CHAPTER 2. PRESENT CONDITION OF THE STUDY AREA

2.1 Socio-Economic Conditions

The Malaysian economy in general continued to show impressive performance with the annual GDP growth rate of 8.7 percent during the Seventh Malaysia Plan (1996-2000). The national economic growth reflected the economic growth of the states of Kedah and Melaka where the study areas are located. In fact, the states of Kedah and Melaka had the GDP growth rates of 9.9% and 9.2%, respectively. The economic structure of Kedah as well as Melaka is undergoing significant transformation with a shift towards the secondary and tertiary sectors. The major impetus for these economic growths was made by the manufacturing, construction and service sectors.

The study area of Sungai Petani is strategically located in the economic growth center of Kedah State. The area has excellent road network including Federal Road No. 1, North-South Highway and the railway. The area also enjoys proximity to the international port services at Butterworth and freight services at Penang Island and Alor Setar. The effect of development in Penang Island in particular has tremendous spillover effects to the study area. This is not only due to its well-connected transportation system and infrastructure but also due to the rapid expansion of industrial activities in Penang Island. The study area as well as other southern Kedah areas could offer lower land cost and labor wages as compared with Penang Island, and therefore be competitive and able to attract foreign investments.

The study area of Melaka is located in the District of Melaka Tengah which remains the most popular location for investors due to better road infrastructure and industrial facilities. Due to this background, the area is situated as the focus of economic development of Melaka State. In line with the policy to make Melaka an industrial state by 2010, a high concentration of industrial activities is being input to the study area. The study area is also the main commercial center in the state, having 68% of the total commercial establishment in the District of Melaka Tengah.

The population in the study areas of Sungai Petani and Melaka tend to increase due to their strategic locations as economic growth centers of the states. The increment of population is further pushed up by the spatial strategy of "concentrated decentralization". The following are the future trend of population increase as well as employment increase in the study areas of Sungai Petani and Melaka:

Description	Present	2010	2020
Sungai Petani			
Population	173,727	277,000	372,000
Industrial Workers	23,000	46,000	63,000
Commercial Workers	23,000	52,000	79,000
Melaka			
Population	332,453	500,000	594,000
Industrial Workers	52,000	99,000	120,000
Commercial Workers	54,000	102,000	123,000

2.2 Topography

2.2.1 Sungai Petani

Topographically, the study area in Sungai Petani falls under three groups: (1) the low-lying flat plain, (2) the slightly sloping area, and (3) the hilly area. The rivers originate in the hilly area, flow down eastward through the slightly sloping area and the low-lying flat plain and, finally, into the estuary of Sg. Merbok. The frequent flood overflow of the rivers has progressively developed the thick alluvial deposits that form the low-lying flat plain. An extensive swamp spreads out in this low-lying flat plain, and a part of the area is used as paddy field.

The slightly sloping area with an elevation of 20 m or less spreads westward and northwestward. This area is where the existing major built-up areas such as the city proper of Sungai Petani are located. The hilly areas with an elevation of 20 to 100 m lie along the eastern and southern borders of the study area, forming a watershed boundary between Sungai Merbok and Sungai Muda. A part of the hilly area has been intensively excavated due to land development and civil construction activities such as highway construction and so on.

2.2.2 Melaka

The topography of the study area in Melaka is characterized with the wide alluvial plain and the pedimental and hilly areas. The alluvial plain area is composed of the coastal plain and the river flood plain, which have been formed with sediment deposits from Sg. Melaka, Sg. Malim and Sg. Lereh. The coastal plain is generally narrow as a whole, while the river flood plain spreads out from the coastline for a distance of more than 3 km inland. The river flood plain is dotted with several hills, which are probably the remnants of erosion-resistant riverbeds in the sedimentary rock series.

The alluvial plain was formerly utilized as paddy field and/or settlement area, but is now being intensively developed as residential and industrial areas. A wide swamp also previously existed along Sungai Melaka about 3 to 8 km upstream from the river mouth, which was probably formed by the insufficient drainage capacity of Sungai Melaka. However, a greater part of this swamp is now also being developed as residential and industrial areas.

The pedimental area is relatively small and distributed at the foot of the hilly area. However, a part of this area has transformed into a flat terrain due to intensive residential and industrial land development. The major hilly areas with elevations of 70 to 110 m tend to lie around the northern and northeastern part of the study area, while the minor hilly areas with elevations of 20 to 30 m exist along the coastal line at Tangga Batu. Intensive land development is also being made at several parts of these hilly areas, particularly, Ayer Keroh, Bukit Katil, Paya Rumput and Tanjong Minyak, where the original hilly terrain is no longer seen.

2.3 Present Land Use

2.3.1 Present Land Use in Sungai Petani

The study area in Sungai Petani is at a stage of rapid development with several large projects committed and approved. The present built-up area is almost 50% of the whole study area (refer to Table 2-1 (1/2) and Fig. 2-1 (1/2)).

(1) Residential Use

Residential use is defined as all types of residential use including major housing schemes and informal housing such as village settlements. Total land use under this category accounts for 2,758 ha or 27.4% of the total study area. The major housing schemes are located on the east of the Federal Highway and/or near the Southern Toll Plaza. Traditional village houses are found along the road to Sg. Pasir and the areas near Sg. Layar where several paddy fields exist. There are also several new housing projects especially in the north at locations near Sg. Lalang such as Bandar Laguna Merbok, Taman Ria and Bandar Aman Jaya.

(2) Commercial Use

The total land for commercial use including shops, retail establishments and offices is 244 ha or 2.43% of the total study area. The present major commercial center is located downtown at Bandar Sungai Petani. A major commercial center is now being developed at the town center of Aman Jaya and the other is the Cayman Development alongside Sg. Petani. Several sub-commercial centers have also been developed in housing schemes to cater to retail needs of the resident population. However, large commercial retail projects such as Bandar Sri Utama and the Plaza Mutiara have been put on hold in view of the depressed economic situation. Many of the large commercial complexes including the SP Plaza were reported to be not doing well in terms of commercial turnover, suggesting that disposable incomes may not be as high as expected.

(3) Industrial Use

Total industrial use including factories, warehouses, go-downs and service industry account for 853 ha or 8.5% of the total study area. The more established industrial estates are found at Bakar Arang near the southern toll plaza and the Sg. Petani Industrial Estate (LPK) near Taman Ria Jaya. Both of these industrial estates were developed by the SEDC and are all sold out. Another major industrial project has been proposed in Aman Jaya to the north of the Study Area. The general policy in the Local Plan for Sg. Petani is to position Sg. Petani and Aman Jaya as the major industrial manufacturing centers in Kuala Muda. Under the current depressed economic situation, several large industrial projects have been put on hold. There have also been several development applications to convert approved light industrial projects to housing, suggesting again that there are too many light industrial premises in Sg. Petani.

(4) Institutional Use

Institutional use is defined as public land use such as schools, government buildings, military camps, religious establishments and airports. The total land use under this category accounts for 634 ha or 6.3% of the total study area. The major user is the Sg. Petani Military Base which also includes an airstrip. Other locations for institutional uses are found in the downtown area where there are several schools, government buildings, library and the traffic police complex. Other large users are the District Hospital and the Prisons located along the Federal Road to Alor Setar. The other concentration of institutional uses are along the Jalan Kuala Ketil, including the Teachers Training Center, INTAN and the Pusat Serenti.

(5) Recreational Use

Recreational use such as parks and other amenity open spaces account for 103 ha or 1% of the total study area. The major recreational uses are the Cinta Sayang Golf Club and the public golf club near Taman Jubilee in the downtown area. Open space requirements for housing schemes are usually about 10% of the total area. Other major recreational projects planned include the Sg. Petani Riverfront Park, new Golf clubs at Aman Jaya and the public park at Ria Jaya.

(6) Nature Area

Nature areas such as forests, mangroves and other nature protected areas account for 600 ha or 6% of the total study area. Most of the existing nature areas are found near the confluence of Sg. Pasir and Sg. Petani, and Sg. Merbok. These areas are part of the Merbok Forest Reserve. Other locations are along the tributaries of Sg. Merbok.

(7) Agricultural Use

Agricultural land account for 43% of the study area (4,358 ha). Most of the agricultural areas are planted with rubber or paddy. Paddy areas account for 570 ha of the study area and most of them are found in Sg. Layar, Sg. Pasir, and the Kuala Ketil.

(8) Roads and Railway

Major trunk roads and railway account for 4.1% of the total study area. Several road projects including the Inner Ring Road and the Outer Ring Road have been planned as part of the traffic dispersal scheme. Other spinal road networks will also be provided in Bandar Aman Jaya.

(9) Others

Other uses include vacant lands and cemeteries. This only accounts for 1% of the total study area but this percentage will be much higher if current projects under construction are included. This is particularly so for projects in the north at Aman Jaya and near Sungai Lalang.

2.3.2 Present Land Use in Melaka

Non-built-up areas currently account for 71% of the study area with about 48% for agriculture [refer to Table 2-1 (2/2) and Fig. 2-1 (2/2)].

(1) Residential Use

The total area under residential use is 3,007 ha. or 15.7 % of the study area. Most of the formal housing schemes are found in Bandar Melaka, Batu Berendam and the Air Keroh area. Small housing schemes are also found along Federal Road 19 to Paya Rumput and Alor Gajah. It is likely that the future spread of development from Melaka City will be along this corridor. Most of the housing in the outlying areas of Sungai Udang, Tangga Batu and Bukit Rambai are generally traditional village housing spread along the major roads.

(2) Commercial Use

The total area under commercial use is 246 ha or merely 1.3% of the total study area. The commercial uses are located in the downtown Bandar Melaka area and in local townships. Most of the commercial uses operating outside Bandar Melaka are small retail premises.

(3) Industrial Use

The existing industrial land use accounts for 1,220 ha or 6.3% of the total study area. The main industrial areas are at Air Keroh, Batu Berendam, Malim Jaya, Cheng, Bukit Rambai, Tg. Minyak, Petronas Oil Refinery at Tangga Batu and at Rembia. In line with the policy to make Melaka an industrial state by 2010, new industrial areas have been identified at Krubong including the Composite Technology Industry near the old airport at Batu Berendam. About 160 ha of land has been earmarked for the development of the Composite City which will focus on the manufacture and repair of light aircraft.

(4) Institutional Use

The total area under institutional use is 556 ha or 2.9% of the total study area. The main institutional uses include the airport at Batu Berendam and several parcels of government land and public facility land at Air Keroh and near the Bachang area. Large institutional facilities include the hospital, police stations, schools and religious establishments.

(5) Recreational Use

Recreational use accounts for 236 ha or 1.2 % of the total study area. Again, most of the recreational uses are found at Air Keroh.

(6) Nature Area

The nature area is mainly located along Federal Road 5 near the Terendak Military Camp. The total area is estimated at 563 ha or 2.9% of the total study area. The rest of the study area is basically cultivated or developed.

(7) Agricultural Area

About 48% of the study area or 9233 ha is still under agriculture. This includes basically tree crop plantations such as rubber and food crop farms such as vegetable farms and paddy fields. Paddy cultivation is mainly carried out at Mukim Bukit Rambai with patches of paddy land in most of the mukims in Block 3, 4, 5 and 6. In the next 20 years, it is expected that these areas will be transformed from agricultural to urbanized areas.

(8) Roads

Trunk roads only account for 2.7% or 518 ha. This indicates the relatively underdeveloped state of the sub-region. With the proposed urbanization of the sub-region, new trunk roads including the newly proposed Coastal Highway are expected to pass through the area.

(9) Others

Vacant land and cemetery areas are significant at 3,577 ha or 18.7% of the total study area. Large areas of vacant land are found at the Air Keroh, Batu Berendam, Cheng and Tg. Minyak. Most of these areas have been cleared for development. The study area also has large Chinese cemeteries at Batu Berendam and the famous Bt. Cina in the Melaka town area.

2.4 Drainage Conditions

2.4.1 Drainage Channel

Trunk drains in the study area are colloquially called “Line”, “Alur” or “Cabang” in Sungai Petani and “Parit” in Melaka, while the rivers are usually called “Sungai”. Most of the trunk drains have drainage areas of less than 4 km^2 as shown Fig. 2-2, and collect the drainage discharge from several roadside drains and infrastructural drains (i.e., secondary and tertiary drains).

Flow capacity of the existing trunk drains is estimated as bank-full capacity, as shown in Tables 2-2 to 2-3. This estimation is based on the results of cross-sectional survey and additional field measurement. The estimated flow capacity is then compared with the probable basin runoff discharges of 2 to 5-year return period, as shown below.

Range	Number and Percentage of Trunk Drains					
	Sg. Petani		Melaka		Total	
	Number	(%)	Number	(%)	Number	(%)
$Q<0.2Q_2$	27	63	7	26	34	49
$0.2Q_2 \leq Q<0.5Q_2$	12	28	9	33	21	30
$0.5Q_2 \leq Q<Q_2$	2	5	6	22	8	11
$Q_2 \leq Q<Q_5$	1	2	0	0	1	1
$Q_5 \leq Q$	1	2	5	19	6	9

Q: Drainage Flow Capacity; Q_2: Peak Discharge of 2-Yr Flood; Q_5: Peak Discharge of 5-Yr Flood

As shown above, most of the existing trunk drains in Sungai Petani and Melaka have a extremely small channel flow capacity. That is, about 90% of the entire trunk drains have a flow capacity of less than the probable peak runoff discharge of a 2-year return period. Moreover, 49% of the entire drainage channels have a flow capacity lower than 20% of the probable peak discharge of a 2-year return period. This extremely low flow capacity can be seen in Sungai Petani in particular where 63% of the channels fall under this category. Many culverts and bridges cross over the drainage channels and most of them are a great hindrance to channel flow, leading to one of the important factors for such low flow capacity.

2.4.2 Flood Detention Ponds

There are twenty-one (21) flood detention ponds in the study area (refer to Table 2-4). It is however noted that out of the 21 ponds, 20 of them are located in Sungai Petani, while only one is in Melaka. Land developers have constructed these ponds in accordance with the administrative guidance on land development. The storage capacity and environmental conditions of these existing ponds are evaluated below.

(1) Storage Capacity

For evaluation of the storage capacity, adopted is an index called V/A (m^3/ha), where V is the storage volume and A is the catchment area of the pond. The V/A index can be converted to storage depth over the catchment. For instance, 600 m^3/ha is equivalent to 60 mm in effective rainfall depth over the catchment.

The maximum depth of an effective hourly rainfall of a 5-year return period is estimated at about 60 mm for both Sg. Petani and Melaka. Out of the 21 ponds, 12 ponds have the V/A index of more than 30 mm. This means that almost half of the existing ponds have the potential to control 50% of the peak storm rainfall of a 5-year return period (refer to Fig. 2-3). Moreover, six (6) of the existing ponds have the V/A index of more than 60 mm, and therefore could absorb almost 100% of the peak storm rainfall of a 5-year return period. Thus, it is presumed that about half of the existing flood detention ponds could function well to control the storm runoff of a 5-year return period.

(2) Environmental Conditions

Environmental degradation was recognized in most of the existing ponds in the course of the field survey, as stated below.

(a) All ponds have two functions: flood control for storm water and oxidation for domestic wastewater. As a result, the impounded wastewater emits an offensive odor, leading to sludge accumulation and methane fermentation due to lack of proper maintenance.

(b) The rubbish thrown in the drainage channels and the roadsides is flushed out into the ponds during a rainstorm. The accumulated rubbish mainly cause the clogging of the outlet.

In connection with the issue in item (a) above, Indah Water Konsortium Sdn Bhd (IWK), the organization responsible for domestic wastewater management in Malaysia, revised the guidelines in 1998. According to the new guidelines, mechanical treatment facilities using microbiological contact media have to be constructed in the newly developed areas instead of the prevailing oxidation ponds. This means that domestic wastewater in the new estates will no longer enter the detention ponds directly, and therefore the issue in item (a) could be minimized in case of new detention ponds. As for the issue in item (b), however, no significant countermeasure has been taken yet, and the following comprehensive approaches will be required to cope with the issue.

(a) A rubbish trap screen should be considered for both inlet and outlet in the structural design of detention ponds. After construction of the ponds, periodical and proper maintenance work is crucial for sustaining the flood control function.

(b) The use of ponding area as recreational or amusement space could be one of the effective measures to enhance the residents' concern on the environment of detention ponds.

(c) The government agencies should make continuous efforts to enhance the residents' concern on cleaning up the town area through mass media information campaign such as the "save forests, save rivers, safe water" being done at present. In parallel with this activity, it is necessary for the responsible agencies to intensively pursue the upgrade of solid waste management.

2.5 River Channel Conditions

There are the following six (6) major river basins in the Study Area:

Sungai Petani		
Name of River	Major Tributary	Catchment Area (km^2)
1. Lalang	Bakap, Line A	25
2. Tukang		8
2. Petani	Line A1	38
3. Pasir		23

Sungai Melaka		
Name of River	Major Tributary	Catchment Area (km^2)
1. Sg. Lereh	Udang, Gajah	35
2. Sg. Malim	Ayer .Salak, Ayer Hitam	52
3.Sg. Melaka	Cheng, Putat	92

The rivers in Sungai Petani flow into the estuary of Sg. Merbok. Channel bed slopes range from 1/1,000 to 1/7,500 in the downstream, and 1/700 to 1/800 in the middle stream, which are quite gentle. Therefore, a substantial extent of the river channels is seriously affected by the tidal backwater effect. Moreover, the rivers have remained as natural channels without any major improvement, and the bank level is extremely low as compared with the Mean High Spring Tide Level. As a result, the channel flow capacity is marginal and flood overflow frequently occurs. A serious flood occurs in particular when a flash flood flows into the river channel during high tide.

According to the hydraulic analysis on channel flow capacity, all river channels except a few tributaries in the upper reaches have far smaller channel flow capacities than the probable discharge of even a 2-year return period [refer to Table 2-5 (1/2)]. Moreover, there are 33 box culverts crossing over the river channels, a great hindrance to channel flow. In addition to such small channel flow capacities, the basin runoff discharge has remarkably increased due to intensive land use. According to the interview survey at the site, flood inundation is becoming more serious every year.

As for Melaka, all rivers directly flow into the Melaka Strait. Similar to the conditions in Sungai Petani, the downstream of rivers in Melaka has a very gentle channel slope of 1/1,000 to 1/10,000, and it is seriously affected by tide. Among the rivers in Melaka, Sg. Lereh, and tributaries of Melaka such as Sg. Cheng, and Sg. Putat have remained in their natural condition without any major river channel improvement. As a result, the present flow capacity of these rivers are extremely low as compared with even a probable discharge of a 2-year return period [refer to Table 2-5 (2/2)].

In contrast to the above rivers, river channel improvement was made to the downstream of Sg. Malim and the tributaries of Sg. Ayer Salak. A rather large channel flow capacity was designed to prevent channel overflow from the probable discharge of 5 to 100-year return period [refer to Fig. 2-4 and Table 2-5 (2/2)].

The downstream of Sg. Melaka also has been improved by the construction of a flood bypass channel and channel improvement works. As shown in Fig. 2-5, the flood discharge of Sg. Melaka is diverted into the bypass channel before it enters the urban center of Melaka. A regulator that closes if overflow occurs in the diversion weir regulates the river flow in the urban center and the flood discharge is diverted into the bypass channel. The flow capacity of the bypass channel is designed to accommodate a probable discharge of 50-year return period which was verified in this study through non-uniform calculation [refer to the channel flow capacity of Sg. Malim in Table 2-5 (2/2)]. As a result, channel overflow with a probable discharge of 50-year return period is prevented in the downstream of Melaka. It is, however, noted that Sg. Putat flows into Sg. Melaka in the downstream from the regulator. The present channel flow capacity of Sg. Putat is extremely small and flood overflow occurs during flood time. Hence, the flood discharge from Sg. Putat is not likely to seriously increase, at present, the flood flow discharge in the downstream of Sg. Melaka. However, should Sg. Putat be improved to prevent channel overflow, the runoff discharge from Sg. Putat will concentrate on Sg. Melaka. As a result, the river discharge in the downstream of Sg. Melaka from the regulator will remarkably increase due to the far smaller channel flow capacity than even a probable discharge of 2-year return period, as shown in Fig. 2-6 and Table 2-5 (2/2).

2.6 Flood Damage Conditions

Flooding information was obtained from the Welfare Department, the DID and the Municipal Council. Flooding situations were also obtained through interview survey with the residents at the site. The habitual flooding areas and their situations are given in Table 2-6 and their locations are shown in Fig. 2-7.

Based on the flooding situations, the major causes of flooding could be attributed to the following factors:

(a) The flow capacity of the existing drainage channels/the existing rivers and the flood control capacity of the existing flood detention ponds are extremely small as mentioned in the foregoing subsection.

(b) Development activities in the upper reaches tend to cause drastic increment of flood runoff discharge and accelerate flooding in the lower reaches.

(c) There are the topographically unfavorable areas for drainage such as low-lying flat plains and depressed hinterlands, which are usually situated as the habitual inundation areas.

Intensive land development is being made in the study area and the increment of flood discharge due to land development seems to be the major cause of flooding. Particular attention should be paid to reduce the peak flood runoff discharge through the construction of flood detention ponds or other types of flood detention and retention facilities.

2.7 Surface Soil Conditions and Ground Infiltration Capacity

The "Generalized Soil Map, Peninsular Malaysia, MOA (1970)" gives an overview of the soil condition of the study area (refer to Figs. 2-8 and 2-9). According to the soil map, components of soil in the coastal plain and hilly areas of both Sungai Petani and Melaka have a strong resemblance.

The coastal plain areas of both Sungai Petani and Melaka show unconsolidated and sandy clay as the major component of surface soil that has impermeability characteristics. Moreover, the coastal plain area has a high ground water level that reaches up to LD. –0.3 m to 1.2 m. Due to the impermeable surface soil and the high ground water level, storm rainfall could hardly infiltrate in the coastal plain.

On the other hand, most of the hilly areas are made up of lateritic soil that has a rather high permeability due to its high void ratio and large macro-pores. However, the layer of lateritic soil is thin having the thickness of only less than 1 m in Sungai Petani and 1 to 2 m in Melaka. Variegated and pallid layers are seen under the surface lateritic soil. These underlying layers have impermeability because they have massive structures and clay to silty facies. It was observed that the ongoing land development in the hilly area removed the surface lateritic soils, exposing the underlying impermeable layers and causing puddles on the surface ground after a storm rainfall.

2.8 Environmental Conditions

Most channel flow of trunk drains and rivers, as well as water impounded in the existing flood detention ponds, tend to be polluted. Extremely serious water pollution is seen in the river flow of Sungai Petani, in particular, where the water quality is in Class III of the INWQ Standard. Main pollution sources are rubbish, effluent from septic tanks of individual houses, effluent from factories, and the nutrient-laden runoff from agricultural areas. Eutrophication of water impounded in the flood detention ponds has also led to massive algae bloom and water lily growth. These decompose in the water leading again to organic loading into the drainage channels and rivers thus deteriorating water quality.