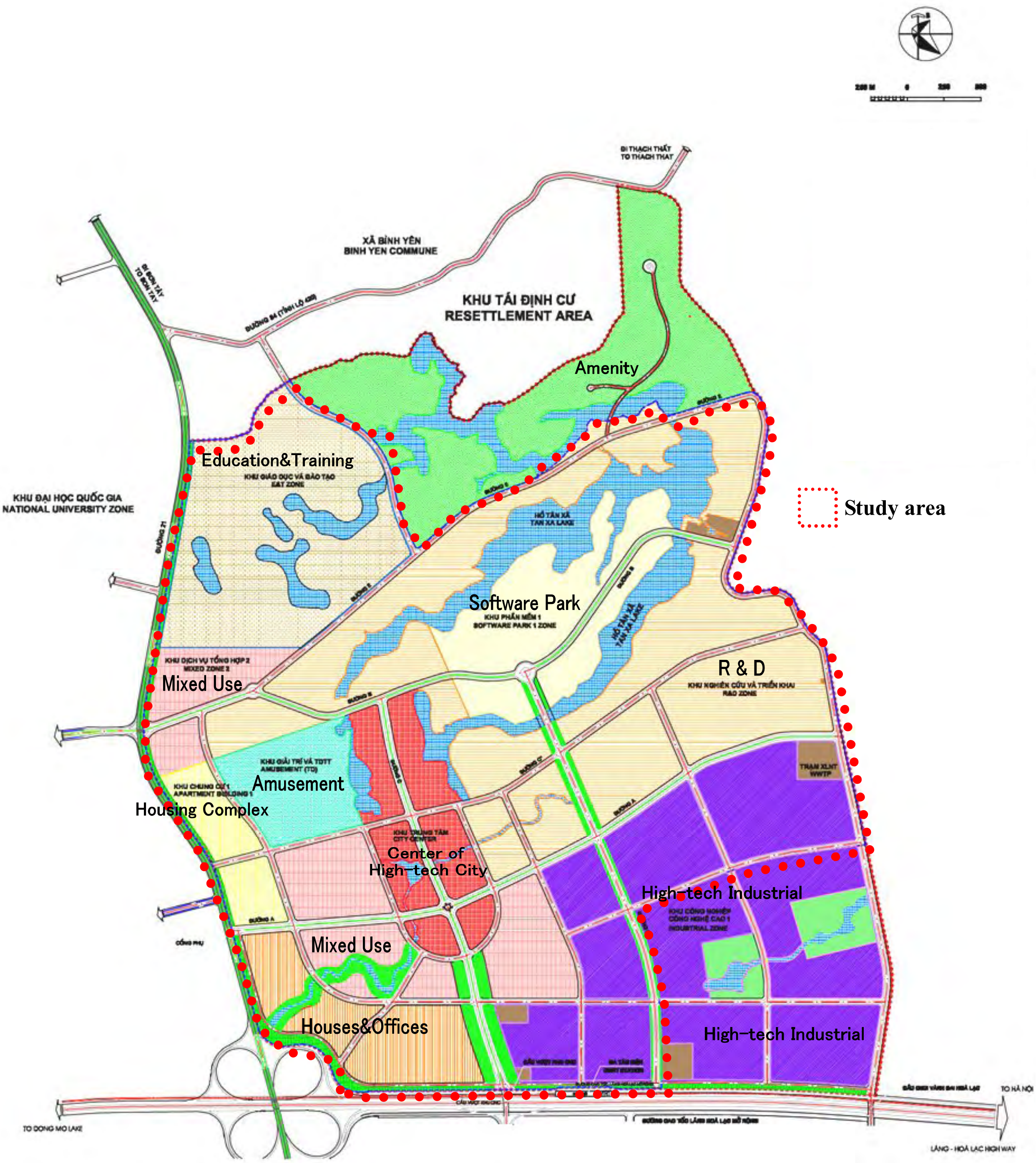
The arrangement of the land use plan has not changed. However, re-examination of the width of roads was carried out in the road plan. In the VN Revised M/P, roads within the High-tech Industrial Zone were included in the area of this zone. Since the zone areas defined for the HHTP exclude the road part, the area listed for the High-tech Industrial Zone has been decreased. For this reason, the infrastructure area increases and the area of each development zone decreases.

The zone layout was prepared by considering the sequence of construction and accessibility between the related zones, differences in user levels, and safety. Moreover, to make it easier to create synergy between the zone functions, zones with functions that will have similar characteristics have been located close together.

Table 5.1.1 Proposed Land Use and Predicted Population (Hoa Lac Area)

Land Use		Study Area (ha)	Area (ha) Total	Population Projection (persons)		Classification of Population	
				Total	Density (p/ha)	Daytime Population	Nighttime Population
1	Software park	64.4	64.4	12,880	200.0	12,880	0
2	R&D	227.9	227.9	13,674	60.0	13,674	0
3	High-tech Industrial	114.7	231.6	23,160	100.0	23,160	0
4	Education & Training	108.0	108.0	43,200	400.0	25,920	17,280
5	Center of high-tech City	49.0	49.0	12,250	250.0	7,350	4,900
6	Mixed Use	84.5	84.5	12,675	150.0	5,070	7,605
7	Houses & Offices	41.9	41.9	34,149	815.0	0	34,149
8	Housing Complex	22.6	22.6	34,691	1,535.0	0	34,691
9	Amenity	0.0	110.0	220	2.0	220	0
10	Amusement	33.2	33.2	1,660	50.0	1,660	0
11	Traffic & Infrastructure	146.6	147.1	0	0	0	0
12	Lake & Buffer	112.4	117.0	0	0	0	0
13	Greeneries/Trees	30.8	30.8	0	0	0	0
Sub-total		1,036.0	1,268.0	188,559		89,934	98,625

Note: The Study Area excludes the Amenity Zone and a part of High-tech Industrial Zone from the Hoa Lac Area
Source: JICA Study Team



Source: JICA Study Team

Figure 5.1.1 Proposed Land Use Plan

5.2 LAND RECLAMATION AND LANDSCAPE PLAN

5.2.1 Land Reclamation Plan

(1) Plan Concept and Design Criteria

HHTP covers an extensive area exceeding 1,000ha and a substantial proportion of the area is lower than the required ground level. For this reason, land reclamation will be necessary. This will be done by cut and fill work, and by importing a large volume of soil. However, in order to reduce the cost, the volume of imported soil should be minimized. In addition, it will also be necessary to establish the existing ground level with consideration for safety aspects, such as the prevention of flooding during heavy rain, and so on. VN Revised M/P established the ground level that is required so that the land surface remains above the height of a 100 year return period flood event. The design ground level that was established is shown in Table 5.2.1.

Table 5.2.1 Design Ground Level

	Ground Level
Ground level of R&D, Education & Training, and High-Tech Industrial Zones	≧MSL+11.0m
Ground level of Other Zones	≧MSL+10.0m
Ground level of Roads	≧MSL+10.0m

Source: VN Revised M/P

The height of the reclamation established by the Study is as follows:

- The ground level established by VN Revised M/P will be satisfied.
- The ground level of the R&D, Education & Training, and High-Tech Industrial Zones will be made higher than MSL+11.0m.
- Soil preparation (cut and fill) will the primary means of reclamation.
- The ground level of other zones will be at, or higher than, the road height.
- The land surface slope will be established by considering drainage to the roads.
- Each tenant will prepare the land accordingly for each ground area and building.
- Soil fill will be acquired from the neighborhood of the HHTP.

(2) Evaluation of Soil

Three quarters of HHTP site is made up of low hills, with the ground level varying from 2.30m to 20.0m ASL. The slope angle of the topography is about 5 - 15 degrees. In general, the topography is not even or flat. Therefore, it should be leveled before executing HHTP development work.

The ground water level that was determined from twenty one (21) soil quality testing boreholes varied from 0.50m to 5.0m. In the rainy season, the water level could rise and cause problems, such as water flows to excavation areas. The sub-surface soil condition is very complex, with twelve (12) distinct layers being observed.

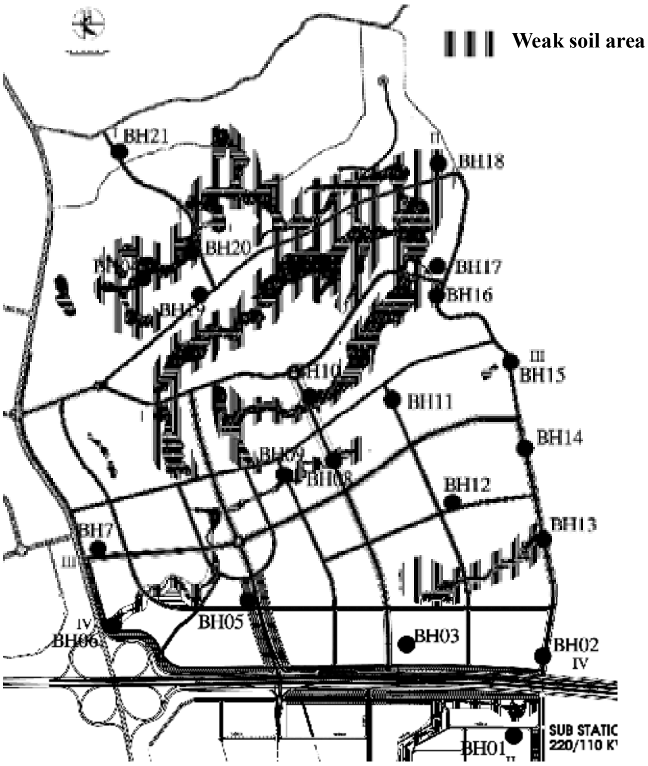
A study of the results obtains from technical investigations carried out for the 21 soil quality testing boreholes has allowed the JICA Study Team make some conclusions and formulate recommendations, as described in the supporting report.

The depth of the base material for each of the 21 soil quality testing boreholes is shown in Table 5.2.2. The location of these 21 boreholes is shown in Figure 5.2.1. And, weak soil is spread around the lake, as shown in Figure 5.2.1.

Table 5.2.2 Depth of Base Material for the Soil Quality Testing Boreholes

Boreholes	Layers	Distributed depth		Thickness(m) with SPT>30
		Top (m)	Bottom (m)	
BH1	6	8.5	10.0	1.5
	8	10.0	18.0	8.0
	11	18.0	20.0	2.0
BH2	11	24.7	30.0	5.3
BH3	8	14.0	20.0	6.0
BH4	6	10.0	12.0	2.0
	11	12.0	20.0	8.0
BH5	6	34.0	39.0	5.0
BH6	6	9.8	19.0	9.2
	9	19.0	30.0	11.0
BH7	8	9.0	15.0	6.0
BH8	11	42.0	45.0	3.0
BH9	8	9.0	15.0	6.0
BH10	8	8.0	20.0	12.0
BH11	8	4.4	15.0	10.6
BH12	8	4.0	15.0	11.0
BH13	8	14.7	25.0	10.3
BH14	9	25.0	28.0	3.0
	11	28.0	30.0	2.0
BH15	11	34.0	35.0	1.0
BH16	8	13.8	20.0	6.2
BH17	8	12.7	20.0	7.3
BH18	9	19.8	25.0	5.2
BH19	8	11.7	20.0	8.3
BH20	8	9.5	20.0	10.5
BH21	6	10.5	20.0	9.5

Source: JICA Geological Survey Report



Source: JICA Geological Survey Report

Figure 5.2.1 Location of the Testing Boreholes

(3) Ground Level

It is assumed that land within the HHTP site will generally need to be filled to a height that is above the 100-year return period flood level, as established by VN Revised M/P. In addition, each building site will need to be higher than the height of the road, considering the present land height and the height of the water surface. Within HHTP area, the primary land reclamation will generally be prepared with a gentle slope, considering the need for drainage to storm water pipes that will be installed at the side of roads. However, each development tenant which prepares the individual building sites will need to finish the leveling work according to the location and function of the site.

The estimated volume of soil that is required to be moved during cut and fill work done for primary land reclamation in HHTP, is summarized in Table 5.2.3. The total volume of soil that will need to be moved is 28,000,000m^3. This is a cut and fill of 2.2m on average for the Study Area. Compared with a flat area, it increases for configuration with a hill and a depressed ground.

The currently estimated volume of soil required for reclamation is a slightly larger than the volume given in VN Revised M/P. The following factors contribute to differences between the estimates for the soil volume required for land reclamation given in VN Revised M/P and the Study:

- Since a topographical survey was carried out for the Study, the estimate has a relatively high accuracy.
- Farmland, etc. occurs in the HHTP area. It is thought that the surface soil in these agricultural areas will be structurally poor. For this reason, the top 300mm of the surface soil will need to be disposed.

- Over time, the soil in the site may settle. Therefore, the soil which will be required to compensate for this settlement is assumed.
- A gentle slope was prepared in consideration of the drainage of the site.

Table 5.2.3 Total Cut and Fill Volume (1,000m^3)

		Filling	Excavation	Sub-Total	Disposal	Supplement	Total
Site total (excluding roads)		18,010	3,117	21,127	2,246	2,246	25,619
	Research & Development	8,125	200	8,325	662	662	9,649
	Education & Training	990	611	1,601	258	258	2,117
	Center of High- tech City	916	150	1,066	119	119	1,304
	Sub-total	10,031	961	10,992	1,039	1,039	13,070
	Other zones	7,979	2,156	10,135	1,207	1,207	12,549
Roads		1,745	574	2,319	126	-	2,445
Grand Total		19,755	3,691	23,446	2,372	2,246	28,064

Note: All the high-tech industrial zones are included in other zones. A supplement is necessary when it settles.
Source: JICA Study Team

(4) Acquisition of Soil Fill

The required volume of soil fill has been increased in the Study reclamation plan. Therefore, to reduce material handling time and cost, it will be necessary to obtain the additional soil from the neighborhood of the HHTP development area as much as possible.

It is expected that the location of the soil extracting will be within 10km of HHTP. These positions are also utilized and the volume of soil is obtained. HHTP-MB needs to make a contract for acquisition of soil.

Farmland occurs within HHTP and the surface soil soft in comparison to non-farming land. Therefore, the soil which is unsuitable for use as filling should be removed. Part of this soil will be used for the scenery (greeneries, hill etc.) in HHTP. The remainder will need to be disposed of off-site. HHTP-MB needs to prepare a site where the unsuitable soil can be disposed.

5.2.2 Landscape Plan

(1) Plan Concept

HHTP has many natural features, particularly near Tan Xa Lake. When developing HHTP, it will be necessary to utilize these natural features to create an attractive working and living environment. For this reason, guidelines have been provided for the landscape design in HHTP.

Currently, guidelines for landscaping have been prepared by HHTP-MB. In order to ensure that future construction is compatible with the land use plan and the goals of HHTP, landscape unity is required. Based on HHTP-MB's proposed regulations (Draft Management Regulations for Construction and Planning of Landscape Architecture for Hoa Lac High-tech Park), main policy of the plan to ensure landscape unity is as follows:

- The scope of the regulations should be based on the zone categorization described in VN Revised M/P. As mentioned therein, programming for the total land use of premises, organization, town planning and landscaping should be required.
- General regulations on requirements for town planning framework should set forth guarantees for the planning contents of technical infrastructure systems within the programmed area, including landscaping.
- Specific rules should be provided for each categorized zone, comprising guidelines for land use, spatial design, landscape requirements, architectural design, and construction activities within the programmed zones.

In order to standardize the landscape in HHTP, guidelines will be provided in the form of building regulations. The building regulations (draft) have been prepared by HHTP-MB. The height of buildings, required setback distance from roads, etc. are defined in this proposed building regulation according to the function of each zone. In addition, regulations for maintenance of green tracts of land, and water areas such as lakes and rivers; and specification of building type, color, tone and exterior appearance, are established. This standard was verified in the JICA Study team. Guiding by this standard is appropriate.

By following proposed building regulations, the landscape throughout HHTP will convey a feeling of unification. However, to ensure that the proposed regulation is followed correctly, it will be necessary to guide the developer when HHTP-MB issues investment certification

The main items regulated are shown below. For details, refer to a "Management regulations on construction and planning for landscape architecture of Hoa Lac High-tech Park".

- Land Utilization and Plot size
- Construction limit, set-back space and works height
- Construction density
- Architecture shape and color
- Requirements on green space, external decoration and non- construction space
- Other requirements

(2) Landscape Plan

1) Building Restrictions

The volume and the height of buildings should be controlled, and formation of the urban environment should be promoted. It conforms also to the building codes of Vietnam (Decision No. 682/BXD-CSXD, 1996).

A building restricts height, the distance of the setback from a road, etc. depending on the function of a zone. The building restrictions by zone which arranged the proposed regulation are shown in Table 5.2.4.

Table 5.2.4 Proposed Building Restrictions by Zone

Land Use	Max. Floors	Construction Ratio (%)*3	Max Use Coefficient	Setback from Road (m)*1			
				2-floor	3-floor	5-floor	6-floor
Software Park	5	30	1.5		5-7	10-12	20*2
R&D	5	30	1.5		5-7	10-14	
High-tech Industrial	5	60	3.0		5-7	10-14	
Education & Training	10	30	3.0		5-50	10-50	20-50
Center of High-tech City	30	50	15.0		5-7	10-14	20
Mixed Use	20	50	10.0		5-7	7-10	14-15
Houses & Offices	15	45	6.8		5-7	7-10	14-15
Housing Complex	15	55	8.3		5-50	10-50	14-50
Amenity	2	3	0.1	5	10		
Amusement	3	5	0.2	5	10		
Greenery, Lake and Buffer				Water areas are not affected.			

Note:
*1 The setback distance is based on the front width-of-road.
*2 In the Software Park Zone, 5 floors is the maximum. However, if the standard is satisfied in part at a place, it may be possible to build more floors in special cases.
*3 The construction ratio limit may be eased where construction occurs adjacent to shoreline areas because the land is affected by the shoreline protection zone.
Source: JICA Study Team, based on the draft from HHTP-MB.

2) Green Buffer Zone

Green tracts of land will be provided along roads, rivers, and adjacent to lakes within the HHTP. In addition, green tracts of land will be provided beside external roads and highways adjoining the HHTP. These green tracts of land will have the following functions:

- Residential areas will be separated by a green belt, allowing coexistence and co-prosperity between residents and industry, as well as ensuring that the environment is full of grace and vitality.
- The rich green areas will cleanse the air, soften noise, and provide a visual screen. In addition, the green areas will provide a measure of safety for people in the area by shielding them from industrial disasters to some extent. In times of emergency, the green areas will also be used as a refuge place.
- Green areas will give grace to the HHTP and will improve the townscape, as well as providing a place of peacefulness and relaxation for workers.
- Larger green areas will be provide sport and recreation opportunities for residents and factory employees. In addition, the green areas will help produce a healthy community in the area, leading to improved productivity in companies.

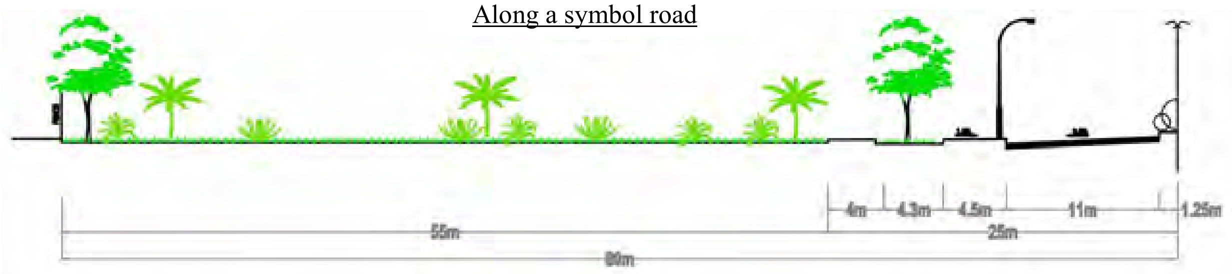


Figure 5.2.2 Typical Green Buffer

3) Tan Xa Lake and Shoreline Protection

Many shoreline areas, including those adjacent to lakes and rivers, exist within the HHTP. In particular, the Tan Xa Lake is located in the central part of the HHTP, and this is a symbolic shoreline area, which creates rich employment environment. For this reason, it is necessary to protect the environment of shoreline areas as much as possible, and to utilize these areas as places for recreation and relaxation, and for landscape to fit the HHTP development concept.

The shoreline environment and landscape will be promoted by adopting the following policy:

- The existing shoreline of the Tan Xa Lake will be retained as much as possible. Shore protection works will be needed for protection of these areas, particularly where they are near to buildings within the HHTP site. Shore protection will consider the environment and landscape by using natural materials.
- To ensure environmental protection, a fixed distance (25m) buffer will be set to restrict the construction of buildings near shoreline areas.
- Where special circumstances arise and a particular building cannot be setback from the shoreline, the building design must be adjusted to ensure that no detrimental effects will arise.

In order to ensure protection of the Tan Xa Lake shoreline, the environmental protection and landscape plan is proposed as shown in Figure 5.2.3. In this plan, the Tan Xa Lake protection zone will extend 25m inland from the shoreline. This zone will include a maintenance road that will be built in accordance with the Building Code of Vietnam (Decision No. 682/BXD-CSXD, 1996). The following scope of work is planned for the Tan Xa Lake environmental protection zone:

- The slope of the shore protection zone will be made as gentle as possible, while being consistent with the needs for the Tan Xa Lake to serve an auxiliary role as a water retention basin. The function and design of the maintenance road, promenade, etc. will consider the design water level and the environment.
- The Tan Xa Lake shoreline will be improved so that the lake can serve an auxiliary role as a water retention basin. The holding capacity will be designed for a 10 year return period storm. (The elevation of bank of the Tan Xa Lake will need to be more than MSL+13.10).
- A regulating gate and overflow weir are to be constructed at the outlet of the Tan Xa Lake.
- Revetment work for the Tan Xa Lake is to be conducted under the HHTP project and will secure a retention capacity of 350,000m^3.
- The protection zone with width of 25m, including the maintenance road, is improved.
- Tan Xa Lake is not to be used for irrigation purposes after development of the HHTP.

As a result, the protection area is necessary in order to keep this conservation area safe. The boundary of protection in the following four cases basically in a developer and HHTP-MB, and is decided.

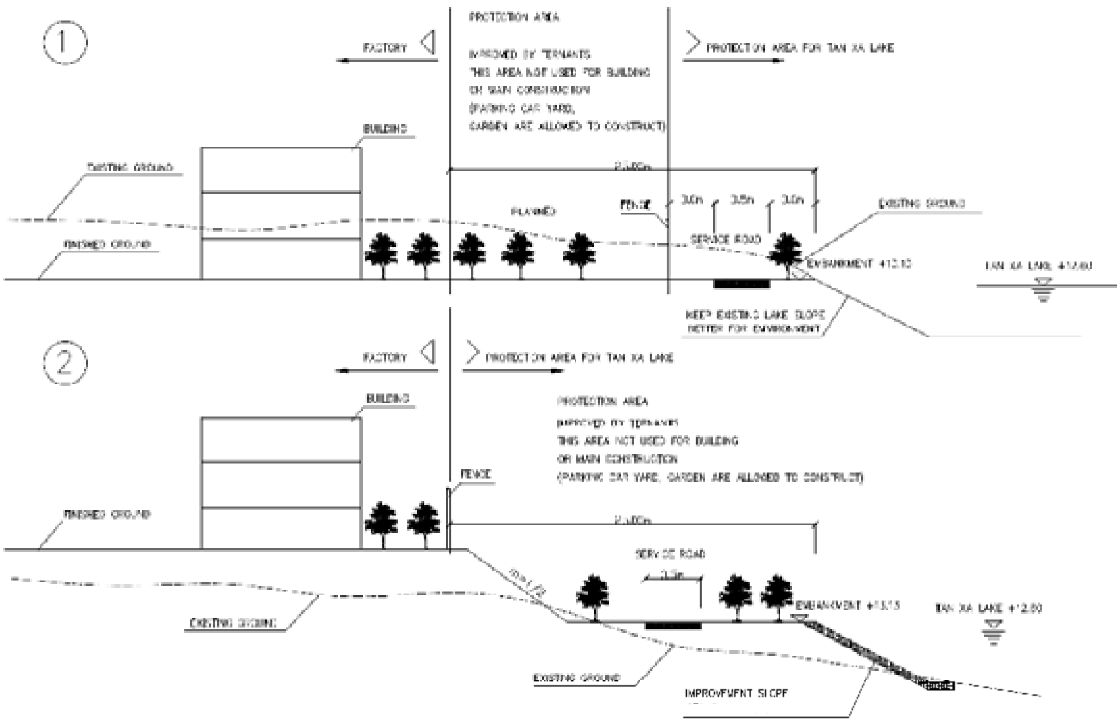


Figure 5.2.3 Proposed Shoreline Protection Area

5.3 ROAD AND TRANSPORT SYSTEM

As a result of reviewing the VN Revised M/P and related plans, following issues were noted for HHTP internal road and transport system plan:

- Planning coordination is required between HHTP internal road plan and LHLE construction plan regarding diamond interchanges, fly-over bridges, and underpasses.
- Modification of the right of way for road typical cross sections is required due to the necessity for additional space to accommodate utilities.
- Modification of traffic demand is required in connection with the revised land use, based on modification of the road right of way.
- Modification of the vertical alignment plan is required to be coordinated with the land reclamation plan, river improvement plan, and bridge plan.

The issues mentioned above have been incorporated into the Study and the following road and transport system related issues were also included in the Study:

- Recommendation of introduction of the internal transport system.

5.3.1 Traffic Demand Projection

In JICA Updated M/P, traffic demand in the HHTP was projected by using population forecast, estimated based on the proposed land use and traffic parameters in Hanoi Metropolitan area that have been set by the Comprehensive Urban Development Program in Hanoi Capital City (hereafter referred to as HAIDEP). In VN Revised M/P, land use plan and basic unit of population generation ratio for land use were revised, and population forecast values were changed. Since the land use plan was slightly modified in this Study due to modification of right of way, population forecast values have been revised accordingly, as shown in Table 5.3.1.

Table 5.3.1 Revised Land Use Plan and Population Forecast

Land Use	Area (ha) for F/S	Area (ha)			Population Projection (persons)				Classification of Population (2015)			Classification of Population (2020)		
		Total	Stage 1 (2015)	Stage 2 (2020)	Total	Stage 1 (2015)	Stage 2 (2020)	Density (p/ha)	Day Ratio	Daytime	Nighttime	Day Ratio	Daytime	Nighttime
Hoa Lac Area														
1 Software park	64.4	64.4	43.7	20.7	12,880	8,740	4,140	200.0	1.0	8,740	0	1.0	12,880	0
2 R&D	227.9	227.9	132.7	95.2	13,674	7,962	5,712	60.0	1.0	7,962	0	1.0	13,674	0
3 Hi-tech Industrial	114.7	231.6	197.4	34.2	23,160	19,740	3,420	100.0	1.0	19,740	0	1.0	23,160	0
4 Education & Training	108.0	108.0	20.6	87.4	43,200	8,240	34,960	400.0	0.6	4,944	3,296	0.6	25,920	17,280
5 Center of hi-tech City	49.0	49.0	49.0	0.0	12,250	12,250	0	250.0	0.6	7,350	4,900	0.6	7,350	4,900
6 Mixed Use	84.5	84.5	45.2	39.3	12,675	6,780	5,895	150.0	0.4	2,712	4,068	0.4	5,070	7,605
7 Houses & Offices	41.9	41.9	41.9	0.0	34,149	34,149	0	815.0	0.0	0	34,149	0.0	0	34,149
8 Housing Complex	22.6	22.6	12.2	10.4	34,691	18,727	15,964	1,535.0	0.0	0	18,727	0.0	0	34,691
9 Amenity	0.0	110.0	110.0	0.0	220	220	0	2.0	1.0	220	0	1.0	220	0
10 Amusement	33.2	33.2	33.2	0.0	1,660	1,660	0	50.0	1.0	1,660	0	1.0	1,660	0
11 Traffic & Infrastructure	146.6	147.1	147.1	0.0	0	0	0			0	0		0	0
12 Lake & Buffer	112.4	117.0	117.0	0.0	0	0	0			0	0		0	0
13 Greeneries/Trees	30.8	30.8	30.8	0.0	0	0	0			0	0		0	0
Sub-total	1,036.0	1,268.0	980.8	287.2	188,559	118,468	70,091			53,328	65,140		89,934	98,625
Northern Phu Cat Area														
1 Software park	0.0	10.9	0.0	10.9	2,180	0	2,180	200.0	1.0	0	0	1.0	2,180	0
2 R&D	0.0	0.0	0.0	0.0	0	0	0	60.0	1.0	0	0	1.0	0	0
3 Hi-tech Industrial	0.0	289.0	0.0	289.0	28,900	0	28,900	100.0	1.0	0	0	1.0	28,900	0
4 Education & Training	0.0	0.0	0.0	0.0	0	0	0	400.0	0.6	0	0	0.6	0	0
5 Center of hi-tech City	0.0	0.0	0.0	0.0	0	0	0	250.0	0.6	0	0	0.6	0	0
6 Mixed Use	0.0	2.4	0.0	2.4	360	0	360	150.0		0	0		0	360
7 Houses & Offices	0.0	0.0	0.0	0.0	0	0	0	815.0	0.0	0	0	0.0	0	0
8 Housing Complex	0.0	2.6	0.0	2.6	3,991	0	3,991	1,535.0	0.0	0	0	0.0	0	3,991
9 Amenity	0.0	0.0	0.0	0.0	0	0	0	2.0	1.0	0	0	1.0	0	0
10 Amusement	0.0	0.0	0.0	0.0	0	0	0	50.0	1.0	0	0	1.0	0	0
11 Traffic & Infrastructure	0.0	1.9	1.9	0.0	0	0	0			0	0		0	0
12 Lake & Buffer	0.0	0.0	0.0	0.0	0	0	0			0	0		0	0
13 Greeneries/Trees	0.0	11.2	11.2	0.0	0	0	0			0	0		0	0
Sub-total	0.0	318.0	13.1	304.9	35,431	0	35,431			0	0		31,080	4,351
Total	1,036.0	1,586.0	993.9	592.1	223,990	118,468	105,522			53,328	65,140		121,014	102,976

Note: Day ratio of the population is applied to the JICA Updated M/P
Source: JICA Study Team

To examine the validity of the road plan proposed by VN Revised M/P, traffic demand for

HHTP was re-projected based on the revised population generation ratio prepared by the Study.

The revised land use plan for Stage-1 (2015) and Stage-2 (2020) and population forecast proposed by the Study are shown in Table 5.3.2. As a result, re-projected traffic demand in the Stage-1 and Stage-2 are 27,358pcu/day and 49,123pcu/day respectively, based on the traffic parameters for Hanoi Metropolitan Area set by the HAIDEP and the predicted population in Stage-1 and Stage-2.

Table 5.3.2 Revised Traffic Demand Projection

Trip Demand

	Population		Trip Rate	Daily Trips	
	2015	2020		2015	2020
Residents within HHTP	65,140	98,625	2	130,280	197,250
Daytime Population	118,468	188,559			
People from outside HHTP	53,328	89,934	2	106,656	179,868

Modal Split

Mode	Share(%)		Daily Trips (PT)	
	2012*	2020	2015	2020
Bicycle	16	3.8	17,065	6,835
Motorcycle	61.1	52.9	65,167	95,150
Car	9.7	15.8	10,346	28,419
Truck	2.3	3.5	2,453	6,295
Public Transport	10.9	24	11,626	43,168
Total	100	100	106,656	179,868

Traffic Demand Projection

Mode	Occupancy Rate		Daily Trips (VT)		PCU	Daily Trips (PCU)	
	2012*	2020	2015	2020	Factor	2015	2020
Bicycle	1.13	1.13	15,102	6,049	0.2	3,020	1,210
Motorcycle	1.36	1.36	47,917	69,963	0.3	14,375	20,989
Passenger Car	2.02	2.02	5,122	14,069	1	5,122	14,069
Truck	1.7	1.7	1,443	3,703	2.5	3,607	9,258
Sub-total			69,583	93,784		26,124	45,526
Public Transport	23.56	30	493	1,439	2.5	1,234	3,597
Total			70,077	95,223		27,358	49,123

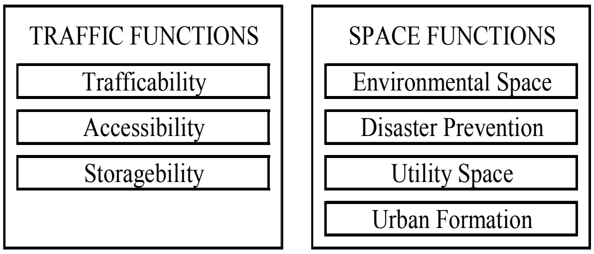
Note: Share and occupancy rates are adopted parameters in 2012 established by HAIDEP as approximate values
Source: JICA Study Team

5.3.2 Plan Concept and Design Criteria

(1) Development Concept

Since HHTP internal roads are categorized as urban roads, appropriate road functions shall be given to consideration of the roadside land use plan and anticipated traffic condition. Figure 5.3.3 shows expected road function for urban roads.

Table 5.3.3 Road Functions of Urban Roads



The following principles were used to examine appropriate road functions for the HHTP internal roads and set the planning concept:

<u>Traffic Functions (Trafficability, Accessibility, Storability)</u>

- Adequate vehicle lane widths shall provide for heavy vehicle passage, especially at intersections.
- Adequate additional lanes shall be provided intersections connecting with circumference roads of the HHTP.
- Facilities to formulate a safe pedestrian network such as sidewalks, pedestrian crossings, and pedestrian traffic signals shall be provided.
- Roadside space shall be provided at high parking demand area and at bus stops, etc.

<u>Space Functions (Environmental Space, Disaster Prevention, Utility Space, Urban Formation)</u>
- A buffer zone shall be provided to create a hospitable roadside environment.
- Adequate utilitiy accomodation space shall be provided to support various utilities.
- Landscaping shall be considered to enhance the attractiveness of the HHTP.

The development concept for bridges and culverts are as follows:

- Maintain required opening space, based on hydrological analysis.
- Consider utilization of existing structures for widening of the B04 bridge.
- Consider landscaping for planning of the B05 Bridge.
- Base the structure height on fixed condition of land reclamation heights.

(2) Design Criteria

Design standards applying to roads, bridges and box culverts were conform to the current Vietnamese standards, as follows:

- Vietnamese construction specifications TCXDVN 104–2007: Urban road specifications for design
- Highway specification for design TCVN 4054 – 2005
- Pavement specification for flexible pavement design 22TCN-211-2006
- Specification of traffic sign 22TCN-237-01
- Design Standard of artificial lighting outside of civil construction 20TCN 95-83
- Vietnam Construction Standard TCXDVN 259- 2001: design standard for artificial lighting in streets, road, square
- Building code of Vietnam, Ministry of Construction
- 22TCN 272-05

Clearances for roadways and waterways were not considered because grade separation and waterway crossing points were not planned. The major design criteria for planning the bridges and box culverts are summarized in Table 5.3.4.

Table 5.3.4 Major Design Criteria for Planning of Bridges and Box Culverts

Item	Criteria	Remark
Design high water level (DHWL)	100 years return period	Followed land reclamation plan
Vertical clearance for DHWL	Minimum 0.5m	Without driftwood condition
Navigation clearance	Not considered	No planned waterway at crossing points
Clearance for roadway	Not considered	No planned grade separation at crossing points

Source: 22TCN 272-05

5.3.3 Proposed Road and Transport System Development Plan

(1) HHTP Internal Road Network Development

The HHTP internal road system consists of 18 roads, 11 bridges, and 6 culverts, as listed in Table 5.3.5 and Table 5.3.6, and shown in Figure 5.3.1. About 45% of roads, 5 bridges, and 2 culverts have been constructed or are in the process of detailed design; the remaining roads, bridges, and culverts are subjected to the planning controls in the development plan. Outlines of the proposed development for these roads, bridges and culverts are also shown in Table 5.3.5 and Table 5.3.6.

Table 5.3.5 Status of the HHTP Internal Road Development - Roads

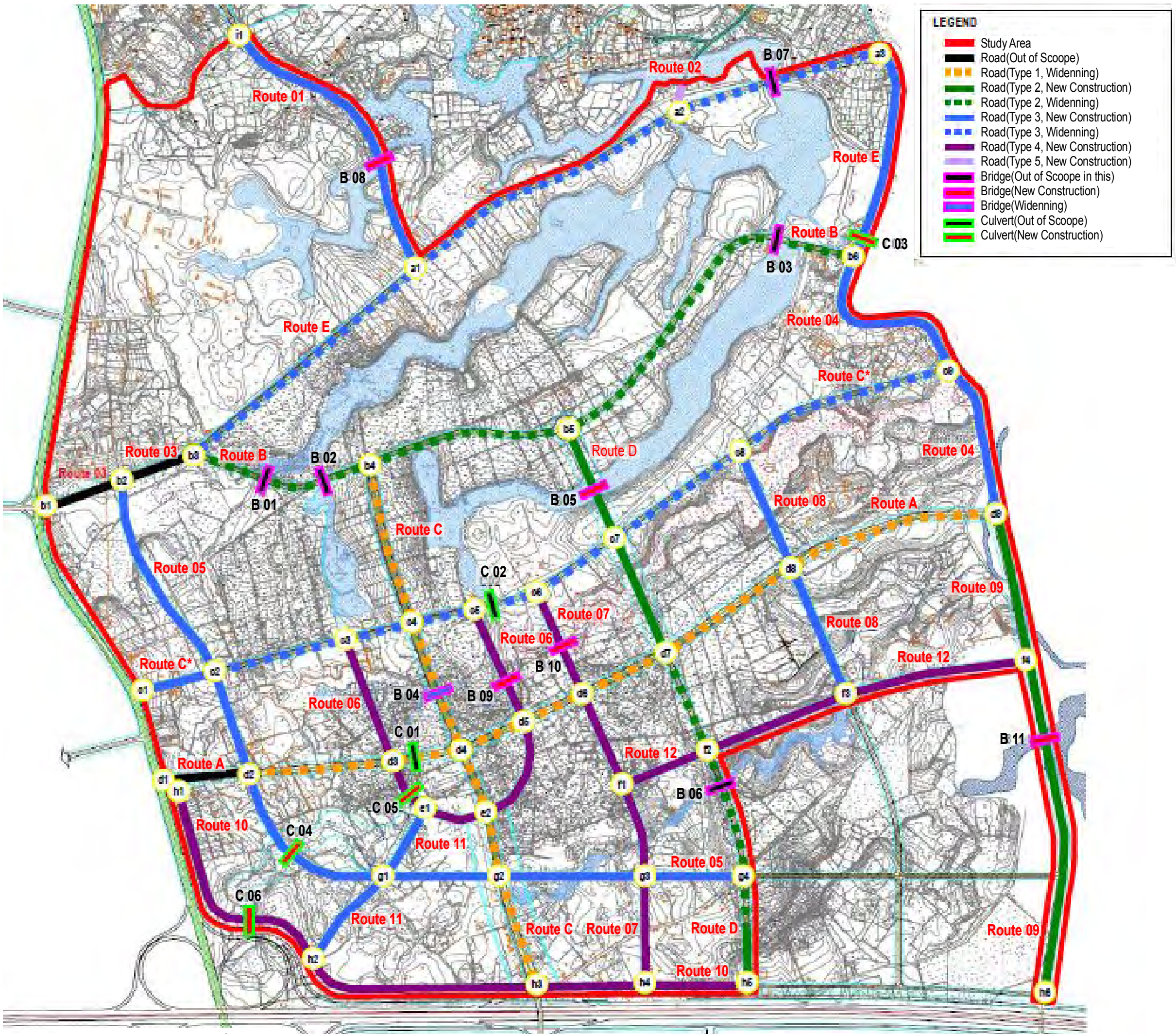
Routes	Type	Length (m)	Road Right of Way (m)	No. of lanes	Development Type and Length		Implementation Status						Remarks
					New Const-ruction	Widening (m)	Comp-letion (m)	Transitional Completion		Incompletion			
								length (m)	width (m)	Under Construct	D/D Complete	No Design (m)	
Route A	1	3,306	50	6	–	3,036	–	3,036	50	–	270	–	Median narrowing, lane widenning
Route B	2	2,931	38	4	–	2,931	–	2,091	33	840	–	–	Under construction section needs widenning, Replacement
Route C	1	2,125	50	6	–	2,125	–	2,125	25	–	–	–	
Route C*	3	3,430	34	4	340	3,090	–	280	29	2,810	–	340	Under construction section needs widenning
Route D	2	2,289	38	4	1,156	1,133	–	1,133	33	–	–	1,156	
Route E	3	3,940	34	4	873	3,067	–	730	29	–	2,337	873	D/D complete section needs widenning
Route 01	3	1,193	34	4	1,193	–	–	–	–	–	–	1,193	
Route 02	5	96	16	2	96	–	–	–	–	–	–	96	
Route 03	1	632	50	6	–	–	–	–	–	–	632	–	
Route 04	3	1,353	34	4	1,353	–	–	–	–	–	–	1,353	
Route 05	3	3,366	34	4	3,366	–	–	–	–	–	–	3,366	
Route 06	4	1,875	31	2	1,875	–	–	–	–	–	–	1,875	
Route 07	4	1,611	31	2	1,611	–	–	–	–	–	–	1,611	
Route 08	3	1,034	34	4	1,034	–	–	–	–	–	–	1,034	
Route 09	2	1,885	38	4	1,885	–	–	–	–	–	–	1,885	
Route 10	4	2,700	31	2	2,700	–	–	–	–	–	–	2,700	
Route 11	3	732	34	4	732	–	–	–	–	–	–	732	
Route 12	4	1,628	31	2	1,628	–	–	–	–	–	–	1,628	
Total		36,126			19,842	15,382	0	9,395		3,650	3,239	19,842	

Source: JICA Study Team

Table 5.3.6 Status of the HHTP Internal Roads Development - Bridges and Culverts

Code	Plan	Route	Station			DHWL (m)	Clearance (m)	Minimum Height (Girder/Top Slab Bottom)	Structure Type	Width (m)	Length (m)
			Beginning	Center	End						
B01	Completed	Route B	–	–	–	–	–	–	–	–	–
B02	Completed	Route B	–	–	–	–	–	–	–	–	–
B03	Under Construction	Route B	–	–	–	12.63	0.5	13.13	Concrete Arch	26	0.05+52+0.05=52.1
B04	Plan (Widening)	Route C	Followed the existing condition						PC Hollow Girder	33.5	0.05+15.0+0.05=15.1
B05	Plan (New Construction)	Route D	0+241.110	0+267.160	0+293.210	12.63	0.5	13.13	Concrete Arch	26	0.05+52+0.05=52.1
B06	Completed	Route D	–	–	–	–	–	–	–	–	–
B07	Under Construction	Route E	–	–	–	–	–	–	–	–	–
B10	Plan (New Construction)	Route 07	0+169.950	0+176.000	0+182.050	12.63	0.5	13.13	PC Hollow Girder	22	0.05+12.0+0.05=12.1
B11	Plan (New Construction)	Route 09	0+867.950	0+880.000	0+892.050	9.6	0.5	10.1	PC Hollow Girder	26	0.05+24.0+0.05=24.1
C01	Completed	Route A	–	–	–	–	–	–	–	–	–
C02	Completed	Route C*	–	–	–	–	–	–	–	–	–
B08	Plan (New Construction)	Route 01	0+454.347	0+475.422	0+496.497	12.63	0.5	13.13	PC Hollow Girder	29	0.05+21+0.05+21+0.05=42.15
C03	Plan (New Construction)	Route 04	0+743.625	0+747.000	0+750.375	12.63	0.5	13.13	Box Culvert(2@3.0*2.0)	29	0.25+3.0+0.25+3.0+0.25=6.75
C04	Plan (New Construction)	Route 05	1+617.750	1+619.000	1+620.250	12.63	0.5	13.13	Box Culvert(1@2.0*2.0)	29	0.25+2.0+0.25=2.5
C05	Plan (New Construction)	Route 06	0+661.750	0+663.000	0+664.250	12.63	0.5	13.13	Box Culvert(1@2.0*2.0)	22	0.25+2.0+0.25=2.5
B09	Plan (New Construction)	Route 06	1+738.450	1+746.000	1+753.550	12.63	0.5	13.13	PC Hollow Girder	22	0.05+15.0+0.05=15.1
C06	Plan (New Construction)	Route 10	0+526.750	0+528.000	0+529.250	12.63	0.5	13.13	Box Culvert(1@2.0*2.0)	22	0.25+2.0+0.25=2.5

Source: JICA Study Team

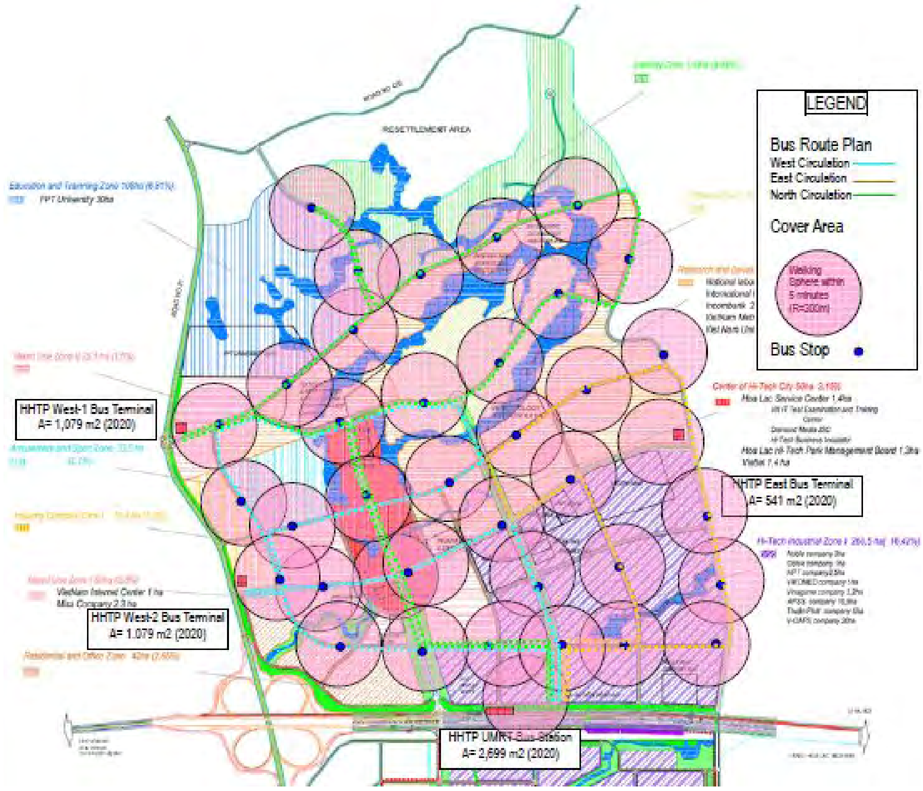


Source: JICA Study Team

Figure 5.3.1 Implementation Status of the HHTP Road Network

(2) HHTP Internal Transport System

Circulating buses are assumed to be the mode for the internal transport system. Where three (3) circulating bus routes are introduced, as shown in Figure 5.3.2, the necessary number of buses in 2015 and 2020 is estimated at 9 (2 large buses, 7 middle-sized buses) and 30 (6 large buses, 24 middle-sized buses) respectively, based on the revised traffic demand. Necessary bus terminal areas in 2015 and 2020 are also estimated at 1,537m^2 and 5,398m^2, respectively. The introduction of electric buses shall be considered, so as to emphasize the eco-friendly environment of the HHTP.



Source: JICA Study Team

Figure 5.3.2 Proposed Circulating Bus Routes and Bus Stops

(3) Project Implementation, Operation and Maintenance of the HHTP Internal Transport System

Project implementation of the HHTP internal roads would be conducted by the HHTP PMU. Appropriate capacity development and empowerment must be undertaken to allow for smooth project implementation. Operation and maintenance for the HHTP internal roads would be conducted by the HHTP Infrastructure Bureau.

5.3.4 Proposed Underpass and Intersection Plan

(1) Comparison of the HHTP M/P and MOT Linkage Plans

The linkage plan between the HHTP and the LHLE proposed by HHTP-MB and the MOT are shown in Figure 5.3.3. There are discrepancies between the connection methods between both plans, as follows:

- No off-ramp on the outbound of the LHLE at the main gate interchange is planned in the MOT plan.

(2) Issues for the MOT Linkage Plan

Since the LHLE will be the most crucial route for external transportation to/from the HHTP, development of a linkage to maintain smooth and efficient traffic flow between the LHLE and the HHTP is essential. However, inflow and outflow traffic to/from the HHTP from/to Hanoi Corner through the LHLE will need to detour at the main gate interchange if the MOT plan is followed. In addition, the following issues are anticipated:

<u>Inflow traffic</u>

- Traffic concentration at the western gate along NH21A due to the shorter route compared to the route to the main gate.
- Traffic congestion at southern part of the main gate interchange due to diverted traffic.

<u>Outflow traffic</u>

- Traffic concentration at western gate along NH21A due to the shorter route compared to the route to the main gate.

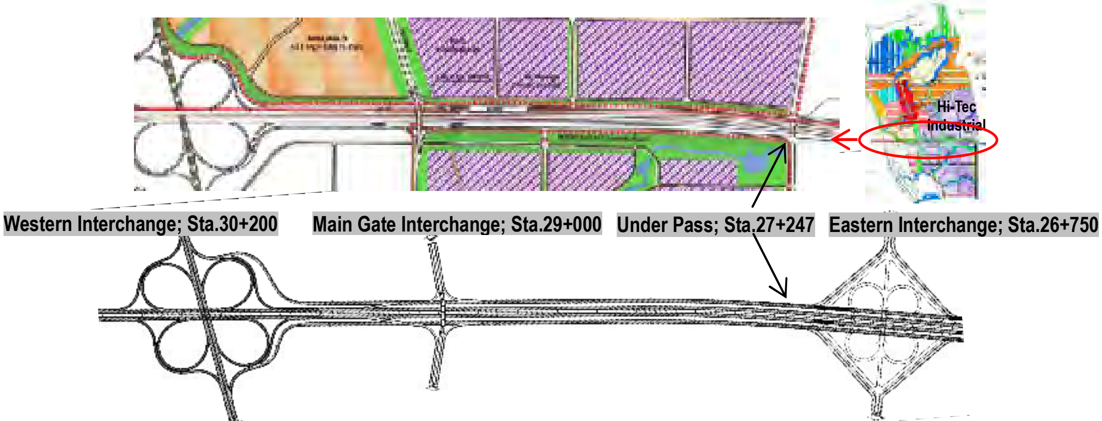


Figure 5.3 3 Comparison of Linkage Plan (Upper: HHTP M/P, Lower: MOT)

(3) Recommendation of the MOT Linkage Plan

Assuming that the diamond type interchange will be implemented in 2015, inflow and outflow traffic to/from the HHTP from/to Hanoi Corner through the LHLE can be dispersed preferably. In addition, installation of additional on-ramps and off-ramps connecting the frontage roads and the expressways is essential to ensure efficiency of traffic flow, as shown in Figure 5.3.4 to Figure 5.3.5 below. Installation of these additional ramps will regulate the traffic flow properly.

Two alternatives are proposed for the outflow traffic from the HHTP, as illustrated in Figure 5.3.5. Alternative 1 has an advantage over Alternative 2, because adequate U-turn space is provided in the HHTP south area and the main volume of traffic from the HHTP south area passes through the main gate.

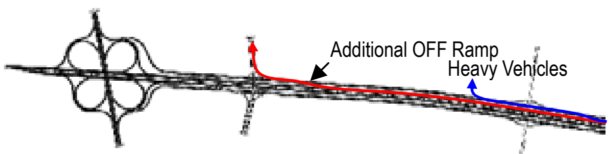


Figure 5.3.4 Recommended Modification of the LHLE Connection Plan (Inflow)

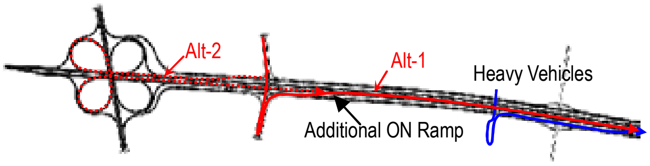


Figure 5.3.5 Recommended Modification of the LHLE Connection Plan (Outflow)

(4) Recommendation for the Main Gate Fly-over Bridge and the Underpass

1) Main Gate Fly-over Bridge

MOT has proposed typical cross sections for the main gate fly-over bridge, which has a total road width of 17m, including vehicle lanes (8.0m×2) and a median strip (1m). MOT revised the design of the main gate fly-over bridge after receiving the comments from JICA Study Team through the HHTP-MB.

The HHTP roads are designing based on Design Standards TCXDVN 104-2007 and TCVN 4054-2005. According to these standards, a total width of 18m is necessary (lanes 3.75m×4, shoulders 0.5m×2, and median strip 2.0m). The main gate over the bridge connects to Road C in the HHTP, with frontage roads and a uniform lane width to ensure smooth trafficability.

2) Underpasses

MOT proposed a typical cross section for the underpass, which had a total road width of 6m and provided 4.925m for height clearance.

According to the above standard, and assuming that the road type of the underpass is a main urban minor street, a total width of 9.5m is necessary (lanes 3.50m×2, shoulders 0.25m×2, and median strip 1.5m). However, the connecting road to the underpass is given a 3.75m lane width, and the underpass should also be given 3.75m lane width to ensure smooth trafficability. Therefore, a total width of 10.0m is recommended.

4.925m clearance height is complied with the geometric standard. However, the underpass is intended to mainly use for heavy vehicle passages, and it should avoided bridge damage from over loaded vehicle heights. Therefore, an additional 1.0m is recommended to be added to 4.925m (total 5.925m), in consideration of practical experience in Vietnam.

5.3.5 Design for Road Network

(1) Road Alignment

1) Horizontal Alignment

Road network pattern is sortable by ringer radial and grid types. It was planned the grid type in the VN Revised M/P. In consideration of the lot pattern in the HHTP, the grid type is appropriate. As for road densities in the VN Revised M/P, it is satisfied the standard applied in the JICA Updated M/P as shown in Table 5.3.7. Therefore, the horizontal alignment was followed the VN Revised M/P.

Table 5.3.7 Standard Road Density by Land Use Plan

Land use	Standard Road Density (km/km^2)
Software Park	2.0
Research and Development	2.0
High-tech Industrial Area	1.0
Education and Training	2.0
Center of High-tech City	5.0
Mixed Use Area	4.5
Residential Area	4.0

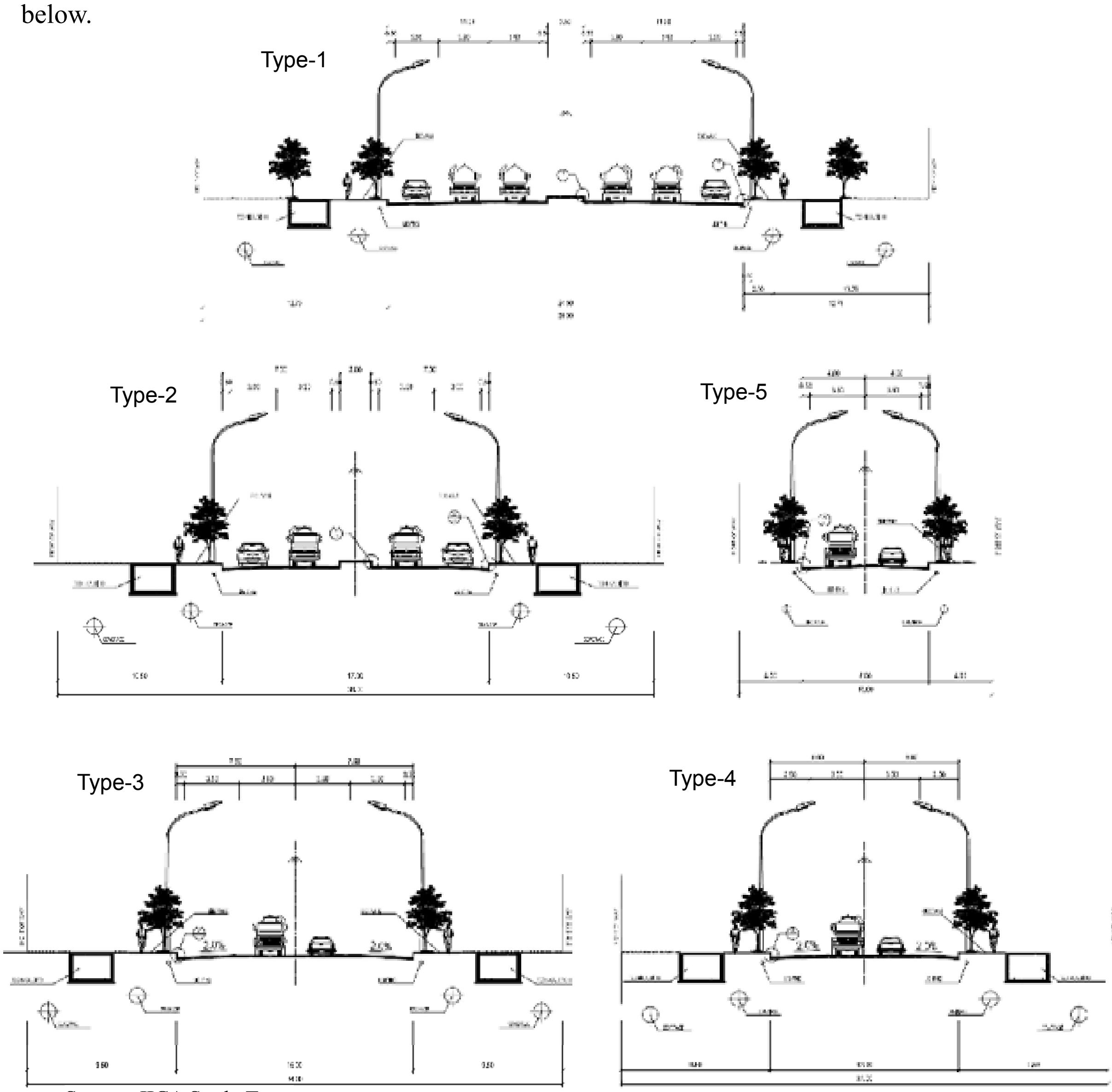
Source: JICA Updated M/P

2) Vertical Alignment

Topography in the HHTP area is flat. Therefore, design controls to the vertical alignment were established based on the land reclamation plan and design high water level. The maximum gradient is 2.17%, and it is satisfied the design criteria for 60km/hr design speed road.

(2) Typical Cross Sections

Typical cross sections were planned 5 types in the VN Revised M/P. The carriageway and sidewalk is appropriate for the required traffic functions. However, the buffer zones on road type 2, 3 and 4 were revised due to the review of buried utility plan in accordance with the Vietnamese building code 2008. The typical cross sections planned in the Study are shown as below.



Source: JICA Study Team

Figure 5.3.6 Typical Cross Sections

(3) Pavement Design

Pavement structures were designed in accordance with the 22TCN-211, 2006. The sub-grade was designed on condition that CBR on embankment would be constructed 6 and over. As for the design traffic loads, it was applied the ESAL values as shown in the above standard.

(4) Bridge and Culverts

Bridge and culverts were planned in accordance with the 22TCN 272-05. The typical cross sections were followed the road sections, however, planting and buffer zones were omitted.

The planned bridge and culverts are summarized below.

Table 5.3.8 Plan of the Bridge and Culverts

Category	Road		Bridge and Culvert Plan						Remark
	Route	Type	Code	Station (km)	Structure Type	Width (m)	Length (m)	Arrangement (m)	
Bridge	B	2	B03	—	Concrete Arch	26.0	52.10	1@52.0	Replacement
	C	1	B04	0+910.164	Hollow Girder	33.5	15.10	1@15.0	Widening
	D	2	B05	0+267.160	Concrete Arch	26.0	52.10	1@52.0	
	01	3	B08	0+475.422	Hollow Girder	29.0	42.15	2@21.0	
	06	4	B09	1+746.000	Hollow Girder	22.0	18.10	1@18.0	
	07	4	B10	0+176.000	Hollow Girder	22.0	12.10	1@12.0	
	09	2	B11	0+880.000	Hollow Girder	26.0	24.10	1@24.0	
Culvert	E	3	C03	0+747.000	Box Culvert	29.0	6.75	2@3.0*2.0	
	05	3	C04	1+619.000	Box Culvert	29.0	2.50	1@2.0*2.0	
	06	4	C05	0+663.000	Box Culvert	22.0	2.50	1@2.0*2.0	
	10	4	C06	0+528.000	Box Culvert	22.0	2.50	1@2.0*2.0	

(5) Road Facilities

1) Street Lighting

Street lighting was planned in accordance with the TCXD 259-01. The lamps are planned as sodium type in consideration of maintenance ease. Distance of the lighting is planned at 35m intervals for all the routes by calculation of the brightness.

2) Traffic Lights

Traffic lights were planned for pedestrian's safety at intersections. The signal lamps are planned as 3 signal patterns, with installation of vehicle and pedestrian lamps. The signal control is planned as a synchronized system, and it could be procured in Vietnam.

3) Technical Tunnel

Technical tunnels were planned at each intersection. The minimum separation distance of the utility lines was applied according to the Vietnamese building code 2008. For O&M of technical tunnels, common regulations are necessary among the utility suppliers. Therefore, HHTP MB shall coordinate among the suppliers

5.4 DRAINAGE PLAN

5.4.1 Hydrological Analysis and Conditions

It is noted that the hydraulic analysis of the drainage system is a preliminary examination since the hydraulic studies were conducted under the conditions of the following issues and risks:

a) In general, collection of data and information on water bodies related with HHTP development, such as the Tan Xa Lake, Dua Gai Stream, Vuc Giang Stream and the Tich River, are most formidable due to the limited response of HHTP-MB and in consequence, this caused a deficit of data and information required for the hydraulic analysis and design;

b) The existing sewer is designed with a storm return period of three (3) years for the High-Tech Industrial Zone and one (1) year for the other zones;

c) Allowable flood return periods for the Vuc Giang Stream, the Tich River and the Day River, which are deemed as the final receiving water areas of storm water discharged from HHTP, are not clear; and

d) As a result of the deficit of data and information, planning and design of the drainage facilities was conducted by using assumed hydrological conditions for water bodies related with the HHTP development.

The hydrological factors for the drainage development plan were determined, as shown below:

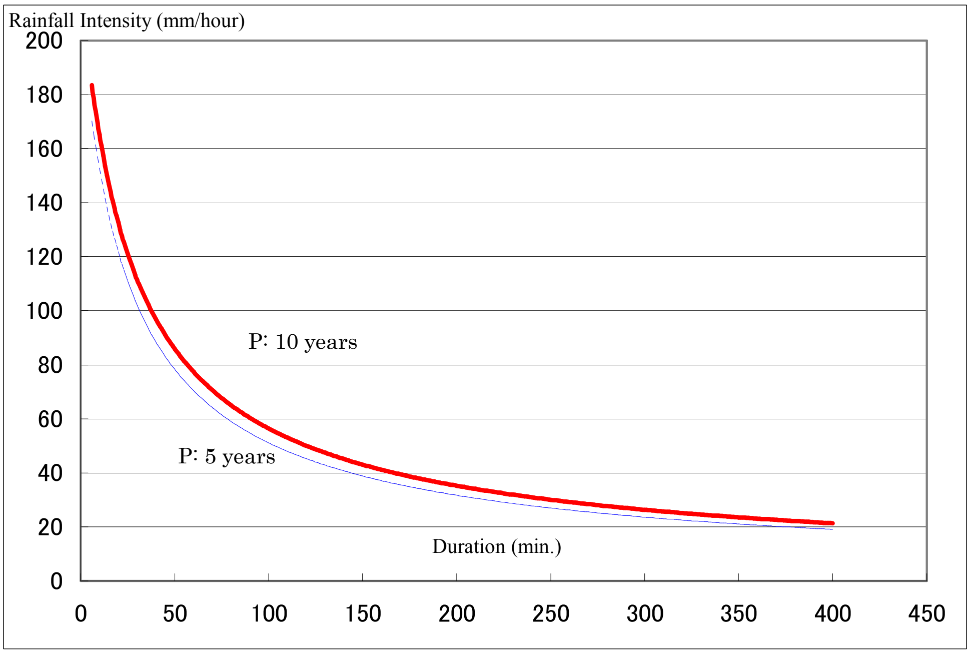
(1) Rainfall Intensity

A rainfall intensity formula for Hanoi developed by MOC was adopted for the drainage system in the Hoa Lac Area as follows:

$$I = 0.36 \cdot [5416 \cdot (1+0.25 \cdot \log P \cdot t^{0.13})]/(t+19)^{0.82}$$

where, I: Rainfall intensity (mm/hour) (36 mm/hour = 100 l/sec/ha)
P: Return period (year)
t: Concentration time (minute)

Rainfall intensity curves for 5 year and 10 year return period storms are shown in Figure 5.4.1.



Source: JICA Study Team

Figure 5.4.1 Rainfall Intensity Curves

(2) Hydrological Data for Water Bodies

The hydrological factors for the water bodies comprising Tan Xa Lake, Dua Gai Stream and Vuc Giang Stream were determined, as shown in Table 5.4.1 below.

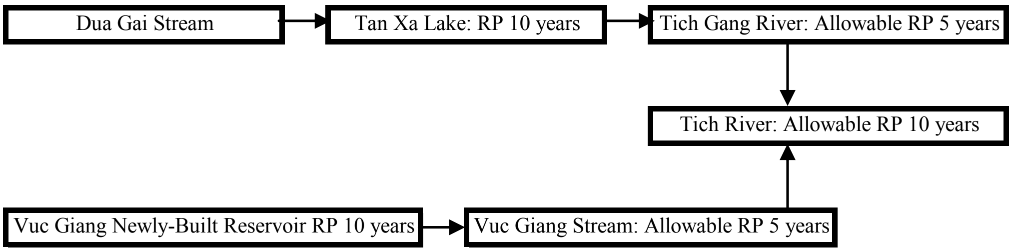
Table 5.4.1 Dimensions of Three Basins

Description	Tan Xa Lake	Dua Gai Stream	Vuc Giang Stream
Surface area (ha)	107.0	5.4	4.6
Highest water level (m)	E.L.12.0	E.L.12.0	E.L.09.6
Average water level (m)	E.L.10.5	E.L.10.5	-
Lowest water level (m)	E.L.07.5	E.L.07.5	E.L.07.5
EL of 10 years Return Period (m)	E.L.12.3	E.L.12.3	E.L.08.7
EL of Bank (m)	E.L.13.1	E.L.13.1	E.L.10.1

Source: VN Revised M/P & JICA Study Team

The maximum water level (H max) is EL. 12.40m, which was recorded in 2008 and the lowest water level (H min) is EL. 7.50m, which was recorded in 2002 according to daily water level record of the Phu Sa Company. Average H max and H min for 10 yeas are EL. 11.61m and 9.03m respectively. According to hydrological analysis by the Hanoi Water Resources University under the feasibility study on overhaul of Tan Xa Lake irrigation system, the maximum water level of Tan Xa Lake to 50 years of return period is estimated to be EL.12.63m above mean see level based on the daily water level record of the Tan Xa Lake. It is recommended by that the maximum water level with EL.12.63m shall be secured for environmental conservation of the Tan Xa Lake, flood control and irrigation purpose.

Storm water in the Hoa Lac Area is discharged to the Tick River through the Tich Gang River and the Vuc Giang Stream after development of drainage system as shown in Figure 5.4.2.



RP: Return Period

Source: JICA Study Team

Figure 5.4.2 Storm Water Discharge Flow

5.4.2 Storm Water Drainage Plan

The proposed storm water drainage plan should cope well with the variety of public facilities and services, functional zones and environmental requirements particular to the HHTP. The overall storm water drainage plan in the Hoa Lac Area is presented as shown in Figure 5.4.3.

(1) Storm Water Collection System

The design concept and criteria for the storm water drainage system in the Hoa Lac area (north of LHLE) are summarized below and required facilities are estimated as shown in Table 5.4.2.

1) Concept of the Storm Water Drainage System Plan

Planning area	: 1268 ha of Hoa Lac area (north of LHLE)
Design population	: 193,326
Drainage basin	: Four basins of Tan Xa Lake, Dua Gai Stream, Vuc Giang Newly Built Reservoir and Vuc Giang Stream
Collection system	: Separate system
Design storm water flow (DSF)	: 5 years of return period for sewer
Storm water reservoir for flood control	: Tan Xa Lake and Vuc Giang stream
Receiving water bodies	: Tich River through Vuc Giang stream and Tich Gang River

2) Design Criteria for the Storm Water Collection Drain

The hydraulic design has been based on the following criteria:

Design storm water flow (DSF)	: Rational formula
(DSF)	$Q = C \cdot q \cdot A$
	Where, Q: Design storm water flow (m^3/second)

	C: runoff coefficient q: Rainfall intensity (mm/second/ha) A: Drainage area (ha)
Rainfall intensity	: Intensity formulation of MOC
Return period	: 5 years for sewer
Overall runoff coefficient	: 0.6 before development, 0.8 after development
Hydraulic design of drain	: Manning's formula $Q = A \cdot V$, $V = (1/n) \cdot R^{2/3} \cdot I^{1/2}$ Where, Q: Storm water discharge (m^3/sec) A: Sectional area of pipe (m^2) V: Mean velocity (m/sec) n : Roughness coefficient R: Hydraulic radius (m) I : Hydraulic gradient
Allowable flow velocity	: 0.8 - 3.0 m/s
Minimum size of drain	: 250mm
Allowance of sewer capacity	: 10%-20% of design storm water flow
Minimum earth covering	: 1.0m
Maximum manhole interval	: 50m for less than D300mm, 75m for less than D600mm 100m for D1000mm, 150m for less than D1500mm 200m for less than D1650mm
Pipe connection method	: Pipe bottom connection or water surface connection
Material of drain	: Hume concrete pipe
Roughness coefficient	: 0.013
Hydraulic gradient	: 2.0‰for less than D500mm, 1.0‰for less than D1000mm 0.7‰for less than D1500mm, 0.6‰for more than D1500mm

3) Storm Water Collection Facilities

The required storm water collection facilities are listed as below.

Table 5.4.2 Require Storm Water Collection Facilities

Item	Unit	Replacement	Newly Installed	Total
1 Storm water Collection Sewer	m	11,630	26,724	38,354
D600 Reinforce Concrete Pipe	m		1,659	1,659
D800 Reinforce Concrete Pipe	m	3,992	4,050	8,042
D1000 Reinforce Concrete Pipe	m	472	3,031	3,503
D1250 Reinforce Concrete Pipe	m	566	3,102	3,668
D1500 Reinforce Concrete Pipe	m	1,846	5,076	6,922
D1750 Reinforce Concrete Pipe	m	45		45
D2000 Reinforce Concrete Pipe	m	1,209	985	2,194
D2500 Reinforce Concrete Pipe	m	90	453	543
Box Cuvert 600x800	m		269	269
Box Cuvert 800x800	m		533	533
Box Cuvert 800x1000	m		355	355
Box Cuvert 1000x1000	m		1,505	1,505
Box Cuvert 1200x1000	m		966	966
Box Cuvert 1200x1200	m		773	773
Box Cuvert 1400x1200	m		635	635
Box Cuvert 1400x1400	m		560	560
Box Cuvert 1400x1900	m		230	230
Box Cuvert 1500x1600	m		320	320
Box Cuvert 1500x1700	m	334		334
Box Cuvert 1600x1600	m		105	105
Box Cuvert 1700x1700	m	333		333
Box Cuvert 1800x1600	m	504		504
Box Cuvert 1800x1900	m		230	230
Box Cuvert 1800x2000	m	454		454
Box Cuvert 2000x1700	m		184	184
Box Cuvert 2000x2000	m	938		938
Box Cuvert 2000x2200	m		290	290
Box Cuvert 2400x2200	m	847		847
Box Cuvert 2400x2400	m		300	300
Box Cuvert 2500x1800	m		440	440
Box Cuvert 2500x2000	m		60	60
Box Cuvert 2800x2400	m		613	613
2 Manhole	Places			536
Manhole for D600, 1.2x1.2m, H=2m	Places			38
Manhole for D800, 1.4x1.4m, H=3m	Places			161
Manhole for D1000, 1.6x1.6m, H=3m	Places			70
Manhole for D1250, H=3m	Places			73
Manhole for D1500-2000, H=3.5m	Places			183
Manhole for D2500-3000, H=5m	Places			11
3 Connection Pipes	m			465
D1500mm Reinforce Concrete Pipe No.1	m			160
D1500mm Reinforce Concrete Pipe No.2	m			40
D1500mm Reinforce Concrete Pipe No.3	m			65
D2000mm Reinforce Concrete Pipe of NR21	m			200

Source: JICA Study Team

(2) Retention Functions

1) Concept of Retention Functions

Planning area	: 1268 ha of Hoa Lac area (north of LHLE)
Drainage basin	: Four basins of Tan Xa Lake, Dua Gai Stream, Vuc Giang Newly Built Reservoir and Vuc Giang Stream
Design storm water flow (DSF)	: 10 years of return period for retention function
Storm water reservoir for flood control	: Tan Xa Lake and Vuc Giang Newly Built Reservoir
Receiving water bodies	: Tich River through Vuc Giang stream and Tich Gai River
Allowable discharge of Tich River	: 10 years of return period for Tich River (assumed)

2) Design Criteria for Retention Functions

Design return period for retention functions	: 10 years
Type of pond	: Natural pond with environmental conservation bank for Tan Xa Lake, and Multiple type with orifice for Vuc Giang Newly Built Reservoir
Capacity of retention function	: $Q = [Q_{10} - Q_a/2] \cdot T \cdot 60$ Where, Q: Design capacity of retention pond (m^3)

	Q_{10}: Design storm water flow (m^3/second)
	Q_a: Allowable discharge flow (m^3/second)
	T: Concentration time (minute)
Volume of sedimentation	: 1.5m^3/ha/yeay and 10 years period

3) Proposed Retention Functions

Required facilities for retention functions are designed with the following features:

a) Tan Xa Lake Regulating Gate

Capacity of reservoir	: 334,000 m^3
Type of Gate	: Steel Roller Sluice Gate
Dimension	: Width 5.5m x Height 6.5m
Design discharge	: 26 m^3/sec

b) Tan Xa Lake Overflow Weir

Type of canal	: Reinforced concrete open canal
Dimension	: Width 8.5m x Height 1.5m x Length 25m
Design overflow	: Only maintenance flow (Maximum flow 26 m^3/sec)

c) Dua Gai Stream Diversion

Type of weir	: Reinforced concrete open canal (Retained wall)
Typical section	: Width 10m x Height 2.5m, Width 15m x Height 2.5m
Design flow	: 92 m^3/sec

d) Vuc Giang Newly Built Reservoir and Orifice

Capacity of reservoir	: 52,000 m^3 (Multipurpose type)
Typical section	: Width $22m^{up}$ x $8m^{bottom}$ x Height 3.5m for stream
	: Width 50m to 100m x Height 2.8m for berm
Dimension of orifice	: Width 4m x Height 2m
Design overflow	: 84 m^3/sec

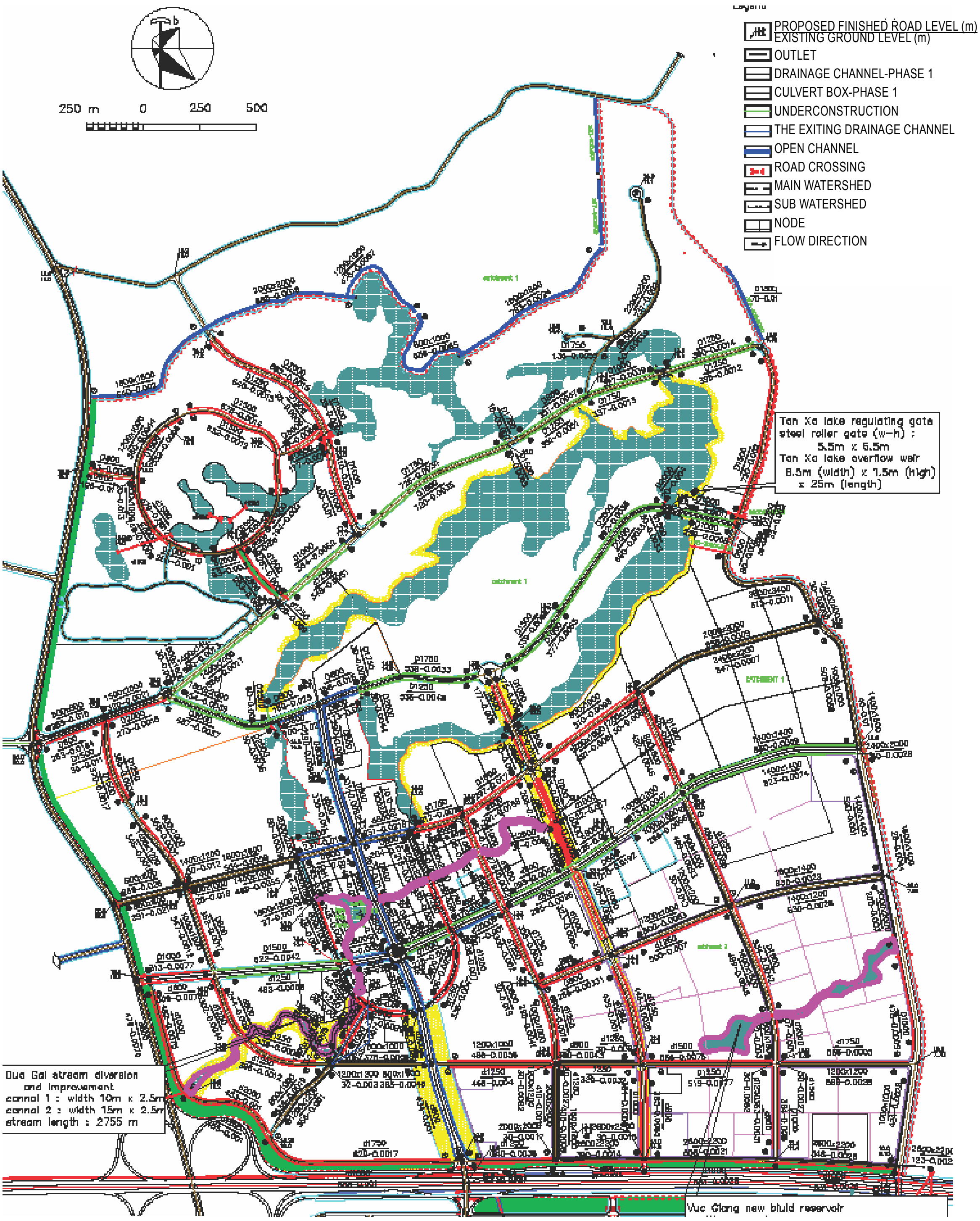
(3) Summary of the Proposed Storm Water DrainageProject

The proposed storm water drainage project is summarized in Table 5.4.3. The total length of sewer consisting of pipes and box culverts is around 39km including the replacement sewer with length of 12km. Flood retention functions consists of the Tan Xa Lake with a capacity of 334,000m^3 and Vuc Giang Newly Built Reservoir with a capacity of 52,000m^3.

Table 5.4.3 Proposed Storm Water Drainage Project

		Work Item	Quantity
1		Storm Water Collection Sewer	
	a)	New Installation	27 km
	b)	Replacement	12 km
	c)	Manholes	536 units
	d)	Connection Pipes: D1500mm & D2000mm	465 m
2		Tan Xa Lake Regulating Facilities	
	a)	Regulating Gate: Width 5.5m x Height 6.5m	1 unit
	b)	Overflow Weir: Width 8.5m x Height 2.0m	1 unit
	c)	Spillway (canal): Width 8.5m x Height 2.0m	300 m
3		Dua Gai Stream Diversion & Improvement	
	a)	Dua Gai Stream Improvement	2.3 km
	b)	Dua Gai Stream Diversion	0.9 km
	c)	Diversion Box Culvert 3000x2000	180 m
4		Vuc Gaing Stream Retention Functions	
	a)	Newly Built Reservoir (Multipurpose Type)	52000 m^3
	b)	Orifice: Box Culvert 4000mm x 2000mm	50 m
	c)	Vuc Gaing Stream Improvement	500 m

Source: JICA Study Team



Source: JICA Study Team

Figure 5.4.3 Overall Drainage Plan

5.5 WATER SUPPLY PLAN

5.5.1 Water Supply Demand Projection

(1) Review of the Water Supply Plan

The VN Revised M/P does not show the water demand estimation in detail. Therefore, to determined water supply demand projection, it is necessary to review the demand unit rate described in the JICA Updated M/P, which mainly following Vietnamese standard. The adopted unit rate demand is summarized in Table 5.5.1.

Table 5.5.1 Demand Unit Rate for Water Supply

Category			TCXDVN-33-2006			Unit Demand for Hoa Lac				
		Urban Grade	II & III		IV	III			Source	Application
		Target Year	2010	2020	2010	2010	phase-1	phase-2		
1.	Domestic	l/cp/d	120	150	60	120	150	150	TCXDVN-33-2006	High Class Residential (R&D, Amenity), Residential Zone, Housing Complex, E&T Zone, Center of Hi-Tech City
	Service Ratio	%	85	100	75	85	100	100		
2.	Public (% to domestic)	%	10	10	0	10	10	10		High Class Residential (R&D, Amenity), Residential Zone, Housing Complex, E&T Zone, Center of Hi-Tech City
3.	Service & Commercial (% to domestic)	%	10	10	10	10	10	10		High Class Residential (R&D, Amenity), Residential Zone, Housing Complex, E&T Zone, Center of Hi-Tech City
4.	Industry *1	m^3/ha/d	22-45	22-45	-	22	22	22		R&D (R&D Zone)
						45	45	45		Hi-Tech Park, Reserved Area
5.	Office *2	l/cp/d	-	-	-	61	76	76	Refering to Japanese Standrad	Software Park, Center of Hi-Tech City
6.	Commercial *3	l/m^2	-	-	-	10.5	13.1	13.1		Amusement
7.	School *4	l/cp/d	-	-	-	19.2	24.0	24.0		E&T Zone
8.	Watering in Park, Ground	l/m^2/d	-	-	-	1.5	1.5	1.5	TCVN-4513-1988	Amusement
9.	Club House *5	l/cp/d	-	-	-	36.0	45.0	45.0	-	Stadium (Amusement), Golf Course (Amenity)
10.	Swimming Pool *6	m^3/d	-	-	-	412.0	412.0	412.0	-	Swimming Pool (Amusement)
	Over Flow Rate	%				10.0	10.0	10.0	TCVN-4513-1988	
11.	UFW	%	<25	<20	<20	25	20	20	TCXDVN-33-2006	all
12.	Daily maximum peak factor	x	1.2-1.4	1.2-1.4	1.2-1.4	1.2	1.2	1.2		all

notes:
*1: R&D: Water demand is assumed to be not so large as production manufacture. Therefore, 22m^3/day is applied.
Hi-Tech Industrial Park: Upper limit of standard water demand (45m^3/day) is applied.
Reserved Area: This area is assumed to be Hi-Tech Industrial Area. Therefore, 45m^3/day is applied.
*2: Japanese standard for office(127l/capita/d)*domestic demand in HHTP (l/capita)/Japanese standard domestic demand (250l/capita)
*3: Japanese standard for department store (21.8l/m^2/d)*domestic demand in HHTP (l/capita)/Japanese standard domestic demand (250l/capita)
*4: Japanese standard for department school (40l/capita/d)*domestic demand in HHTP (l/capita)/Japanese standard domestic demand (250l/capita)
*5: 40% of domestic water demand
*6: assumed size of swimming pool: 25m*15m*1.1mH
source: JICA Study Team

(2) Water Supply Demand Projection

Based on the rates above and the new land use plan proposed by VN Revised M/P, the water demand projection for the HHTP was estimated as shown below.

Table 5.5.2 Estimated Water Demand in the HHTP

ZONE	Stage 1 (m^3/d)	Stage 2 (m^3/d)	Total (m^3/d)
Software Park	660	310	970
R&D	2,920	2,090	5,010
High-Tech Industrial	8,890	1,540	10,430
Education & Training	710	3,020	3,730
Center of High-Tech City	1,440	0	1,440
Mixed Use	940	820	1,760
Houses & Offices	6,150	0	6,150
Housing Complex	3,380	2,870	6,250
Amenity	10	0	10
Amusement	4,100	450	4,550
TOTAL	**29,200**	**11,100**	**40,300**

Source: JICA Study Team

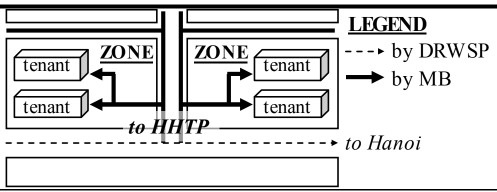
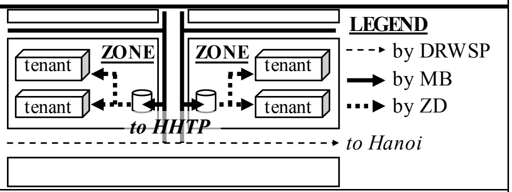
5.5.2 Plan Concept and Design Criteria

(1) Plan Concept

The following plan concept is applied for water supply to HHTP.

- High reliability water supply system both for external (supply from Da River Water Supply Project, hereinafter called as DRWSP) and internal systems.
  For external system, double supply system from current DRWSP's pipeline and future pipeline is recommended. Considering the easy connection and maintenance, future planned pipeline shall be used as a main supply pipe, if its construction can be done before the HHTP water supply construction works completed.
  For internal system, loop network system will be provided to secure the stable supply for 24 hours per day, 365 days per year.
- Simple operation and management in terms of technical and organization aspects.
  Considering the overall DRWSP system, their reservoir with capacity of 60,000m^3 can be assumed for HHTP, because of no any huge consumers upstream of the HHTP site. Therefore for easy maintenance and minimizing the investment and operation cost, own reservoir for HHTP which needs to have pumps operation shall be not required.
  Considering the advantages on the organization structure, JICA Study Team proposed two (2) alternatives below, which should be discussed and determined between HHTP-MB (MB), PMU-DRWSP, Hanoi Water Business Company and Zone Developer (ZD).

Table 5.5.3 Operation and Management (O&M) Structures

<table>
<tr><th>DRWSP – MB - Tenants</th><th>DRWSP – MB – ZD - Tenants</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td colspan="2">[Project Component]
1. Transmission Pipeline (from DRWSP connection point to each zone entrance).
2. Distribution Pipeline (from zone entrance to each tenant).
3. Necessary distribution system by ZD, such as reservoir and pump facilities.</td></tr>
<tr><td>[Project Component for MB]
- Both Transmission and Distribution Pipelines, starting from HHTP entrance (connection point from DRWSP) to every tenant.
- Water Meter for every tenant (connection point to tenants).</td><td>[Project Component for MB]
- Transmission Pipeline, starting from HHTP entrance (connection point from DRWSP) to Zone entrance.
- Water Meter for every Zone (connection point to ZDs).</td></tr>
</table>

[Technical Consideration] - Necessary temporary water supply system to supply water continuously to the current tenants.	[Technical Consideration] - Necessary to adjust the water supply system based on the detailed plan of every zone immediately. - Necessary temporary water supply system to supply water continuously to the current tenants.
[Operation & Maintenance Consideration] - Clear responsibility. - Currently no organization as well as staff of MB can operate and maintain water supply system.	[Operation & Maintenance Consideration] - Sequenced operation with zone development and sales strategy can be achieved. - Not all ZD was determined, therefore water supply system and its O&M structure can not be fixed. - Commonly, the contract for water supply was done between Supplier and Tenant, however in this case, it should be involved MB and ZD which required more over-head cost for O&M.
[General Evaluation] More Sufficient - Considering the capability of MB, it is suggested to out-sourcing the O&M works to private or public water supply company.	[General Evaluation] Not Sufficient - The Project can not be proceeded, due to detailed plan and sales strategy of every zone not decided yet.

Source: JICA Study Team

- Secure water supply plan for JICA Feasibility Study.
  Depend on the operation and management structure mentioned above, the major infrastructure work item will be different between 2 alternatives for O&M. The pipeline network and number of T-branch for the future connection will be much for [DRWSP – Tenants] case. Taking the maximum work item into consideration, the water supply development based on [DRWSP- Tenants] case is planned in the Study.

(2) Design Criteria

The design criteria for water supply are based on the following.

- TCXDVN-33-2006, latest Vietnamese standard for water supply
- TCVN-4513-1988, past Vietnamese standard for water supply
- Japanese design standard for water supply system
- TCVN 2622-95, Vietnamese regulation for fire fighting system.
- Utilization of program named EPANET-2 for pipeline network analysis, which was developed by US Environmental Protection Agency and has been used to calculate many water supply systems in Vietnam.

5.5.3 Proposed Water Supply Plan

Outline of the water supply system is shown in the Table 5.5.3 and Figure 5.5.1 below.

Table 5.5.4 Outline of Water Supply System

pipeline	unit	quantity	accessories	unit	quantity
1. DN100	km	39.25	1. air valve	set	13
2. DN150	km	6.00	2. drain valve	set	8
3. DN200	km	8.74	3. gate valve	set	126
4. DN250	km	1.41	4. T-branch	set	521
5. DN300	km	3.19	5. fire hydrant	set	328
6. DN350	km	2.17	note: all accessories including handhole and necessary civil works.		
7. DN400	km	3.86			
8. DN500	km	0.41			
9. DN600	km	1.33			

Source: JICA Study Team

Source: JICA Study Team

Figure 5.5.1 Layout Plan of Water Supply System

5.5.4 Design for Water Supply Facilities

The following design for the water supply facilities is applied for the Hoa Lac site.

(1) Pipeline

- Water pressure at consuming points must be at least 12m (1.2kg/cm^2) in normal condition and at least 10m (1.0kg/cm2) in condition of fire fighting, following proceedings of Vietnam Construction Standard, Volume VI, TCXD 33-85 (page 455).
- Ductile iron pipe will be used for water supply pipeline.
- Steel pipe will be used for pipeline across the river (on bridge), over the box drainage, etc.

(2) Installation

- Earth covering should be at least 0.6m from the ground surface to the top of pipe.
- For connection at valves, flanges, tees or bends will be used bending pipe. No welding pipe utilized.
- It's necessary to arrange pipe support at tees, bends outside valve pits due to the fact that pipeline in this case are totally placed on stable tamped ground and pressure of the system is not high; in addition, supports are arranged inside valve pits near turning points.
- Pipeline at river crossing point will be accompanied to the bridge structure (beam), therefore not necessary to construct separated pipe bridge.

(3) Accessories

- T-branch with valve and end-cap; will be installed at planned connection point for future development area or future distribution system unit with minimum distance of 100m.
- Air release valve; will be installed at high point a convex part of pipeline.
- Drain valve; will be installed at low point a convex part of pipeline.
- Gate valve with water meter: will be installed at necessary junctions to monitor and define the water leakage in future.

(4) Fire Fighting System

- Distance between 2 fire hydrant connection points (flanges) along a pipeline is 150m.
- The diameter of fire hydrant connection socket should meet with mandatory requirement from Fire Fighting Department of Hanoi Police.
- Fire hydrants shall not be located along radius of a curve at street intersections but located along the roads at 1.6m off the fence lines ensuring a good view and convenience for fire fighting and installation of other systems.

5.6 WASTEWATER SEWERAGE PLAN

5.6.1 Unit Wastewater Yield Projection

(1) Target Population

The target population in the Hoa Lac Area is estimated at about 193,326 by the JICA Study Team, as shown in Table 5.6.1.

Table 5.6.1 Design Population

Description	Stage 1(2015)	Stage 2(220)	Total
1. Area (ha)	980.8	287.2	1,268.0
2. Population in Total	11,8468	70,091	188,559
1) Daytime Population	53,328	36,606	98,625
2) Nighttime Population	65,140	33,485	98,625

Source: JICA Study Team

(2) Unit Wastewater Volume

The unit wastewater volume was set based on the unit water supply volume and 90% of the supplied volume is considered to be discharged to the sewerage system. The estimated daily average wastewater flow (DAWF) for domestic, industrial and commercial usage is as follows:

Classification of Wastewater	Unit Yield
1. Domestic wastewater	
1) Residents	135.0 (l/c/d)
2) Non-residents	68.4 (l/c/d)
3) Non-residents for Education & Training zone	21.6 (l/c/d)
2. Industrial/Commercial wastewater	
1) High-tech Industrial zone	40.5 (m^3/ha/d)
2) Research & Development zone	19.8 (m^3/ha/d)
3) Amenity and Amusement zones	40.5 (l/c/d)
3. Commercial wastewater for general purpose	10% of Domestic use

(3) Groundwater Infiltration

Groundwater infiltration and unexpected surface water intrusion shall be considered when designing the capacity of the sewerage collection system. Groundwater infiltration including unexpected surface water intrusion is assumed to be 10% to 20% of DAWF. In the Study, the proposed rate is 10% of DAWF, in consideration of geological conditions in the HHTP.

(4) Design Wastewater Volume

In this Study, three (3) types of wastewater volumes are set to account for designing various sewerage facilities:

- DAWF (Daily Average Wastewater flow)
  Generally applied to designing sludge treatment process and basic data for tariff collections
- DMWF (Daily Maximum Wastewater flow)
  Generally applied to designing wastewater treatment process which can be retain the maximum inflow around year
- HMWF (Hourly Maximum Wastewater flow)
  Generally applied to designing sewer pipes and pumping station which can accept peak flow rate due to hourly fluctuation of wastewater inflow

The ratio of each factor (peak factor) was adopted by comparing existing cases from big cities in Asian countries and general practices. The ratios were set as follows:

DAWF : DMWF : HMWF = 1.00 : 1.20 : 1.56

However, as for groundwater filtration, the volume calculated by DAWF was applied to DMWF and HMWF.

A summary of the Design Wastewater Yield is shown in Table 5.6.2.

Table 5.6.2 Summary of Design Wastewater Yield

Unit: m^3/day

Zone	Stage 1(2015)			Stage 2(2020)			Total		
	DAWF	DMWF	HMWF	DAWF	DMWF	HMWF	DAWF	DMWF	HMWF
1. Software Park	658	777	992	311	368	470	969	1,145	1,462
2. R&D	2,890	3,416	4,362	2,073	2,450	3,129	4,964	5,866	7,491
3. High-tech Industrial	8,794	10,393	13,271	1,524	1,801	2,299	10,318	12,194	15,570
4. Education & Training	656	775	990	2,783	3,289	4,199	3,439	4,064	5,189
5. Center of hi-tech City	1,353	1,600	2,042	0	0	0	1,353	1,600	2,042
6. Mixed Use	869	1,026	1,311	755	892	1,140	1,624	1,919	2,450
7. Houses & Offices	5,578	6,592	8,418	0	0	0	5,578	6,592	8,418
8. Housing Complex	3,059	3,615	4,616	2,608	3,082	3,935	5,667	6,697	8,552
9. Amenity	10	12	15	0	0	0	10	12	15
10. Amusement	74	87	112	0	0	0	74	87	112
11. Traffic & Infrastructure	0	0	0	0	0	0	0	0	0
12. Lake & Buffer	0	0	0	0	0	0	0	0	0
13. Greeneries/Trees	0	0	0	0	0	0	0	0	0
Total	23,941	28,294	36,129	10,054	11,882	15,173	33,995	40,176	51,302
Nominal Design Flow	**24,000**	**28,300**	**36,200**	**10,100**	**11,900**	**15,200**	**34,000**	**40,200**	**51,400**

DAWF: Daily Average Wastewater Flow, DMWF: Daily Maximum Wastewater Flow, HMWF: Hourly Maximum Wastewater Flow
Source: JICA Study Team

5.6.2 Plan Concept and Design Criteria for Sewerage System

(1) Sewerage Collection System

The VN Revised M/P adopted separated sewer systems for all areas in the HHTP. The same basis has been applied in the Study. In principle, the wastewater produced by industries will be treated in advance of discharging it into the sewerage system in order to meet the HHTP wastewater criteria. Highly loaded gray water and toxic/hazardous materials will be treated individually.

Basically, the sewer pipe will be installed as a gravity flow system. However, pressure pipe lines will also be applied when the depth of the installed gravity pipe goes deeper than around 7m or pipes must cross river channels to avoid difficult and dangerous construction work, as well as the escalation of construction cost.

(2) Materials of Sewer Pipes and Dimensions

Reinforced Concrete (RC) pipe is to be used for gravity sewer lines and Ductile Cast Iron Pipe (DCIP) is to be adopted for pressure lines. The minimum dimension of these pipes is set to 250mm and 150mm, respectively.

(3) Hydraulic Calculation of Sewer Pipes

For designing the gravity sewerage network, Manning’s formula was applied to decide the proper dimensions for accepting the design flow rate from area. This formula is given as below:

$$Q = A \cdot V$$
$$V = (1/n) \cdot R^{2/3} \cdot I^{1/2}$$

Where,
Q: Wastewater discharge (m^3/sec)
A: Sectional area of pipe (m^2)
V: Mean velocity (m/sec)
n : Roughness coefficient
R: Hydraulic radius (m)
I : Hydraulic gradient

The following re-rated criteria were applied to the hydraulic design of sewers:

- Roughness Coefficient (n): 0.015 (RC pipes, considering Vietnamese product)
- Allowable flow velocity(V): 0.6 ~ 3.0m/s (Compliant to Vietnamese Standard)
- Hydraulic gradient(I): Considered as same as gradient of sewer pipe (in full capacity condition)
- Allowance of sewer capacity: 100% of design HMWF

(4) Minimum Earth Cover

In the Study, the minimum earth cover is set at 1.50m so as to allow to access to discharge pipes from industries and buildings. However, the minimum earth cover for pressure pipes, which will be buried in the sidewalk, is set at 0.7m by following Vietnamese standard.

(5) Typical Interval of Manholes

The typical interval of manholes is arranged at 50m by considering a reduction of construction cost and actual necessity for daily maintenances.

(6) Pumping Station

Intermediate pumping stations will be established to lift wastewater from deeper gravity sewers or send wastewater by pressure lines. The pumping unit will use submersible pumps and units are to be located underground at sidewalks or in green areas so as not to restrict land use or affect the landscape of the HHTP.

5.6.3 Proposed Sewerage System Plan

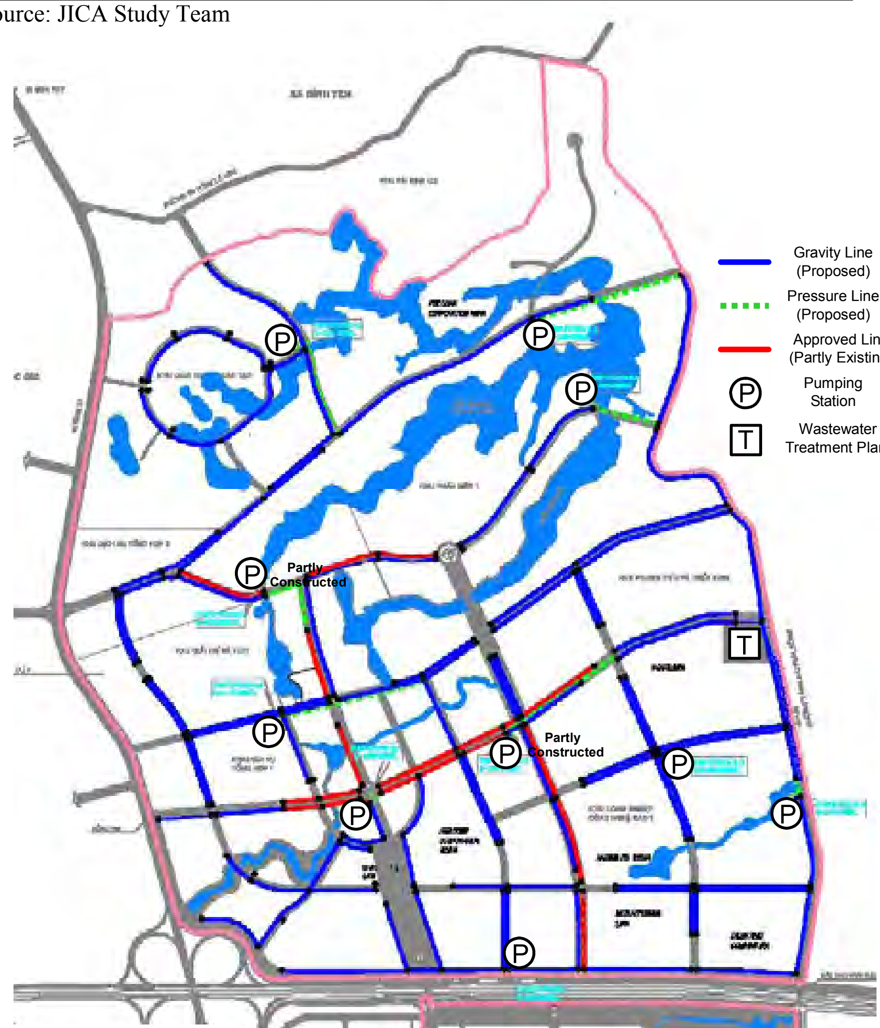
(1) Sewer Pipes

The total length of the sewerage system identified in the study is 53.7km of sewer lines (49.9km for gravity and 3.8km for pressure lines) are proposed. According to the VN Revised M/P, about 6.6km of sewer lines are contained within the approved sewer line of the previous construction scheme. However, most of lines not constructed yet, except for limited areas such as around pumping stations. Therefore, it is reasonable that these uncompleted sewer lines will not be counted as existing facilities for the sake of uncertainty and the lines will be listed as proposed facilities. A summary of the wastewater sewers is shown in Table 5.6.3 and a layout plan of sewerage network is shown in Figure 5.6.1.

Table 5.6.3 Summary of Wastewater Sewers

Type	Material	Diameter (mm)	Length of Pipes (m)		
			Proposed	Total	Approved (Previous Plan)
Gravity	RC	250	30,627	49,893	4,628
	RC	300	3,798		52
	RC	350	1,762		0
	RC	400	2,184		0
	RC	450	3,239		350
	RC	500	1,321		0
	RC	600	3,336		686
	RC	700	808		0
	RC	800	1,251		306
	RC	1,000	797		0
	RC	1,350	770		0
Pressure	DCIP	150	343	3,739	0
	DCIP	200	520		0
	DCIP	250	1,246		221
	DCIP	300	78		0
	DCIP	350	89		0
	DCIP	400	762		0
	DCIP	600	701		351
Total			-	53,632	6,594

Source: JICA Study Team



Source: JICA Study Team

Figure 5.6.1 Layout Plan of the Sewerage Network

(2) Pumping Station

In total, the Study has identified a need for ten (10) pumping stations. However, Pumping Station No.1 and No.3 are partially constructed facilities (only the civil works are completed) and this work was implemented during a previously approved project. In the Study, all the ten (10) pumping stations will be contained within the Project as proposed facilities because of the need to consider uncompleted facilities as being unreliable for utilization. A summary of the pumping stations is shown in Table 5.6.4.

Table 5.6.4 Summary of Pumping Stations

No.	Name	Capacity (m^3/s)	Submersible Pumping Unit					Head (m)	Remarks
			Diameter (mm)	Output (kw)	Nos.				
					Duty	Standby	Total		
1	Pumping Station No.1	0.053	150	11	1	1	2	12.7	Uncompleted
2	Pumping Station No.2	0.037	150	11	1	1	2	16.9	
3	Pumping Station No.3	0.304	350	22	2	1	3	9.1	Uncompleted
4	Pumping Station No.4	0.048	150	7.5	1	1	2	8.8	
5	Pumping Station No.5	0.019	150	5.5	1	1	2	7.1	
6	Pumping Station No.6	0.161	200	22	2	1	3	12.7	
7	Pumping Station No.7	0.079	200	11	1	1	2	8.0	
8	Pumping Station No.8	0.051	150	5.5	1	1	2	5.5	
9	Pumping Station No.9	0.112	200	7.5	2	1	3	7.0	
10	Pumping Station No.10	0.026	150	5.5	1	1	2	4.7	

Source: JBIC Study Team

5.6.4 Unit Wastewater Yield Projection

(1) Capacity of Treatment Facility

Required capacity for expansion units is estimated by considering phased construction and six (6) units of wastewater treatment plant with a capacity of 6,000m^3/day will be identified in the study as shown in Table 5.6.5.

Table 5.6.5 Projection of Capacity for Expansion Unit

Unit: m^3/day

Items	Stage 1(2015)			Stage 2(2020)			Total
	Step 1 Existing	Step 2	Total	Step 1	Step 2	Total	
Number of Unit	1	3	4	2	1	3	7
DMWF	6,000	17,100	23,100	11,400	5,700	17,100	40,200
Capacity per Unit	6,000	6,000	-	6,000	6,000	-	-
Total Capacity	6,000	18,000	24,000	12,000	6,000	18,000	42,000

Source: JICA Study Team

(2) Design Wastewater Quality

The unit pollutant load was determined by applying a biological oxygen demand (BOD) of 60gpcd for domestic wastewater. The pollutant load for partial visitors to commercial areas is distributed by considering the usage of water. The aerial unit pollutant loads that will be applied to Commercial and Industrial areas are based on discharging criteria set in the Vietnamese standard. The unit pollutant load for BOD and suspended solids (SS) are summarized in Table 5.6.6 and the design pollutant load and wastewater quality is shown in Table 5.6.7.

Table 5.6.6 Unit Pollutant Load

Category			Unit Wastewater Volume		Unit Pollutant Load /Water Quality			Remarks
			Unit	Value	Unit	BOD	SS	
Domestic			lcpd	135.0	gpcd	60.0	75.0	
Commercial	Commuters & Guests	Type 1	lcpd	68.4	gpcd	30.0	37.5	Applied to General Commuters
		Type 2	lcpd	40.5	gpcd	20.0	25.0	Specialy applied to Amenity, Amusement
		Type 3	lcpd	21.6	gpcd	10.0	12.5	Specialy applied to Education and Training
	Resident Workers	Type 4	lcpd	13.5	gpcd	-	-	Included in Domestic Load
	Activities	Type 5	m^3/ha	19.8	mg/l	100	125	Specialy applied to R&D
Industrial			m^3/ha	40.5	mg/l	200	250	Applied to Hitech Industrial Zone

Source: JICA Study Team

Table 5.6.7 Pollutant Load and Wastewater Quality

Item		Type	Unit	Stage 1	Stage 2	Total
Design Wastewater Volume		Domestic Wastewater	m^3/day	8,794	4,520	13,314
		Commercial Wastewater	m^3/day	4,976	3,235	8,210
		Industrial Wastewater	m^3/day	7,995	1,385	9,380
		Ground Water	m^3/day	2,176	914	3,090
		Total	m^3/day	23,941	10,054	33,995
Pollutant Load	BOD	Domestic Wastewater	kgBOD/day	3,908	2,009	5,918
		Commercial Wastewater	kgBOD/day	914	593	1,507
		Industrial Wastewater	kgBOD/day	1,599	277	1,876
		Total	kgBOD/day	6,421	2,879	9,301
	SS	Domestic Wastewater	kgSS/day	4,886	2,511	7,397
		Commercial Wastewater	kgSS/day	1,142	741	1,884
		Industrial Wastewater	kgSS/day	1,999	346	2,345
		Total	kgSS/day	8,026	3,599	11,626
Influent Quality	BOD		mg/L	268	286	274
	SS		mg/L	335	358	342

Source: JICA Study Team

(3) Target Treated Water Quality

The target treated wastewater quality was determined by considering the Vietnamese standard and the criteria for Class B shall be fulfilled. Therefore, the effluent quality must comply with the limit of not more than 50mg in BOD and 100mg/L in SS, as regulated by the criteria. The discharge quality criteria are shown in Table 5.6.8.

Table 5.6.8 Standard for Discharge Quality

Key Parameter	Unit	Class A	Class B	Class C
Temperature	^{o}C	40	40	50
pH	-	6~9	5.5~9	5-9
BOD_5	mg/L	20	50	100
SS	mg/L	50	100	200

Class A: Discharging to a water basin used for water supply purpose.
Class B: Discharging to a water way used for transport irrigation, washing purposes.
Class C: Discharging to a sewer.
Source: TCVN5945-1995

However, for the wastewater treatment plant, it is recommended that a stricter capability be targeted in order to cope with unexpected wastewater quality levels in the future. Therefore, the target quality has been set at 20mg/L BOD for facility design.

(4) Treatment Process

Considering the characteristics of wastewater volume and quality, a conventional activated sludge process is recommended for wastewater treatment within the HHTP. In regard to the sludge treatment process, a gravity thickener and mechanical dewatering process are recommended. An outline of the treatment process is shown in Figure 5.6.2.

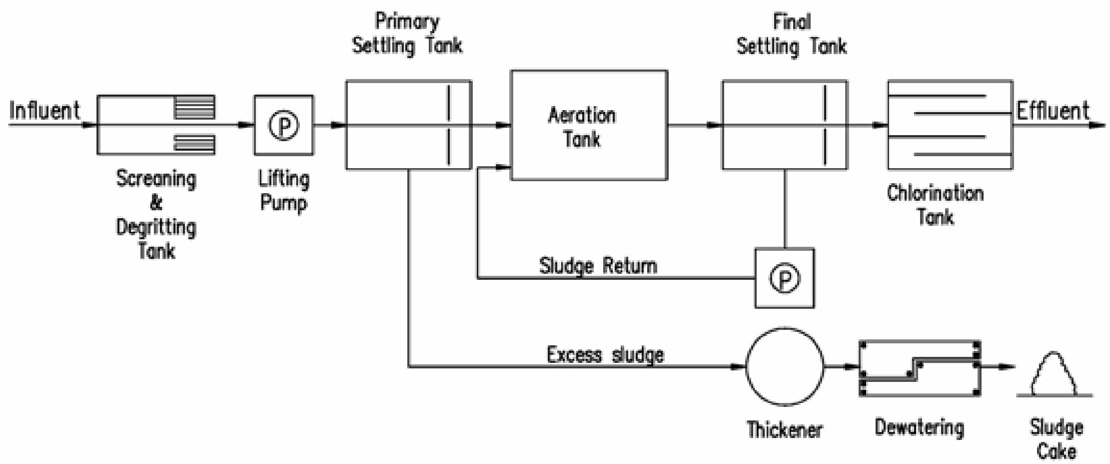


Figure 5.6.2 Outline of Treatment Process

(5) Proposed Wastewater Treatment Plant

Through the preliminary facility design for wastewater treatment plants, it was determined that six (6) units of wastewater treatment plant will be required. These will have a total capacity of 36,000m^3/day, excluding the existing wastewater treatment unit (6,000m^3/day). The general layout plan of a typical wastewater treatment plant is shown in Figure 5.6.3 and a summary of the design criteria is shown in Table 5.6.9.

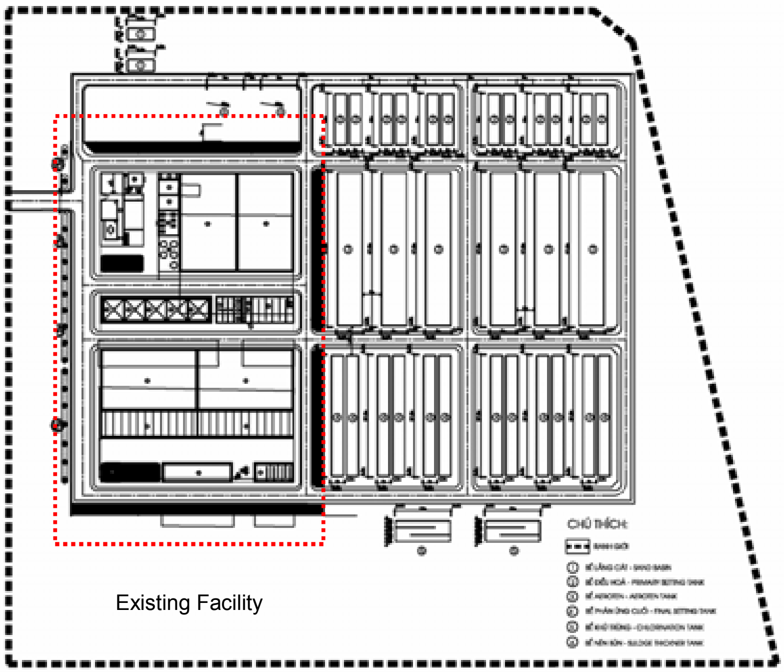


Figure 5.6.3 General Layout Plan of Wastewater Treatment Plant

Table 5.6.9 Proposed Facilities of Wastewater Treatment Plant

Item		Unit	Existing	Proposed				Total
				Stage 1(2015)	Stage2(2020)		Subtotal	
					Step 1	Step 2		
Design Flow Rate		m^3/d	6,000	17,100	11,400	5,700	6,000	6,000
Nominal Capacity		m^3/d	6,000	6,000	6,000	6,000	-	-
Number of Units		nos	1	3	2	1	6	7
Total Capacity		m^3/d	6,000	18,000	12,000	6,000	36,000	42,000
Sand Basin	Length	m	2.1	8.5	-	-	-	-
	Breadth	m	5.7	1.5	-	-	-	-
	Depth	m	5.9	1.1	-	-	-	-
	Number	nos	1	2	-	-	2	3
Primary Settling Tank	Length	m	6.2	16.0	16.0	16.0	-	-
	Breadth	m	6.2	4.0	4.0	4.0	-	-
	Depth	m	2.9	3.0	3.0	3.0	-	-
	Number	nos	5	6	4	2	12	17
Aeration Tank	Length	m	29.0	45.0	45.0	45.0	-	-
	Breadth	m	18.5	8.0	8.0	8.0	-	-
	Depth	m	4.4	6.0	6.0	6.0	-	-
	Number	nos	2	3	2	1	6	8
Final Settling Tank	Length	m	29.0	37.5	37.5	37.5	-	-
	Breadth	m	8.0	4.0	4.0	4.0	-	-
	Depth	m	4.4	3.0	3.0	3.0	-	-
	Number	nos	2	6	4	2	12	14
Chlorination Tank	Length	m	5.4*8nos	17*3nos	17*3nos		-	-
	Breadth	m	1.0	2.0	2.0		-	-
	Depth	m	2.1	2.0	2.0		-	-
	Number	nos	1	1	1		2	3
Sludge Thickener	Method		Chemical	Gravity Thickner			-	-
	Diameter	m	-	10.0	-	-	-	-
	Depth	m	-	2.5	-	-	-	-
	Number	nos	L/S	2	-	-	2	3
Sludge Dewatering	Type		Mechanical Dewatering				-	-
			Centrifugal	Filter Press Dewatering			-	-
	Number	nos	6	3	2	-	5	11

Source: JICA Study Team

5.7 POWER SUPPLY PLAN

5.7.1 Power Demand Projection

Initially, the demand projection was carried out for an area of 1,268ha in the Hoa Lac area, which includes of the Study Area comprising 1,036ha, as shown in Table 5.7.1. This was followed by a power demand analysis for an area comprising 318ha in the Northern Phu Cat area, as shown in Table 5.7.2. These calculations, allowed the demand for the HHTP to be determined.

Table 5.7.1 Demand Projection for the Hoa Lac Area (1,268ha)

Area	ha	kVA
Hoa Lac Area (including 1,036ha)	1,268	147,111
Scope of the Study Area	1,036	99,578

Source: JICA Study Team

Table 5.7.2 Demand Projection for the Northern Phu Cat Area (318ha)

Area	ha	kVA
Northern Phu Cat Area	318	116,912

Source: JICA Study Team

Based on the above demand projections, the required total demand for Hoa Lac area and Northern Phu Cat area is estimated as approximately 264MVA, as shown in Table 5.7.3.

Table 5.7.3 Total HHTP Demand Projection

Area	Assumed Demand (MVA)
Hoa Lac Area	147 MVA
Northern Phu Cat Area	117 MVA
Total	264 MVA

Source: JICA Study Team

The calculation sheet of demand projection is shown in the Appendix F of the Supporting Report.

5.7.2 Plan Concept and Design Criteria

The HHTP is a high tech park, which requires high reliability supply networks comprising state of the art facilities. These facilities have to be operated without any power interruption, which is different to many existing electrical facilities in Vietnam. Therefore, as a concept, it is prerequisite to have power entities like EVN and power companies have a different mind from the one toward existing facilities owned by the EVN and the power companies.

The reliability of the power supply system depends not only on each of the components, but also depends on the whole system. The failure of any of the components could cause the failure of whole system. To generally guarantee reliability, exclusive use of 110kV transmission lines for the HHTP is a possible solution, providing that the power station(s) supplying the power remain operational. In comparison, the reliability of a 220kV system is higher than that of the 110kV systems due to its simpler configuration. This is generally because 220kV transmission lines normally connect a few substations, with long distances in between. In order to enable high reliability in the power system, adopting 220kV transmission lines for the supply transmission line is recommended. This construction is planned in the VN Revised M/P.

One of the indexes in electrical supply reliability is appraised with N-1 conditions. The conditions are such that power supply has to be guaranteed provided that one of the electrical components such as a generator, transmission line, or transformer is out of services. For this supplying plan, N-1 conditions will be applied to guarantee the reliability. In the development of power supply for the HHTP, the following criteria are applied for the design:

Criteria	Strategy
a)To follow N-1 conditions that are used as an index to measure electrical supply reliability	- To secure 110kV transmission lines comprising at least 2 cct (circuit) This capacity is sufficient to allow supply of the whole demand through 1cct. This will ensure continuous power supply even if one of the transmission lines is damaged. - To install a standby transformer to ensure continuous power supply even if one of the transformers fails. - To install a double-loop distribution system inside the HHTP.

b)To follow recommendation mentioned in PDP 6th made by Vietnam	- To adopt the recommendation of PDP 6th (The National Power Development Plan in the Period of 2006 -2015, Perspective up to 2025).
c)To achieve easy maintenance	- To adopt open an loop Ring Main Unit distribution system that is widely applied, especially for industrial parks in Vietnam which have Japanese companies in them.

5.7.3 Proposed Power Supply Network Plan

In relation to the power supply up to 2015, there are three (3) plans; i) VN Revised M/P, ii) Plan prepared by Ha Tay Province with the Department of Industry and Trade, and iii) The JICA Updated M/P. The planned installed capacity of the transformers is different in the VN Revised M/P and the JICA Updated M/P. However, the capacity specified in both of these plans is similar because VN Revised M/P was based on the outcome of the JICA Updated M/P. As a result, the installed capacity of the transformers specified in the VN Revised M/P will be used.

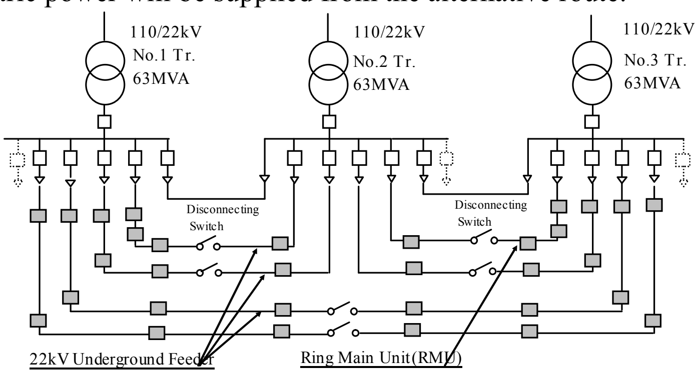
The receiving substation transformer will require a capacity of more than 134MVA in order to cover the demand of the HHTP comprising 1,268ha in Hoa Lac Area. It is planned that one exclusive substation for the transformers should be constructed in accordance with the criteria specified in Table 5.7.4 (capacity and number of units). These criteria are based on the assumption that, except for the power requirements in the 1,036ha that comprise the current Study Area, power for the remaining area of Hoa Lac area will be supplied by the substation that was planned in the VN Revised M/P for the Phu Cat area.

Table 5.7.4 Required Substation Capacity for the Hoa Lac Area (1,268ha)

Area	Assumed Demand (MVA)	Recommended Capacity Installation
Hoa Lac Area	134MVA (147MVA divided by 1.1 of diversity factor)	63MVA×3 units(one unite for standby)

Source: JICA Study Team

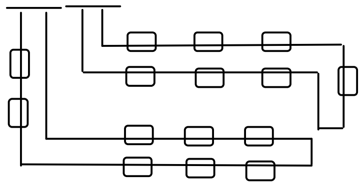
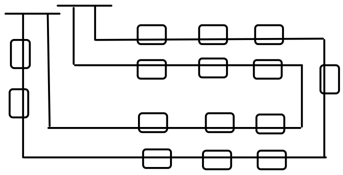
The recommended supply method inside the HHTP is shown in Figure 5.7.1. For the Hoa Lac No.1 S/S as receiving substation, three (3) units of transformers should be installed. Two (2) of the transformers shall be operated regularly. Another one (1) transformer shall be used for standby. Usually, disconnecting switches will be opened, and the status of the looped distribution feeders will be open. In the case of an emergency, the disconnecting switches will be closed and electric power will be supplied from the alternative route.



Source: JICA Study Team

Figure 5.7.1 Recommended Supply System Configuration for Hoa Lac No.1 S/S

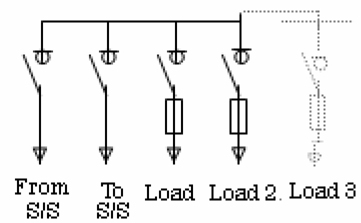
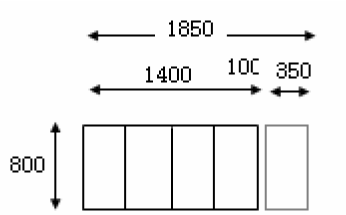
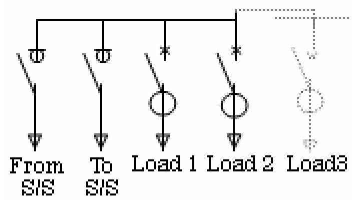
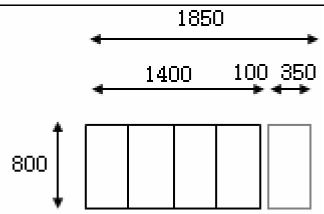
The power supply voltage for the HHTP will be 22kV and the supply system has been designed to use a RMU network. In the RMU network, there are two types of supply systems, as shown in Figure 5.7.2. It is proposed that the Ring Loop system should be adopted in terms of reliability.

	Parallel Loop	Ring Loop
Recommendation	Not recomended	Recommended
Configuration		

Source: JICA Study Team

Figure 5.7.2 Comparison of Loop Installation Methods

Figure 5.7.3 shows the types of RMU that are planned to be installed for this supply network.

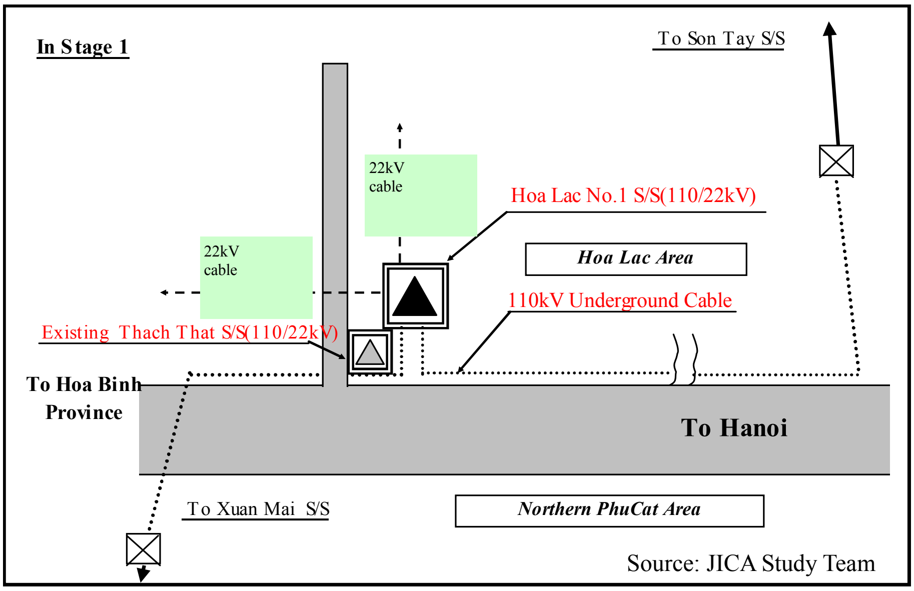
	Single Line Diagram	RMU Dimensions (Top View)
FSx2+Ex RMU (Fuse Switch Feeder x 2) Expandable		
CBx2+Ex RMU (Circuit Breaker Feeder x 2) Expandable		

Source: JICA Study Team

Figure 5.7.3 Types of Ring Main Units (RMU)

5.7.4 Proposed Substation Plan

To cover the demand projected for Hoa Lac area, the Hoa Lac S/S comprising three (3) units of 63MVA transformers should be installed adjacent to the existing Thach That S/S. The location of the substation is shown in Figure 5.7.4 and Figure 5.7.7. Necessary dimension for Hoa Lac No.1 is approx. 3,025m^2 (55m×55m). Further information is mentioned in Chapter 5.7.5.



Source: JICA Study Team

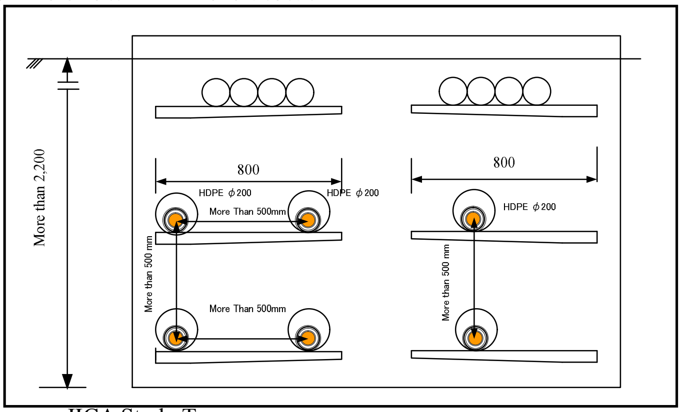
Figure 5.7.4 Location of Hoa Lac No.1 S/S

5.7.5 Design for Power Supply Facilities

The following projects should be implemented to supply power to Hoa Lac area.

(1) Relocation of Over-Head Transmission Line to Underground Cable

Relocation of 110kV overhead transmission line to underground cables should be implemented because existing transmission line will disturb the development of adjacent area of the lines and also there is a regulation in Vietnam that all of transmission lines in new development has to be laid underground. The location of the relocation is shown in Figure 5.7.5. Specification and quantity of equipment is shown in Table 5.7.5.



Source: JICA Study Team

Figure 5.7.5 Section layout of 110kV underground cable

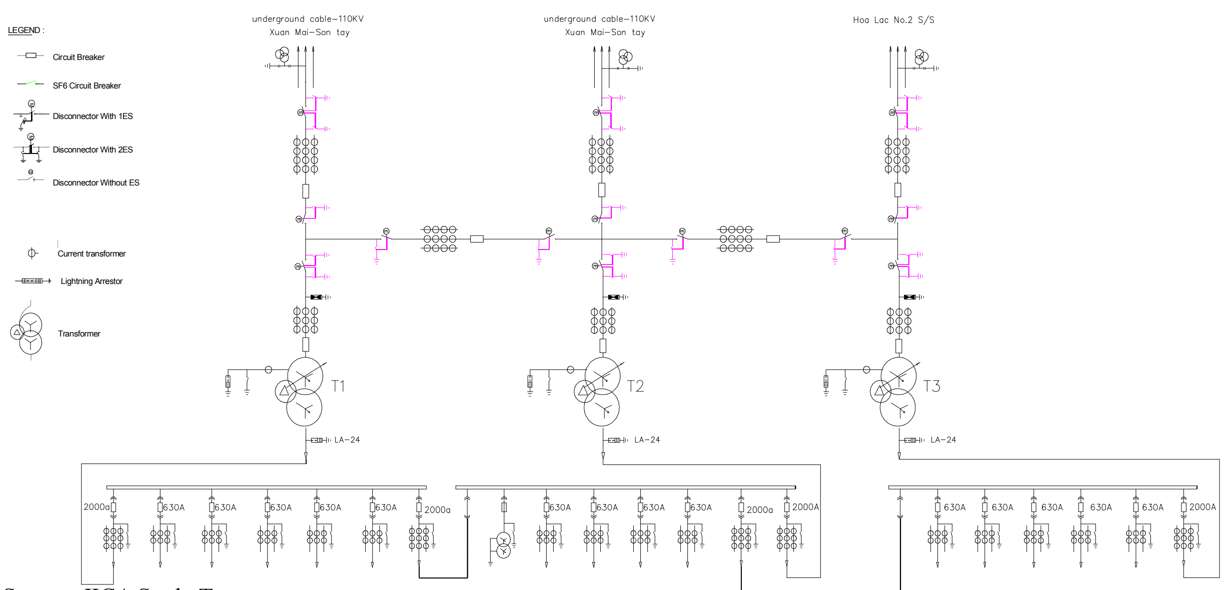
Table 5.7.5 Specification and Quantity of Equipment for Relocation of Transmission Lines

Facilities to be Installed	Specification	Quantity
Dismantlement of existing transmission line	110kV 2cct.	Approx.5km
Underground cable	110kV XLPE 300×3×2cct. Non-flammable	Approx.5km (length of the cable approx.30km)
Cable accessory	For overhead line and transformer	1 lot
Pipe	HDPE φ200	30 km
Manholes		1 lot

Source: JICA Study Team

(2) Construction of Hoa Lac 110 /22kV No.1 S/S

The configuration of electrical equipment for Hoa Lac No.1 S/S is shown in Figure 5.7.6



Source: JICA Study Team

Figure 5.7.6 Configuration of Electrical Equipment for Hoa Lac No. 1 S/S

Specification and quantity of equipment is shown in Table 5.7.6.

Table 5.7.6 Specification and Quantity of Equipment for Hoa Lac No. 1 S/S

Facilities to be installed	Specification	Quantity
Power Transformer	110/22kV, 63MVA	3 units
Disconnecting switch	123kV, 3-pole	13 units
Circuit Breaker	123kV, 3-phase,Ourdoor-use	8 units
22kV distribution cubicle	Incoming and Outgoing 630A, Bus section 2000A	20 units
Control house	Monitoring system, DC supply system, and station use generator	1 lot
Miscellaneous		1 lot

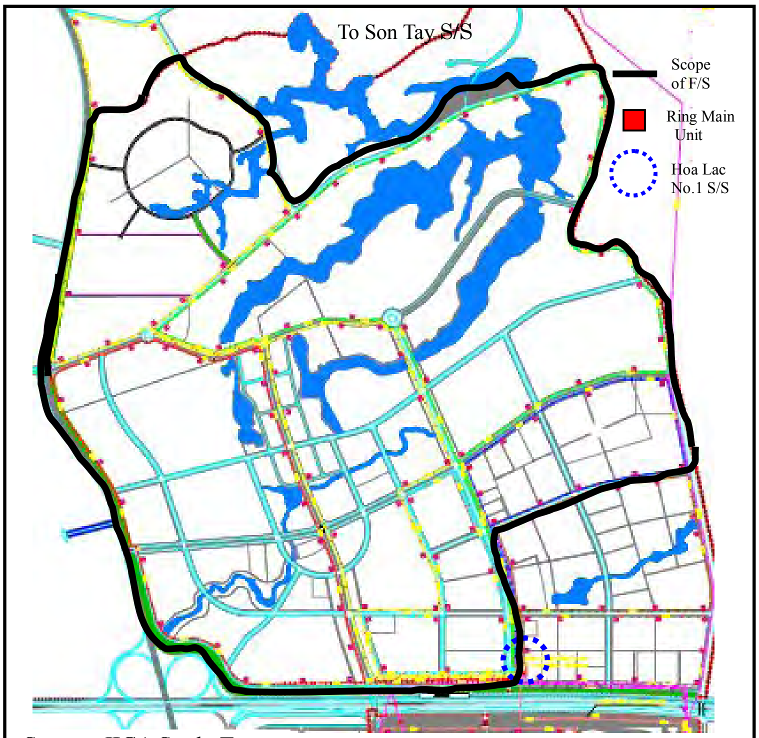
Source: JICA Study Team

(3) Installation of Feeders and Ring Main Unit (RMU)

From Hoa Lac No.1 S/S onwards, it is necessary that 14 distribution lines of 22kV along with other infrastructures in the buffer zone should be installed underground along the roads. The cable to be installed applies to the specification of 24kV-Cu/XLPE/DSTA/PVC.

The route of feeders and the location of the Ring Main Unit are shown Figure 5.7.7. The detail location of Ring Main Unit is shown in Drawing PS-DN-01.

The required specification and quantity of equipment is shown in Table 5.7.7.



Source: JICA Study Team

Figure 5.7.7 Feeder Route and Location of the Ring Main Unit

Table 5.7.7 Specification and Quantity of Equipment for the Ring Main Unit Network

Facilities to be installed	Specification	Q'ty
No. of feeder	22kV Cable installed in technical ditch	14 feeders
Distribution cable	24kV-Cu/XLPE/DSTA/PVC Non-flammable	Approx. 75km
Cable accessory	24kV-Cu/XLPE/DSTA/PVC	1 lot
Pipe	Steel Pipe	Approx. 75km
Miscellaneous		1 lot
Ring Main Unit	Compartment	119 units
	No. 1 loop	22 units
	No. 2 loop	29 units
	No. 3 loop	10 units
	No. 4 loop	25 units
	No. 5 loop	11units
	No. 6 loop	11 units
	No. 7 loop	11 units

Source: JICA Study Team

5.8 TELECOMMUNICATION PLAN

5.8.1 Demand for Telecommunication System

Telecommunication demand within the HHTP has been forecast on the basis of the development area, population projection, estimated number of households in each development zone, the density of subscribers defined in the VN Revised M/P, statistical data for average broadband user network traffic in Japan, etc.

(1) Estimated Number of End-Users

The estimated number of end-users (subscribers) is shown in Table 5.8.1 by considering the differences in user demand. The number of home users, broadband users (companies, factories or other middle users) and ultra-fast broadband users (institution, universities or other heavy users) have been estimated. The total number of end-users within the HHTP is estimated at around 22,000 users. This total comprises 9,380 home users, 12,358 broadband users and 358 ultra-fast broadband users.

Table 5.8.1 Estimated Number of End Users

(As of 2020)

No	Functional zone	Estimated Number of End Users			Total (Users)	Total (Fiber Cable)
		Home Users	Broadband Users	Ultrafast Broadband Users		
1	Software Park	-	1,440	160	1,600	343
2	R&D	-	28	28	56	84
3	Hi-tech Industrial	-	55	-	55	55
4	Education & Training	-	-	4	4	8
5	Center of the Hi-tech City	-	621	69	690	148
6	Mixed Use	-	869	97	966	221
7	Houses & Offices	4,410	4,410	-	8,820	276
8	Housing Complex	4,935	4,935	-	9,870	308
9	Amenity	1	-	-	1	1
10	Amusement	34	-	-	34	34
Total		9,380	12,358	358	22,096	

Source: JICA Study Team

(2) Network Traffic Demand Forecasting

The total network traffic demand in the HHTP was forecast on the basis of the predicted conditions. The network traffic demand was estimated to total 27Gbps or more. The forecast traffic demand indicates the necessity for strengthening the carrier's trunk network capacity between the inside and outside of the HHTP.

5.8.2 Basic Plan Concept for the Telecommunication System

Establishment of an efficient telecommunication system will be one of key items for promoting and assisting the development of the HHTP. The telecommunication system will be an essential tool for accelerating Research & Development, for promoting advanced high-tech manufacturing and commercialization, for advancing human resources development, and for assisting business incubation. The telecommunication system within the HHTP has been proposed by considering the following basic concepts.

- Fascinating information services, such as mega-data transfer, teleconferencing, video on demand, security services, etc. will be provided to all end-users within the HHTP, matching the future image of the HHTP.
- In order to offer the required high-level services, a telecommunication system based on the Next Generation Network (NGN), which can provide high reliability, safety and seamless communications will be introduced. The latest communication system using optic fiber technologies and advanced wireless mobile access systems will be supplied for the user network access services.
- The above telecommunication systems will be provided to end-users as the final goal. However, it is recommended that these telecommunication systems will be constructed, operated and maintained by the communication carriers themselves from view points of maintaining network connectivity with the outside of the HHTP, operation license regulation of the telecommunication system, etc. Therefore, the Project shall cover optic fiber cable, telecommunication conduits (pipelines for cables) and antenna towers so that the carriers can install the telecommunication systems smoothly.

5.8.3 Final Goal of Telecommunication System

(1) End-user Telecommunication Services

In recent years, telecommunication services and applications requested by end-users have become more multifaceted, i.e. data communication and multimedia services represented by internet, video conference and IPTV, as well as conventional voice/fax communication are required. Furthermore, considering the features of the HHTP, provision of large file transfer services such as are required for images and CAD data, security services to protect the system from cyber attack, e-education, telemedicine or other specific applications are expected. The end-user services to be provided within the HHTP and their expected beneficiaries are summarized in Table 5.8.2 below.

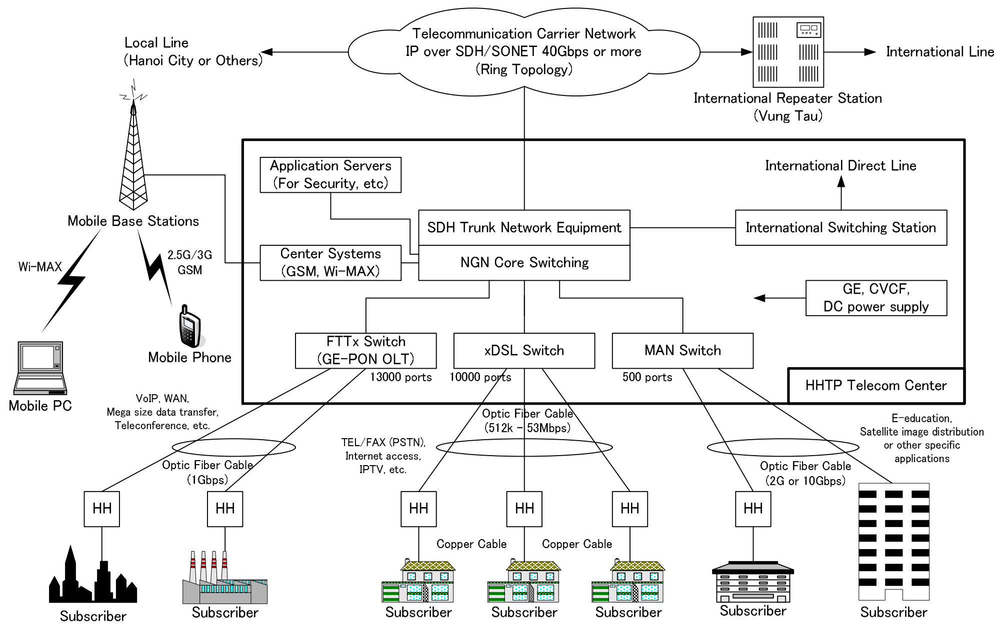
Table 5.8.2 End-User Services and Expected Beneficiaries

End-User Services		Expected End-Users		
		Home User	Office User	Institution, Others
Audio/Data Communications	Voice Communication/FAX	O	O	O
	Internet Access Service	O	O	O
	Office Network System (WAN)	-	O	O
	Large File Transfer/Sharing Service	-	O	O
Multimedia Communications	Videoconference	-	O	O
	IPTV	O	-	-
	Triple/Quattro Play Services	O	O	O
Others	Security Service	O	O	O
	E-education	-	-	O
	Telemedicine	-	-	O
	Satellite Image Dissemination Service	-	-	O
Mobile Access	GSM Mobile Communication Services	O	O	O
	Wireless Access Service	O	O	O

Source: JICA Study Team

(2) Telecommunication System Configuration

The expected overall telecommunication system configuration in the HHTP is shown in Figure 5.8.1.



Source: JICA Study Team

Figure 5.8.1 Proposed Overall Telecommunication System Configuration

The main features of the proposed telecommunication system are summarized below.

- A telecommunication network based on the latest NGN standard with sufficient network capacity will be introduced. Introduction of NGN will also contribute to reduce the network construction costs.
- The telecom center where the network switching, server systems to provide various end-user services, etc. are to be installed will be built within the HHTP.
- Three types of wired communications will be provided, depending on the end-user demands. These are i) xDSL[*1] network for home users; ii) FTTx[*2] network for office users; and iii) MAN[*3] network for heavy users. All these services will utilize optic fiber technologies.
- Two types of mobile communications will be established. These are; i) Mobile phone use, and ii) Mobile computer access use. As for the mobile phone system, an advanced 3G GSM[*4] (Global System for Mobile Communications) which is one of the latest mobile communication standards in Vietnam, as well as existing 2.5G GSM, will be introduced. Furthermore, to realize a good mobile computer access environment, a wireless broadband computer access system such as Wi-MAX will be introduced.
- To strengthen the linking between the inside and the outside of the HHTP, high capacity network facilities connected to the carrier's trunk line and international switching station will be installed in the telecom center.

5.8.4 Proposed Realistic Telecommunication Plan

The telecommunication services and systems that comply with NGN standards, as described above, shall be provided all end-users in the HHTP as the final goal. However, from the following points of view, it is considered that construction and operation of the telecommunication system by HHTP-MB is not a realistic approach.

(1) The telecommunication system inside the HHTP must keep the network connectivity with communication carrier's system to communicate with the outside of the HHTP. Generally, it is difficult to secure the network interface between different vendors' facilities. Therefore, if the telecommunication system inside the HHTP were provided by HHTP-MB, the system may not connect to the carrier's network. To avoid such risks, it is proposed that the carriers themselves supply the telecommunication system.

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[1] xDSL: xDSL is a contraction of Digital Subscriber Line, which is wired communication technology that provides digital data transmission with a capacity from 512kbps to tens Mbps over the wires of existing telephone networks. Internet data is carried over a high-frequency band whereas the voice is carried over a lower-frequency band in a single phone line. Asymmetric Digital Subscriber Line (ADSL) is one of major xDSL technologies.

[2] FTTx: "Fiber to the x" (FTTx) is a collective term for any network architecture that uses optic fiber to connect directly to homes, condominiums, buildings, etc. For example, Fiber to the Home (FTTH) and Fiber to the Building (FTTB). FTTx allows delivery of broadband services (1Gbps or more).

[3] MAN: Metropolitan Area Network (MAN) is a larger computer network that spans a metropolitan area or campus. When connected directly to a carrier network core-switch, a MAN can provide 2Gbps or 10Gbps broadband services to users.

[4] GSM: Global System for Mobile communications (GSM) standardized by European Telecommunications Standards Institute (ETSI) is the most popular standard for mobile communications in the world.

(2) Companies that do not have a license issued by MIC cannot provide telecommunication services to end-users. Thus, the communication carriers owned the license instead of HHTP-MB must operate and maintain telecommunication system inside the HHTP.

(3) Some communication carriers have already made agreements with HHTP-MB and these carriers have already committed to invest in the telecommunication system within the HHTP, including the telecom center, with an appropriate total budget.

For this reason, the demarcation of the telecommunication system within the HHTP is proposed as follows.

Table 5.8.3 Proposed Demarcation Plan of the Telecommunication System

No.	Item	HHTP-MB Side	Communication Carrier
1.	Construction		
(1)	Wired Communication		
1)	Telecommunication Pipe	○	
2)	Optic Fiber Cable	○ (Initial Stage)	○
3)	Carrier's Trunk Network System		○
4)	Network System (xDSL, FTTx, MAN)		○
(2)	Wireless Communication		
1)	Network System (GSM, Wi-MAX)		○
2)	Antenna Tower and Base Station House	○	
(3)	Telecom Center		
1)	Building		○
2)	Server System		
3)	Power Supply System, Others		○
2.	Operation & Maintenance		
1)	Operation		○
2)	Maintenance		○

Source: JICA Study Team

An application for an ODA funding scheme will be required for the telecommunication conduits optic fiber cable and the antenna towers, including the base station houses, so that the carriers can install the telecommunication systems smoothly. Other communication facilities shall be provided by the communication carriers.

In addition, the payment structure for telecommunication services will be determined by the communication carriers.

5.8.5 Design of Telecommunication Infrastructures

(1) Conduit System

As mentioned previously, all telecommunication network cables will be applied for fiber optic cable due to its cost merit comparing with metallic cable. For the security and landscape purpose, whole telecommunication cables shall be installed in the underground. As for protection of the cable, four (4) conduits for each zone will be laid in the technical ditch installed along the road (under pathway).

Meanwhile, in consideration of the telecommunication demand at initial stage, one (1) optic fiber cable with 100 cores are planned to be installed in the telecommunication pipe. In order for easy connection with end-user’s building, interval of the optic fiber splicing box should not be less than 100m.

Figure.5.8.2 below shows the telecommunication conduit and optic fiber cable plan. Estimated quantities of the telecommunication conduits and optic fiber cables are summarized as follows.

Table 5.8.4 Estimated Quantities of the Telecommunication Conduit

Item	Description	Unit	Quantity
1. Conduit	Steel Pipe D=100mm x 4 x 4	km	61
2. Optic Fiber Cable	SM-100C	km	64
3. Optic Fiber Splicing Box		unit	500

Source: JICA Study Team

(2) Antenna Tower and Base Station House

Installation of a common antenna tower shared by the wireless communication carriers is recommended to avoid damage to the aspect and radio disturbance of the SPI satellite system. According to discussions with carriers, the coverage area for a wireless base station is generally a diameter of 1km for inner city locations and around 5km in suburban locations. In this study, the locations of antenna towers have been planned so that one base station covers a diameter of 2km. A total of seven (7) new antenna towers will be installed. The main components of the antenna tower system are shown in Table 5.8.5. The height of antenna tower is set 50m for cost estimate, however, the detailed plan shall be reviewed in the detailed design.

Table 5.8.5 Summary of the Antenna Tower Components

Item	Description	Unit	Quantity
1.Antenna Tower	4-legged self supporting steel tower, H=50m	unit	7
2.Base Station House	4m x 4m	unit	7

Source: JICA Study Team

Figure 5.8.2 below shows the planned telecommunication conduit and antenna tower layout.

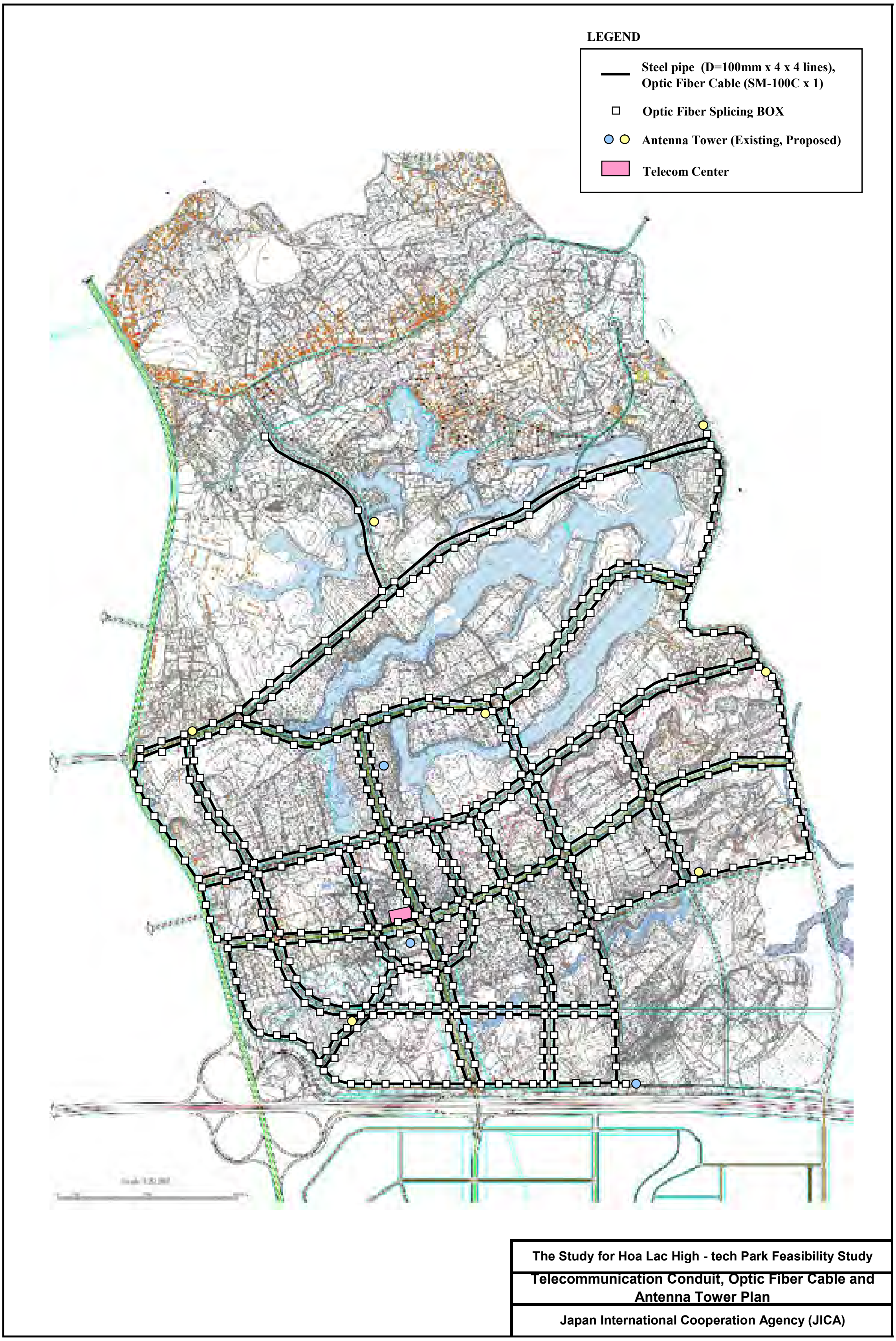


Figure 5.8.2 Telecommunication Conduit and Antenna Tower Plan

5.9 SOLID WASTE MANAGEMENT PLAN

5.9.1 Solid Waste Generation Projection

(1) Projection of Solid Waste Generation and Collection Ratio

The Vietnam Building Code (QCVN: 01/2008/BXD), which was issued in parallel with Decision No.04/2008/QD-BXD, regulates domestic solid waste generation per capita. The collection ratio is determined according to the classification of cities under Decree No.72/2001/ND-CP. Domestic solid waste generation and collection ratios for each classification of city are shown in Table.5.9.1.

As the population density of the HHTP is projected to be 12,079 person/km^2 in Stage-1 and 14,871 person/km^2 in Stage-2, the HHTP's urban management level is assumed as Grade I for both Stage-1 and Stage-2. Therefore, setting a unit rate of 1.3 kg/person/day for waste generation and a collection ratio of 100% has been adopted for domestic waste.

Table 5.9.1 Domestic Solid Waste Generation and Collection Ratio

Class of city	Solid waste generation rate (kg/person/day)	Solid waste collection ratio (%)	Population density criteria (person/km^2)
Special, I	1.3	100	> 12,000
II	1.0	≥95	> 10,000
III, IV	0.9	≥90	> 6,000
V	0.8	≥85	> 2,000

Note: Criteria for class of cities is given in Decree No.72/2001/ND-CP.
Source: Vietnam Building Code (QCVN:01/2008/BXD)

The office/commercial and industrial waste generation rates are estimated roughly in the VN Revised M/P. However, these rates are dependent on the characteristics of the type of enterprise and/or activity undertaken by each tenant.

VN Revised M/P estimated that the office waste generation rate would be 20% of the domestic waste generation rate, i.e. 0.26 kg/staff/day. As for industrial waste, VN Revised M/P estimated a generation rate of 0.3 ton/ha/day for manufacturing factory and this has been adopted for the High-tech Industrial Zone. The collection ratios for office waste and industrial waste are both assumed to be the same as the domestic waste collection ratio of 100%.

The estimated solid waste generation rate and collection ratio in the HHTP is shown in Table 5.9.2.

Table 5.9.2 Estimated Solid Waste Generation Rate and Collection Ratio in the HHTP

Zone		Domestic Waste		Office Waste		Industrial Waste	
		WGR (kg/person/day)	WCR (%)	WGR (kg/staff/day)	WCR (%)	WGR (t/ha/day)	WCR (%)
1	Software Park	-	-	0.26	100	-	-
2	Research and Development Zone	-	-	0.26	100	-	-
3	High-tech Industrial Zone	-	-	-	-	0.3	100
4	Education and Training Zone	1.3	100	0.26	100	-	-
5	Center of High-tech City	1.3	100	0.26	100	-	-
6	Mixed Use Zone	1.3	100	0.26	100	-	-
7	Residential and Office Zone	1.3	100	-	-	-	-
8	Housing Complex Zone	1.3	100	-	-	-	-
9	Amenity Zone	-	-	0.26	100	-	-
10	Amusement and Sport Zone	-	-	0.26	100	-	-

Note: WGR: Waste Generation Rate, WCR: Waste Collection Ratio.
Source: JICA Study Team

(2) Projection of Solid Waste Generation Quantity

Based on the population, area, solid waste generation rate and collection ratio, the future amount of solid waste that will be generated by and collected from the HHTP was predicted as shown in Table 5.9.3.

The estimated amount of waste generated in the HHTP is 152.6 ton/day in Stage-1 and 215.1 ton/day in Stage-2. As collection ratio is assumed to be 100% for all kind of waste, the amount of generated and collected solid waste are equal.

Table 5.9.3 Predicted Amount of Generated and Collected Solid Waste in the HHTP

Unit: t/day

Zone		Stage 1(2015)				Stage 2(2020)			
		Domestic	Office	Industrial	Total	Domestic	Office	Industrial	Total
1	Software Park	-	2.3	-	2.3	-	3.3	-	3.3
2	Research and Development Zone	-	2.1	-	2.1	-	3.6	-	3.6
3	High-tech Industrial Zone	-	-	59.2	59.2	-	-	69.5	69.5
4	Education and Training Zone	4.3	1.3	-	5.6	22.5	6.7	-	29.2
5	Center of High-tech City	6.4	1.9	-	8.3	6.4	1.9	-	8.3
6	Mixed Use Zone	5.3	0.7	-	6.0	9.9	1.3	-	11.2
7	Residential and Office Zone	44.4	-	-	44.4	44.4	-	-	44.4
8	Housing Complex Zone	24.3	-	-	24.3	45.1	-	-	45.1
9	Amenity Zone	-	0.1	-	0.1	-	0.1	-	0.1
10	Amusement and Sport Zone	-	0.4	-	0.4	-	0.4	-	0.4
	Total	84.7	8.7	59.2	152.6	128.2	17.4	69.5	215.1

Source: JICA Study Team

(3) Projection of Solid Waste Generation Quality

As for the domestic and office waste generated in the HHTP, the supposed components of the waste are organics, paper, textiles, plastics, rubber, leather, wood, hair, feathers, metal, glass, etc. and mostly ordinary waste. However, a part of the domestic and office waste may contain hazardous waste such as used batteries and household chemicals, although though the quantity of such hazardous waste will likely be quite small.

As for the industrial waste, the three (3) tenants (NOBLE, OETEK and KIM CUONG) which have already started their operation in the HHTP do not discharge any hazardous waste from their business activities. However, in the future, there is a possibility that the HHTP will receive tenants who may generate hazardous waste from their business activities.

According to the development plan of the HHTP, the National Institute of Hygiene and Epidemiology (NIHE), which is under the control of the Ministry of Health, has a plan for setting up an International Bio-Medicine Center in the Research and Development Zone of the HHTP. Therefore, there is a possibility that NIHE will generate infectious waste.

In addition, some other institutes in the Research and Development Zone and the Education and Training Zone may discharge some hazardous and/or infectious waste from their activities.

Moreover, as wastewater treatment plants will be set up in the HHTP, sewage sludge will be generated from these plants.

5.9.2 Plan Concept and Design Criteria

(1) Solid Waste Management Facilities

The Vietnam Building Code (QCVN:01/2008/BXD) regulates the minimum distance between waste treatment facilities and other buildings as follows:

- Sanitary landfill for organic and inorganic solid waste: 1,000m
- Inorganic solid waste landfills: 100m
- Solid waste treatment plants (gasification, composting): 500m

Considering the above regulation and the efficiency of the solid waste management system in Hanoi City, the solid waste generated in the HHTP should be treated and disposed of in existing facilities outside the HHTP, together with the solid waste from surrounding area of the HHTP.

(2) Solid Waste Management Companies

To ensure adequate solid waste management in the HHTP, solid waste generators should make contracts with local solid waste management companies that have the capacity, technical competence and experience required for appropriate solid waste management. Candidate solid waste management company is URENCO, which is responsible for solid waste collection, transportation, treatment and disposal services in Hanoi City. An appropriate solid waste management system could be applied by URENCO, considering the characteristics of each kind of waste.

(3) Solid Waste Management Collection Fee

The fee for ordinary waste collection services is regulated by the government. Table 5.9.4 shows the stipulated collection fee in the former Ha Tay Province.

On the other hand, the fee for hazardous waste collection services will be decided by contracts between hazardous waste generators, and hazardous waste transport and treatment companies.

The entrusted solid waste management companies shall collect the fee directly from households and enterprises. Therefore, the staff from entrusted solid waste management company (URENCO) may periodically visit their customers in the HHTP to collect the corresponding fees for their service.

Table 5.9.4 Fee for Ordinary Solid Waste Collection Services in the former Ha Tay Province

No	Type of waste	Collection fee
1	Individuals and families	
	- Ha Dong Town, Son Tay Town	2,000 VND/person/month
	- Districts	1,000 VND/person/month
	- Communes	500 VND/person/month
2	Small business	50,000 VND/unit/month
3	Schools and kindergartens	50,000 VND/unit/month
4	Offices of enterprises, administrative office	
	- Office less than 30 workers	60,000 VND/unit/month
	- Office less than 50 workers	80,000 VND/unit/month
	- Office more than 50 workers	100,000 VND/unit/month
5	Restaurants, hotels, etc.	200,000 VND/unit/month
6	Factories, hospitals, manufacturers, markets, train stations, car stations	120,000 VND/m^3-waste

Source: Decision No.2262/2006/QD-UBND

(4) Solid Waste Management at the Generation Source

All solid waste generators in the HHTP have to make efforts to reduce the amount of waste generation caused by their activities. The waste generators will be encouraged to segregate their waste into categories suitable for recycling and other treatment, as stipulated in the Law on Environmental Protection (LEP) and Decree No.59/2007/ND-CP on solid waste management.

According to the Regulation on Management of Hazardous Waste (Decision No. 155/1999-QD-TTg), hazardous waste must be packed and stored safely at the source, marked with a sign, and isolated from ordinary waste and other hazardous waste. This must be done before transferring the waste to hazardous waste transport and treatment companies.

In addition, infectious waste and sewage sludge should be handled separately, as these waste needs careful consideration for transportation and treatment.

5.9.3 Proposed solid waste management plan

(1) Ordinary Solid Waste

Ordinary solid waste from the domestic, business, service, public, and industrial sectors of the HHTP will be left out for collection in suitable containers, typically garbage bins. Such ordinary waste shall be collected, transported, treated and disposed by the nominated contractor (URENCO).

To reduce the amount of waste disposed of in landfills and minimize the impact to surrounding environment, measures for recycling should be considered. If the feasibility of recycling technology is confirmed, and good segregation of the recyclable waste is guaranteed, recyclable waste could be treated in the Son Tay Recycling Plant operated by Seraphin Company and the Cau Dien Composting Plant operated by Hanoi URENCO. Plastic and inorganic waste will be recycled and used as a plastic raw material and as a building material (e.g. bricks) in the Son Tay Recycling Plant. Organic waste will be recycled by converting it to compost in the Son Tay Recycling Plant and/or the Cau Dien Composting Plant.

Non-recyclable waste should be disposed of in sanitary landfill which has appropriate facilities for preventing environmental pollution. The existing sanitary landfills in Hanoi City are the Xuan Son Landfill (operated by Son Tay URENCO) and the Nam Son Landfill (operated by Hanoi URENCO). However, the Nam Son Landfill is about 70 km away from the HHTP and it is already receiving a large quantity of waste from the urban area of Hanoi City. Therefore, it is assumed that the non-recyclable ordinary solid waste from the HHTP will be transported to and disposed of in the Xuan Son Landfill, which is 20 km away from the HHTP.

(2) Hazardous Solid Waste

The hazardous solid waste will be mainly generated by manufacturing companies in the High-tech Industrial Zone. In addition, institutes in the Research and Development Zone and the Education and Training Zone may generate some hazardous waste. Furthermore, part of the domestic waste may contain hazardous waste such as used batteries and household chemicals. Accordingly, hazardous waste generators will be obliged to minimize the generation of hazardous waste and must segregate their hazardous waste at the source.

As for the collection, transportation, treatment and disposal of hazardous waste, only organizations or individuals licensed by Ministry of Natural Resource and Environment (MONRE) or Department of Natural Resources and Environment (DONRE) may handle hazardous waste. This is in accordance with the LEP and Regulation on Management of Hazardous Waste (Decision No.155/1999-QD-TTg).

In Hanoi City, only Hanoi URENCO has licenses for the transportation, treatment and disposal of hazardous waste. Hanoi URENCO has licenses for the transportation of hazardous waste

(No.1-2-3-4-5-7.001.V) and licenses for the treatment and disposal of hazardous waste (No.1-2-3-4-5-7.001.V). These licenses were issued by MONRE on 27 June 2007.

Therefore, the hazardous waste generated in the HHTP should be transported, treated and disposed in Nam Son Industrial Waste Treatment Facility by Hanoi URENCO.

Hazardous waste generators in the HHTP must register their operations with DONRE and periodically report on hazardous waste management in order to obtain registration. In addition, the registered companies must keep files and diaries of hazardous waste management work undertaken at their sites and are subject to inspection by DONRE. The management of hazardous waste shall be controlled and monitored by a manifest system, as stipulated in Circular No.12/2006/TT-BTNMT.

(3) Infectious Waste

The National Institute of Hygiene and Epidemiology (NIHE) plans to set up an International Bio-Medicine Center in the Research and Development Zone of the HHTP. NIHE may generate infectious waste from their research activities. In addition, some other institutes in the Research and Development Zone and the Education and Training Zone may generate infectious solid waste.

Medical waste, including infectious waste, generated in Hanoi City is incinerated in the Cau Dien Medical Waste Incinerator that is operated by Hanoi URENCO. Therefore, the infectious waste from the HHTP could also be transported to this facility and incinerated there by Hanoi URENCO or treated by them self with sufficient own necessary facility.

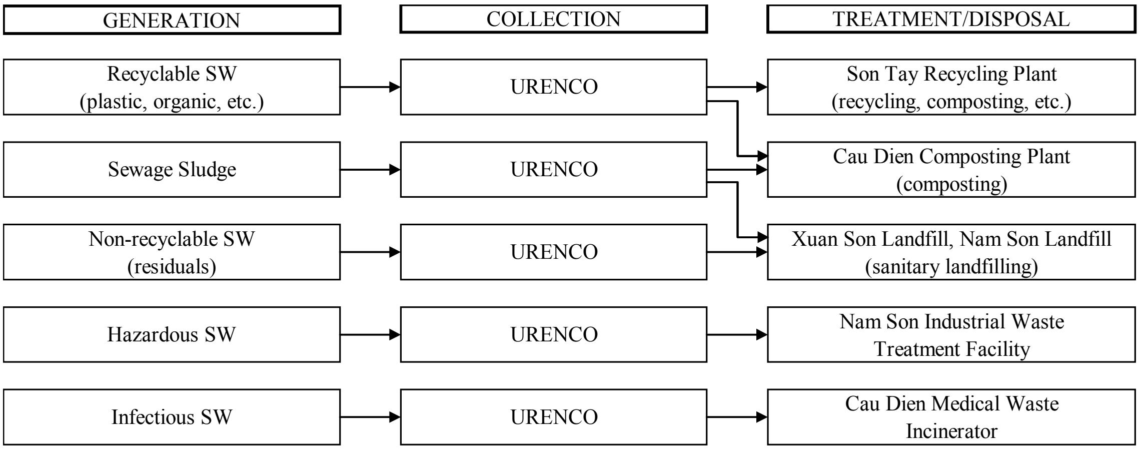
(4) Sewage Sludge

Sewage sludge will be generated by the wastewater treatment plants in the HHTP. The amount of sludge that will be generated is estimated to be about 50 ton/day.

As the fecal sludge generated in Hanoi City is utilized in the Cau Dien Composting Plant, the sewage sludge from the HHTP could also be transported to the Cau Dien Composting Plant for utilization. If the quality of the sludge does not meet the standards set by the Cau Dien Composting Plant, it should be transported and disposed of in sanitary landfill, the same as ordinary solid waste.

(5) Proposed Solid Waste Management System

The proposed solid waste management system for the HHTP is summarized in Figure 5.9.1.



Note: SW: Solid waste
Source: JICA Study Team

Figure 5.9.1 Flow Chart of Proposed Solid Waste Management System for the HHTP

As for the future development plan of solid waste management facilities in the former Ha Tay Province, the former Ha Tay People's Committee made decisions approving the land acquisition for the following projects:

- Waste treatment complex (sanitary landfill, incinerator and recycling facility) in Tran Phu Commune, Chuong My District, with an area of 24.2ha
(Decision No. 929/2006/QD-UBND)
- Sanitary landfill in Tan Linh Village, Ba Vi District, with an area of 12.9ha
(Decision No.1512/2006/QD-UBND)
- Waste treatment complex (sanitary landfill, incinerator and recycling facility) in Tan Tien Commune, Chuong My District, with an area of 8.4ha
(Decision No.1201/2008/QD-UBND)

In addition, Hanoi URENCO is planning to expand the capacity of the Nam Son Landfill with an additional area of 47ha.

As Ha Tay Province has now merged into Hanoi City, the development plan for solid waste management facilities may be revised by the Hanoi People's Committee (HPC). Therefore, in order to improve the quality of solid waste management and to minimize environmental impact, the solid waste management system for the HHTP will need to be reviewed and revised in accordance with the revised solid waste management plan for Hanoi City.

5.10 ZONE DEVELOPMENT PLAN

5.10.1 General

Land use has been prepared by adapting the development concept of the HHTP that was presented in the VN Revised M/P. The policy of the land use plan for the Research and Development Zone, Education and Training Zone, and the Center of the High-tech City Zone is as follows:

- The plan was made so as not to influence areas where operation and planning have already been carried out within the HHTP.
- Size of the lot already operated and planned is referred.
- In order to ensure that each lot can accommodate as many tenants as possible, the roads within each lot section will not be constructed by HHTP-MB. It is considered that each lot

will be accessed from the existing road plan, and each tenant will connect to infrastructure, such as power, water and drainage, that follows alongside the existing plan road.

- The shore of the Tan Xa Lake improves from the reason shown below to the new shore of a lake in consideration of the present shape. The present shore protection height will not satisfy the reservation height (+13.13m) of probability for ten years. It is not desirable to change the water surface for a reservoir-water function. It is necessary to obtain the already established land use. Therefore, the shore of a lake is newly prepared.
- Construction adjacent to the shoreline of lakes and rivers will be restricted in order to preserve the Tan Xa Lake. The setback distance from the front road in each zone has been established from the viewpoint of environmental protection, landscape and disaster prevention.

5.10.2 Research and Development Zone

(1) Function of the Zone

The Research and Development Zone provides one of the most important functional areas of the HHTP. Specialists and people with excellent qualifications will come together to join National Research Institutes, etc. This zone adjoins the Tan Xa Lake, which itself surrounds the Software Park Zone and is located near the center of the HHTP. Since the Research and Development Zone, Software Park Zone and the Center of the High-tech City Zone will be able to use land flexibly in the future, they have been arranged in close proximity for mutual benefit.

(2) Planning Concept

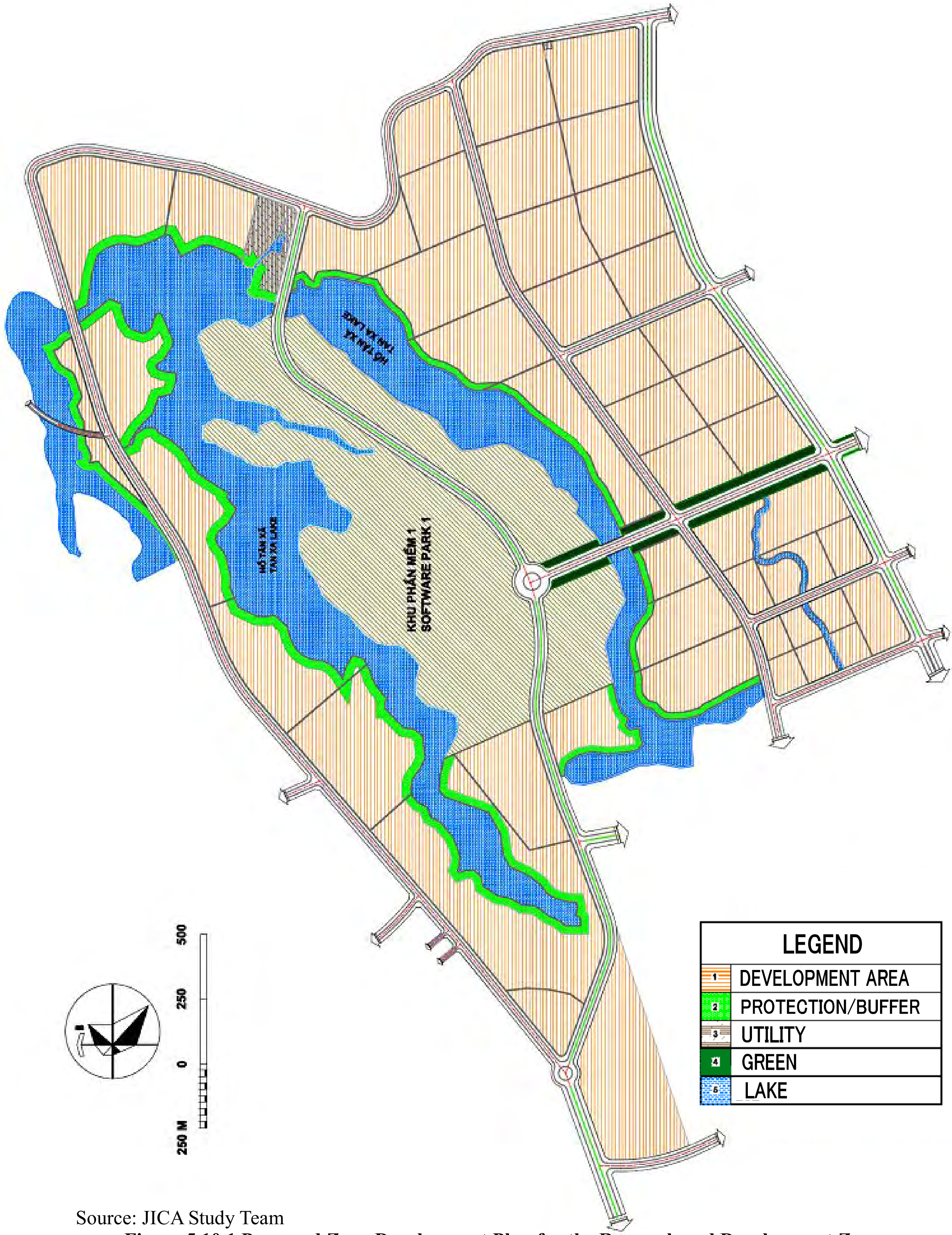
The Research and Development Zone development plan was prepared from the following concepts:

- It is arranged around the Tan Xa Lake in order to create a conductive environment for research and development that is surrounded by nature.
- In order to exhibit the function of research and development, generous lot scales will be established. The building coverage ratio is basically established at 30%. As each site is relatively large, it is considered that buildings will generally have 5 floors or less.
- The lots near the Center of the High-tech City Zone will be allocated to advanced smaller organizations and have relatively small lot areas.
- The lots will effectively use the layout of the Tan Xa Lake and the landscape will be established. Lots which adjoin the Tan Xa Lake will include a shoreline protection zone extending 25m from the shoreline to protect the lake.

(3) Proposed Zone Development Plan

The proposed zone development plan for the Research and Development Zone is shown in Figure 5.10.1. It will be possible to aggregate the planned lots according to the needs of the tenants, and to consider the aggregation as a single large lot. Conversely, subdividing the lot is also possible. When it subdivides, preparation of the road to access is required.

The land use breakdown for the Research and Development Zone and required land preparation work volume are summarized in Table 5.10.1 and Table 5.10.2.



Source: JICA Study Team

Figure 5.10.1 Proposed Zone Development Plan for the Research and Development Zone

Table 5.10.1 Research and Development Zone – Land Preparation Work Volume

Function	Volume
Filling	8,125,000m^3
Excavation	200,000m^3
Disposal	662,000m^3
Supplement	662,000m^3

Source: JICA Study Team

Table 5.10.2 Research and Development Zone - Land Use Breakdown

Function	Area (ha)
Development Area	227.9ha
(Protection area)	(17.6ha)
TOTAL	227.9ha

Note: Protection area is a boundary by which construction is regulated for shore protection preservation. It contains in development area.
Source: JICA Study Team

5.10.3 Education and Training Zone

(1) Function of the Zone

It is planned that the Vietnam National University-Hanoi will move to the Hoa Lac (the HHTP neighborhood). In addition, within the HHTP, education and technical training will be carried out.

Establishment of FPT University is planned in the Education and Training Zone. This zone will be arranged in order to educate engineers and professional staff, including special training and vocational training. The Education and Training Zone is located alongside National Highway Route 21 and near to the Research and Development Zone.

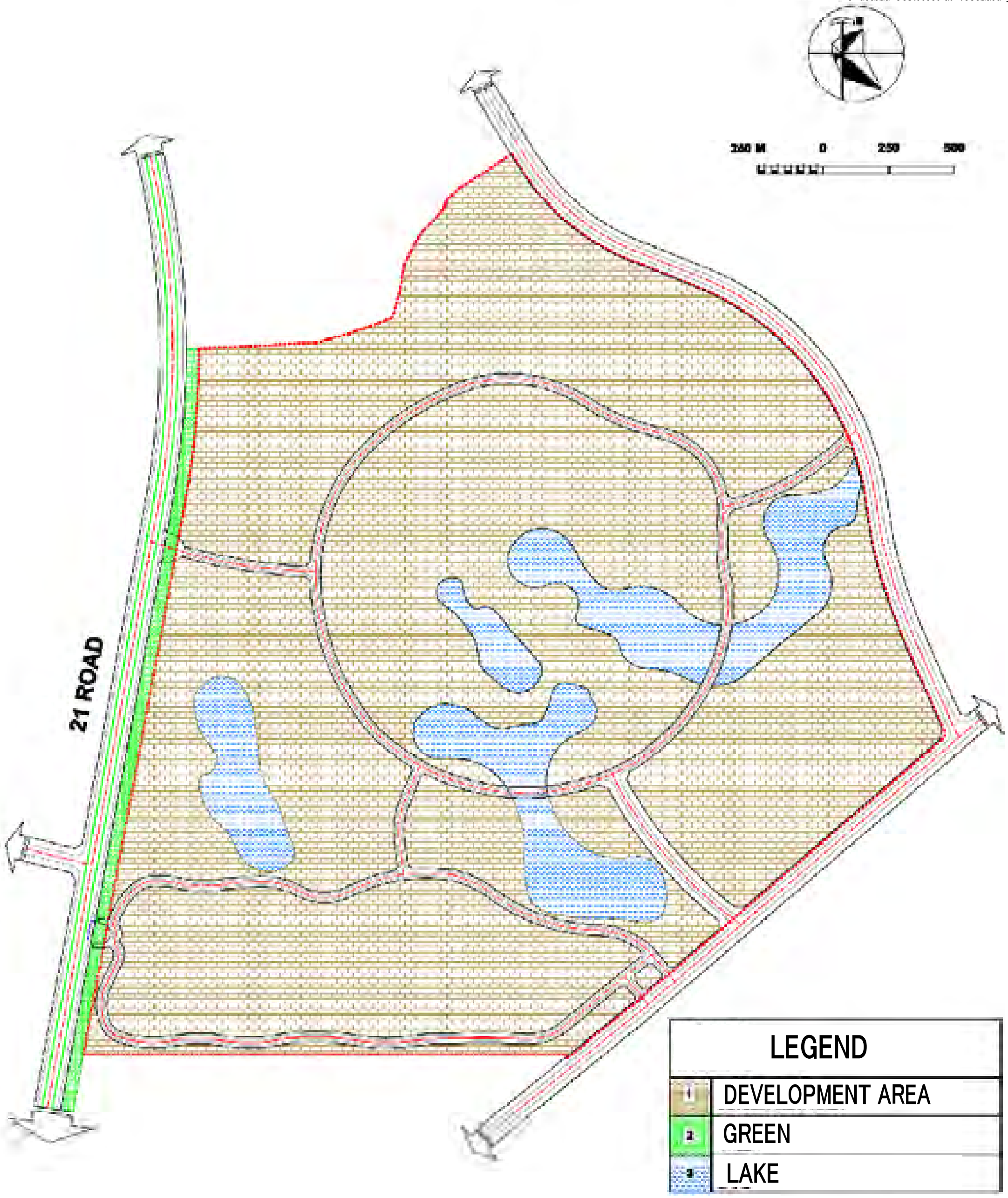
(2) Planning Concept

The Education and Training Zone development plan was prepared from the following concepts:

- The layout was prepared with the aim of attracting a university to establish (FPT University, Hanoi University of Science Technology) in the HHTP. In order to create learning environment, the Education and Training Zone has been located close to the Research and Development Zone, the Center of the High-tech City Zone and the Amusement Zone.
- After the general attraction function was decided, consideration of the function of each lot was done by taking into account the plan proposed by HHTP-MB. Road arrangements were considered on the basis of HHTP-MB proposal, and the form of a lake was examined on the basis of the VN Revised M/P.
- Each lot is extensive, so the layout is also considered the movement (walking distances) of students and staff. In addition, arrangement of the roads within the lot considered connection to main roads.

(3) Proposed Zone Development Plan

The proposed zone development plan for the Education and Training Zone is shown in Figure 5.10.2. It was found that it was necessary to revise road arrangement proposed by HHTP-MB, and to revise the form of the lake shown in the VN Revised M/P. The required infrastructures work volume and land use breakdown for the Education and Training Zone are summarized in Table 5.10.3 and Table 5.10.4.



Source: JICA Study Team

Figure 5.10.2 Proposed Zone Development Plan for the Education and Training Zone

Table 5.10.3 Education and Training Zone – Infrastructure Work Volume

Function	Volume
Filling	990,000m^3
Excavation	611,000m^3
Disposal	258,000m^3
Supplement	258,000m^3
Road(4-4)(Width=31m)	310m
Road(5-5)(Width=16m)	4,340m
Bridge	380m
Drainage System	5,030m
Water Supply System	5,030m
Sewerage System	5,030m
Power Supply/ Telecommunication	5,030m

Source: JICA Study Team

Table 5.10.4 Education and Training Zone - Land Use Breakdown

Function	Area (ha)
Development Area	99.6ha
Roads	8.4ha
Lake & Buffer	14.2ha
TOTAL	122.2ha

Source: JICA Study Team

5.10.4 Center of the High-tech City Zone

(1) Function of the Zone

The Center of the High-tech City Zone provides the complicated services and activities that are essential for the whole of the HHTP. This zone, which is accessed from the Main Gate of the HHTP, is located near the Research and Development Zone. It is also near to the Education and Training Zone. In addition, both the Residential and Office Zone and the Housing Complex Zone are relatively close.

(2) Planning Concept

The Center of the High-tech City Zone development plan was prepared from the following concepts:

- Since emphasis on the central function of the zone in the HHTP is important, direct access from the Main Gate to the central part of the high development area was arranged. In addition, the HHTP-MB office building and a Start-up Center are located in the Center of the High-tech City Zone, so as to provide a centralized area for control of maintenance management in the HHTP.
- Since medium height and high-rise buildings are assumed to be constructed in the Center of the High-tech City Zone, the lot scale is smaller than the lot in the Research and Development Zone and the High-tech Industrial Zone.
- Lots which face the Tan Xa Lake will be relatively bigger, and the arrangement of these lots will also take the landscape into consideration.

(3) Proposed Zone Development Plan

The proposed zone development plan for the Center of the High-tech City Zone is shown in Figure 5.10.3. It will be possible to aggregate the planned lots according to the scale of the tenant, and to consider the aggregation as a single large lot.

The land use breakdown and land preparation work volume of Center of the High-tech City Zone are summarized in Table 5.10.5 and Table 5.10.6.

Table 5.10.5 Center of the High-tech City Zone - Land Preparation Work Volume

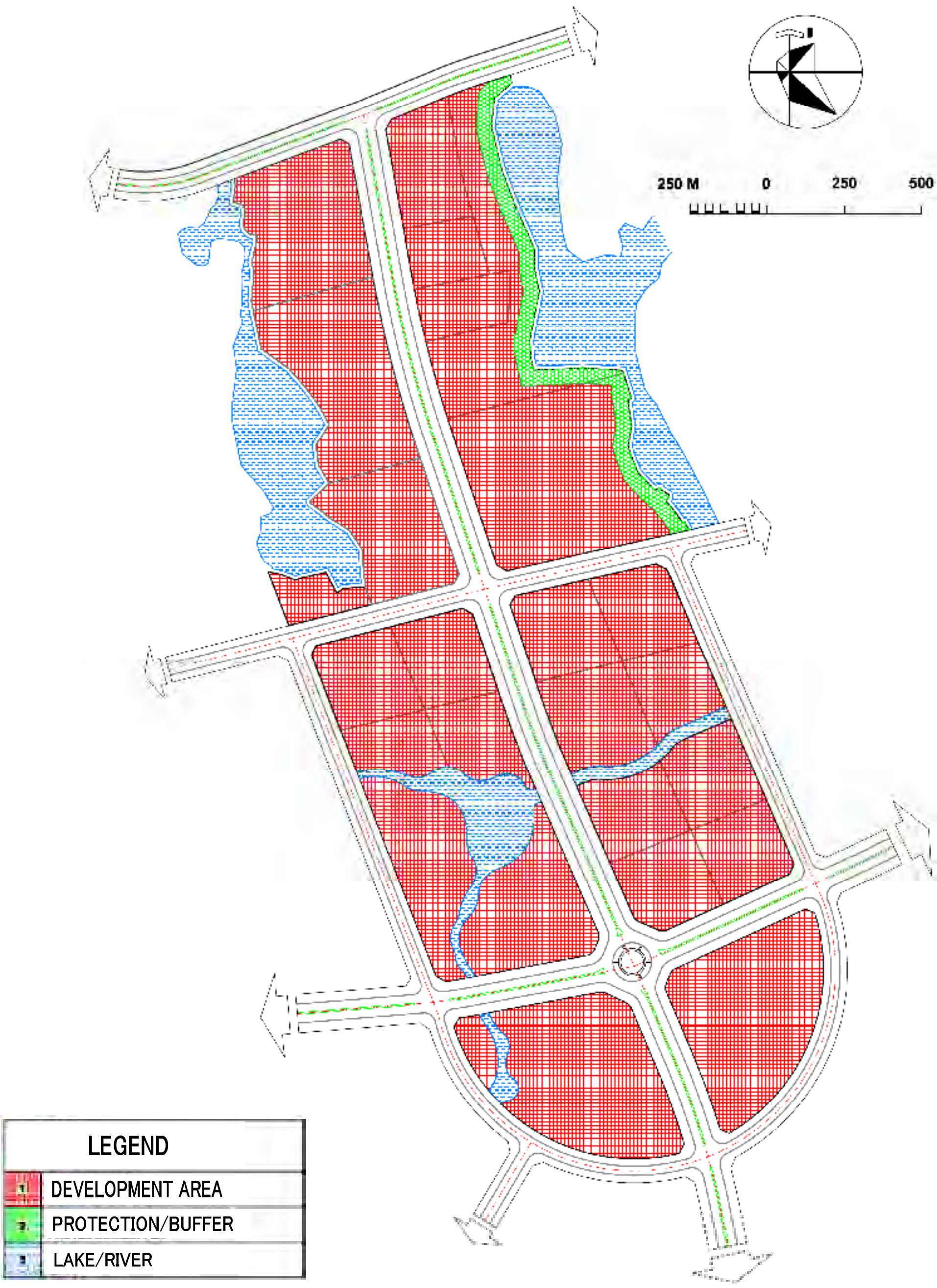
Function	Volume
Filling	916,000m^3
Excavation	150,000m^3
Disposal	119,000m^3
Supplement	119,000m^3

Source: JICA Study Team

Table 5.10.6 Center of the High-tech City Zone - Land Use Breakdown

Function	Area (ha)
Development Area	49.0ha
(Protection area)	(1.5ha)
TOTAL	49.0ha

Note: Protection area is a boundary by which construction is regulated for shore protection preservation. It contains in development area.
Source: JICA Study Team



Source: JICA Study Team
Figure 5.10.3 Proposed Zone Development Plan for the Center of the High-tech City Zone