



## Section 6

# EXISTING ENVIRONMENT

### 6.1 INTRODUCTION

This section describes the existing environment along the Project alignment. The alignment is divided into four segments for the purpose of this assessment, namely Kelantan (1 segment) and Selangor (3 segments).

### 6.2 TOPOGRAPHY

The topography along the ECRL Phase 2 is generally flat to undulating in Segment 1, 2B and 2C. Segment 2A is mostly undulating whereby it passes along Empangan Batu, Templer Park and Serendah Forest Reserve.

#### 6.2.1 Segment 1: Kelantan

The topography along this segment is flat. The elevation is low, ranging between 5 m to 15 m since it is close to the coast (**Figure 6.2-1**). All slopes in this segment are within Class I ( $0^{\circ}$ - $15^{\circ}$ ) (**Figure 6.2-2**).

#### 6.2.2 Segment 2: Selangor

##### Segment 2A: Gombak North to Serendah

The alignment from Gombak North to Serendah traversing the southern part of Batu Dam, Hulu Gombak Forest Reserve, Templer Forest Reserve and Serendah Forest Reserve is characterized by gentle-to-flat topography to hilly areas. The elevation from Gombak North to Batu Dam ranges from 110 m to 254 m, and from there the elevation ranges from 229 m to 387 m towards Ulu Gombak Forest Reserve. Next, the alignment passes through Templer Forest Reserve with an elevation ranging between 215 m – 386 m. Before passing through Serendah Forest Reserve, the alignment goes through north of Templer Impian near Templer Park at elevation levels of 128 m – 220 m. The terrain where the alignment passes through Serendah Forest Reserve is undulating at an elevation range of 199 m to 633 m. The terrain level then descends from 258 m to 30 m at Serendah Forest Reserve towards the existing

KTMB Serendah Freight Terminal. The topography near the KTMB Serendah Freight Station is gentle-to-flat while other areas are quite hilly (**Figure 6.2-3a**). The sections where the alignment traverse from Gombak North, southern part of Batu Dam, Hulu Gombak Forest Reserve, Templer Forest Reserve and Serendah Forest Reserve are mostly dominated by Class III (26°-35°) and Class IV (>35°) slopes (mostly tunnels). Class I (0°-15°) slopes are mostly concentrated from Serendah Forest Reserve until KTMB Serendah Freight Station (**Figure 6.2-4a**).

### **Segment 2B: Serendah to Bandar Puncak Alam**

The alignment from the existing KTMB Serendah Freight Terminal to Bandar Puncak Alam traverses mainly developed areas, Rantau Panjang Forest Reserve and agricultural land such as oil palm plantations. The elevation from the existing KTMB Serendah Freight Terminal, traversing along the residential area of Taman Anugerah Suria, Jalan Bukit Beruntung (Federal Route 3208) and Kg Koskan ranges from 26 m to 42 m. The alignment will then cross the North South Expressway (NSE) and tunnels through the hills south of Bandar Baru Sungai Buaya that is within 32 m to 120 m.

Upon crossing Sg. Garing, the alignment turns south west to a topography of 11 m to 67 m and then crosses the Rantau Panjang Permanent Reserved Forest at an elevation range of 30 m to 67 m. The alignment then passes by Batu Arang and Bandar Tasik Puteri that is located at elevations of 25 m to 67 m. Next, the alignment continues to fly over Jalan Kuala Selangor and LATAR Expressway, passing through mainly oil palm estates and turning south near the future Puncak Alam Station with elevation between 14 m – 88 m. Topography of this segment is characterized as flat topography (**Figure 6.2-3b**). The slope sections in this segment are varied from Class I (0°-15°) to Class IV (>35°). The slope sections at a distance of 1.5 km after the Sg. Serendah crossing are mostly within Class III and Class IV (tunnel section) while other areas along the alignment are mostly within Class I, Class II and Class III (**Figure 6.2-4b**).

### **Segment 2C: Bandar Puncak Alam to Port Klang**

After the alignment passes the future Bandar Puncak Alam Station, the elevation along the proposed tunnel ranges between 42 m to 146 m. Next, the at-grade alignment continues and travel south across oil palm plantations towards the future passenger station at Kapar with an elevation descending from 42 m to 8 m. The alignment will then pass through developed areas from Sg. Kapar Indah Industrial Park, heads further south and runs alongside Kg. Sementa, crossing Sg. Puloh and the mangrove area with an elevation ranging from 2 m to 15 m. The elevation range remains the same where the alignment crosses the New North Klang Straits Bypass (NNKSB), crossing Sg. Klang, Kg. Delek, Kg. Sg. Sireh Tambahan till it reaches Jalan

Kastam Station and terminates near the Klang Port Authority. Generally, Segment 2C is characterized by flat terrain (**Figure 6.2-3c**). Most of the slopes within this segment are within Class I ( $0^{\circ}$ - $15^{\circ}$ ) while the slopes near the future station of Puncak Alam Station are within Class III ( $26^{\circ}$ - $35^{\circ}$ ) and Class IV ( $>35^{\circ}$ ) (tunnel section) (**Figure 6.2-4c**).

## 6.3 GEOLOGY

### 6.3.1 General Geology of Peninsular Malaysia

Peninsular Malaysian geology can be divided into 3 belts and each has its distinctive geologic history and evolution. The belts are known as Central, Eastern and Western Belts in which the division is mainly based on its mineralisation. Bentong-Raub Suture Zone represent the most prominent geological evolution of the Peninsular Malaysia.

In term of geological evolution, it ranges from the Cambrian to the Quaternary, that is from 570 million years to about 10,000 years ago, all are represented. During the Palaeozoic and Mesozoic eras, sedimentation was continuous; and due to the basin's instability, major breaks are apparent within and between the Palaeozoic, Mesozoic and Cenozoic group of rocks. **Chart 6-1** shows the lithological distribution in Peninsular Malaysia and the distinct 3 belts.

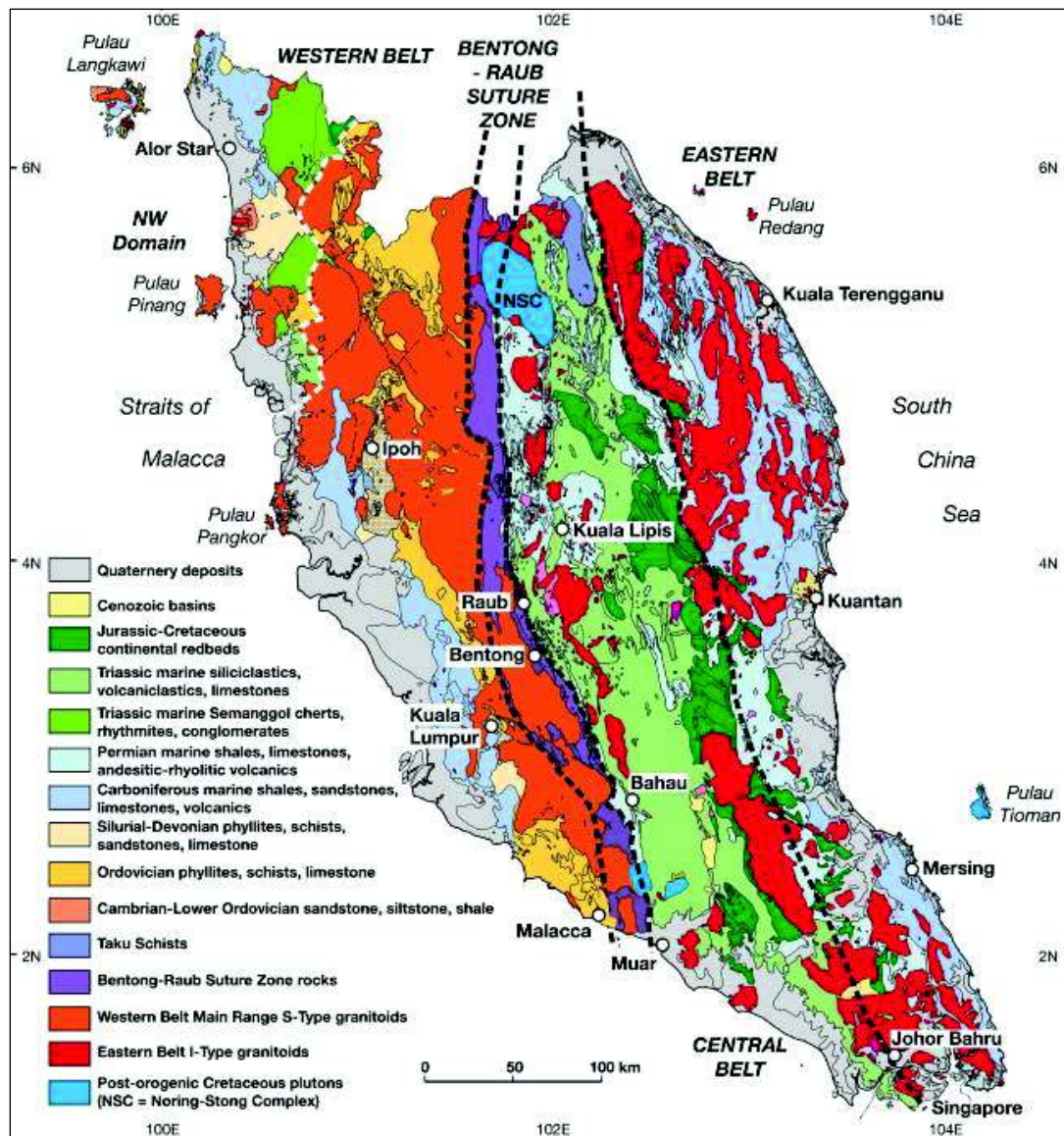
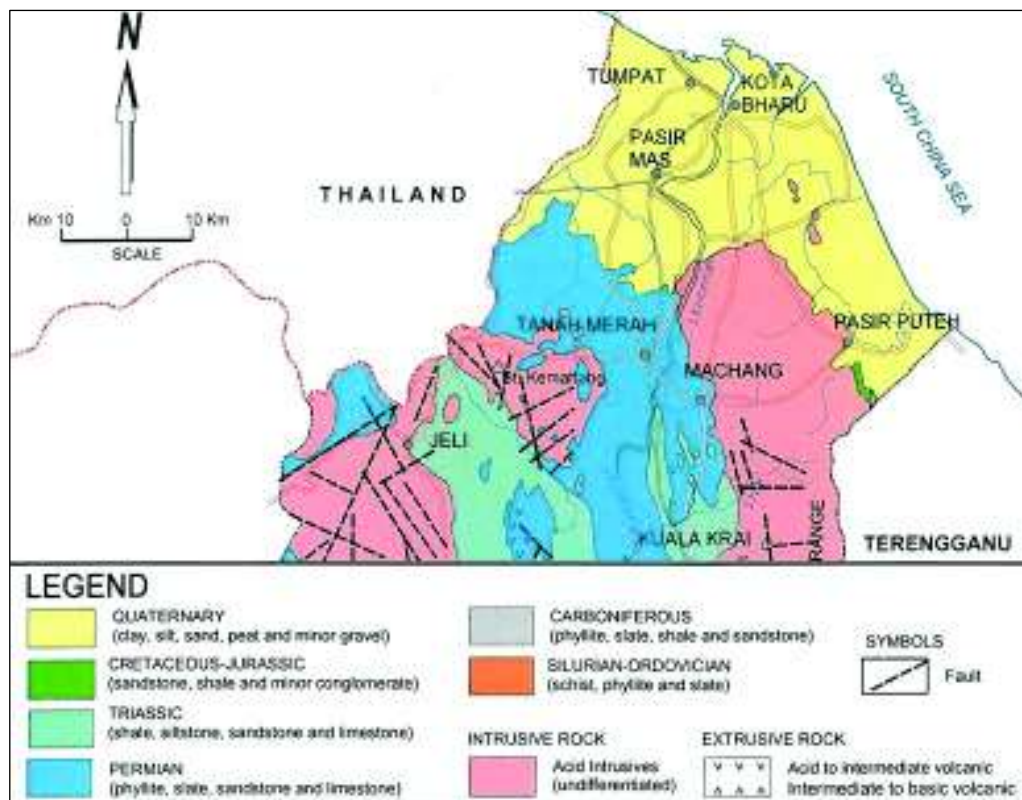


Chart 6-1 : Geological evolution of Peninsular Malaysia (JMG Malaysia)

### 6.3.1.1 Kelantan

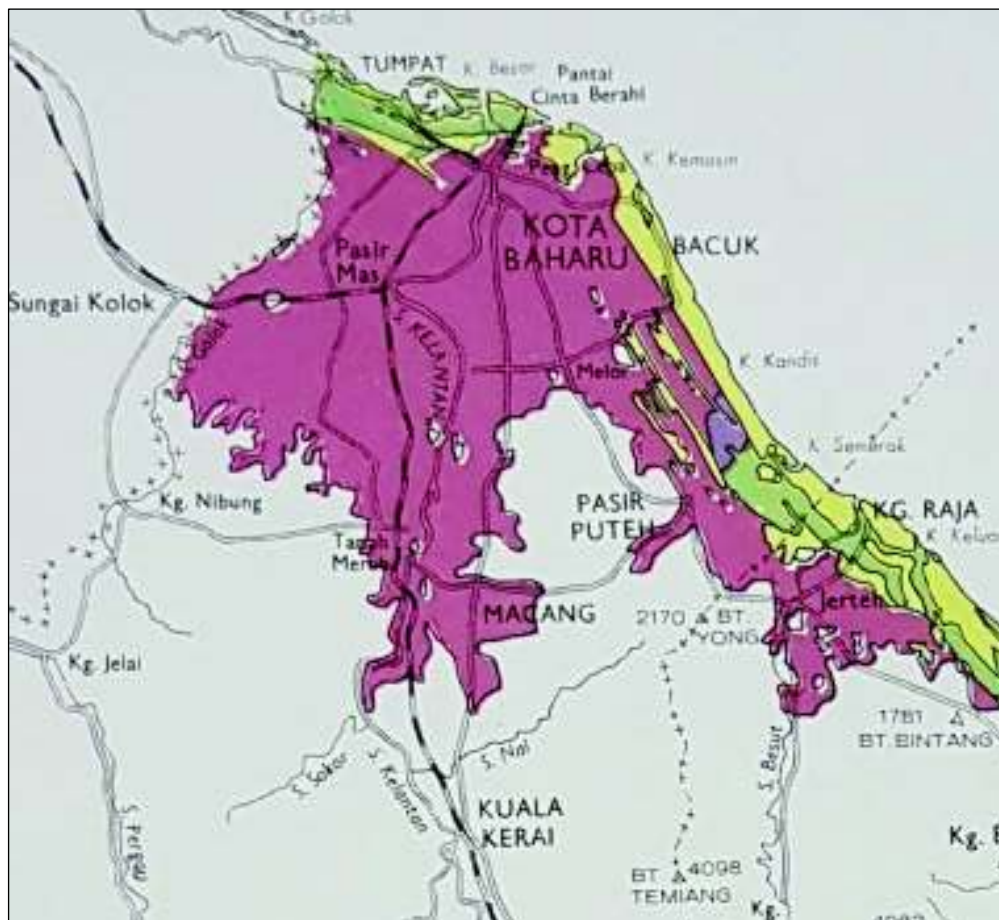
The regional geology of Kelantan consists of a central zone of sedimentary and metasedimentary rocks bordered on the west and east by granites of the Main Range and Boundary Range respectively. Within the central zone, there are windows of granitic intrusives. The oldest rocks in the state are of Lower Palaeozoic age, outcropping as a northerly-trending belt bordering the foothills of the Main Range and extending eastward. Predominantly Permian volcanic-sedimentary rocks occur extensively on the eastern side of, and overlying unconformably, the Lower Palaeozoic sequence in southwest Kelantan. The Taku Schist of pre-Triassic age, dominates central north Kelantan. Triassic rocks are confined mainly to central and south Kelantan. These rocks are mainly argillo-arenaceous sediments with

intercalated volcanics and limestone. Several inliers of Permian rocks crop out through this veneer of Triassic sediments (MacDonald, 1967). The youngest rocks are the Jurassic-Cretaceous continental rocks which overlie the Boundary Range Granite and Triassic sediments in the Gunung Gagau area at the common state boundary between Kelantan, Terengganu and Pahang and to the west in the Gunung Perlis and Gunung Pemumpu areas. This sequence consists of conglomerate overlain by sandstone with sporadic volcanic intercalations (Rishworth, 1974). The sedimentary and metasedimentary rocks consist of shale, sandstones, phyllite and slate occurred in the west. The geology of North Kelantan is shown in **Chart 6-2**.



**Chart 6-2 : General Geology of North Kelantan (JMG Malaysia)**

Along the coast, that is in the northern part of Kelantan, the area is underlain by Quaternary alluvium with thickness from a few meters near the foot of the mountain up to more than 150 m reaching the shore. The thickest and broadest area covered by alluvium is in Kota Bharu area and it consists of clay, sand, silt and gravels (Ang & Ismail, 1996). In the south of Kota Bharu, the alluvium gets narrower and thinner aligning along the coast line (**Chart 6-3**).



**Chart 6-3 : Areas in Kelantan underlain by Quaternary deposits (JMG Malaysia)**

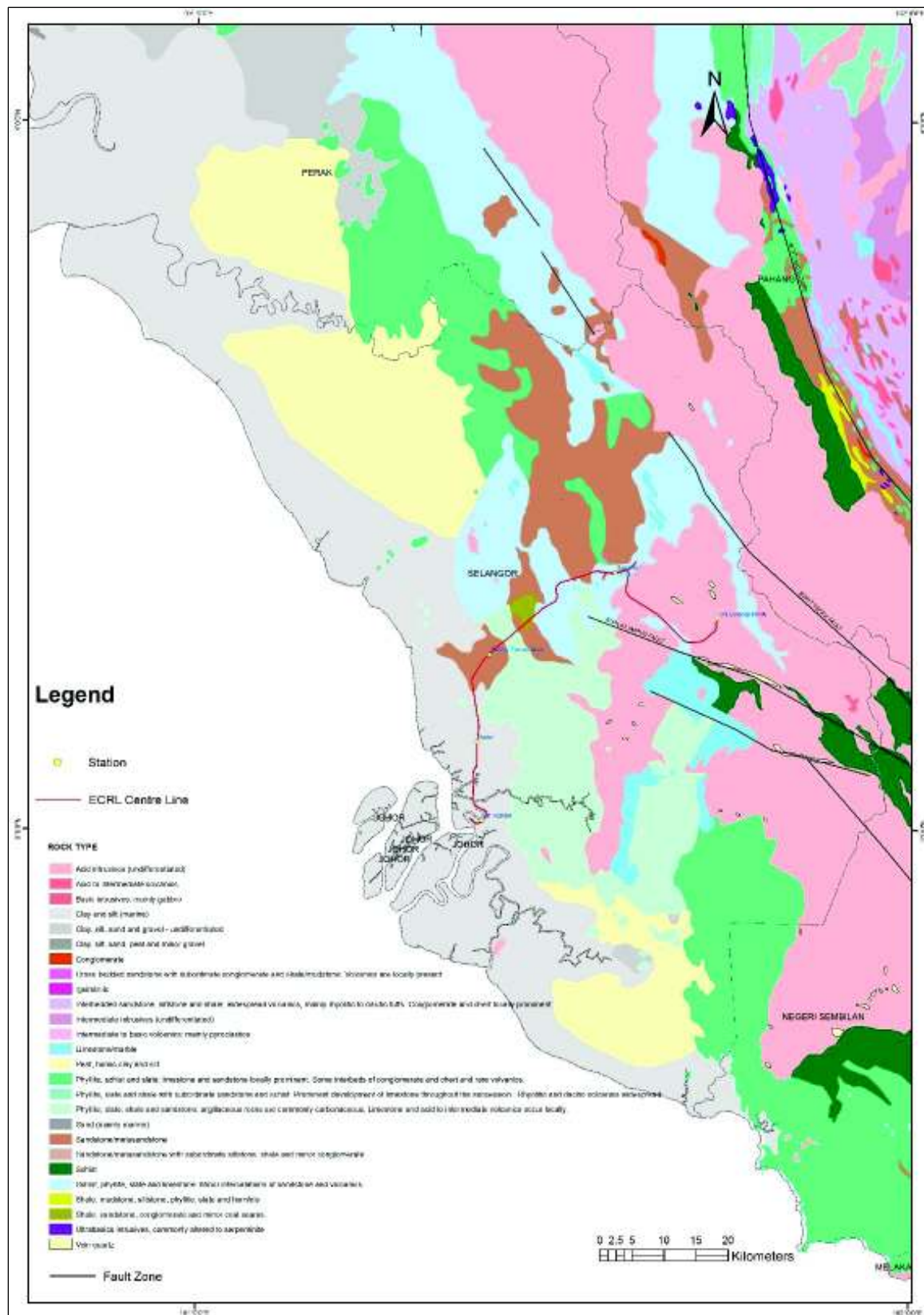
Mineralisation is quite common in central Kelantan in which history of gold mining is associated with the fault controlling hydrothermal mineralisation. Alluvial gold has also been mined in the state. The majority of the gold production apparently came from these Pahang and Kelantan states within the Central Belt.

### **6.3.1.2 Selangor**

The geology of Selangor, broadly there are igneous and metamorphic rocks in the north and north-east with a ridge of granite extending southwards. Sedimentary rocks namely Kenny Hill Formation form the southern and western parts of the State and Kuala Lumpur Limestone is mainly located in the central position. On the southeast, Hawthornden Schist and Dinding Schist are predominant. This terrain consists of schist, sandstone, mudstone and shale (**Chart 6-4**).

Main Range granite of Mesozoic age underlain the most part of Central Selangor extending from the north to south. The vertical dykes of vein quartz occur within the granite along a marked 105° alignment just south of the alignment. The most prominent of these later intrusions forms the Klang Gates Ridge which is breached by both the Gombak and the Klang River.

Quaternary deposits underlain the coastal line on the west made up of sand, silt and clay with occasional gravel. The Quaternary deposits are forming excellent aquifers in the Langat Basin.



### 6.3.2 Project Site Geology

The local geology of an area is important when planning a major construction. Site geology influences the stability of slopes and foundation, and hence shapes the detailed design. Usable rock materials are contributors to successful civil project such as this rail project as large amount of construction material are required for the project. As such, geological, hydrogeological and geotechnical investigations, and planning are crucial in any successful engineering initiatives.

In this rail project, detailed geological investigation will be carried out to understand the geological conditions along the alignment. Certain geological conditions will hamper the progress of the project; hence the investigation will be carried out to:

- Study the lithology of the area.
- Investigate geological structure of the project area.
- Investigate subsurface geology.
- Understand groundwater condition along the alignment, and
- Study seismic condition that may affect the construction and operation of the rail infrastructure.

The common problems related to geology for a railway project especially when it involved tunnelling, might be caused by any of the following geological features:

- faults
- soft alluvial ground
- junctions between hard and soft formations
- boundaries between permeable and impermeable formations
- spring-lines
- fractured rocks
- weathered schists/sandstone/phyllite/granite
- landslide areas
- areas where beds daylight towards the railway line
- permeable quartz dyke/vein in the bedrock
- construction on the uneven ground above the limestone bedrock, and
- cavities in limestone

As the project also involve several tunnelling works in different geological conditions, significant knowledge on site geology, groundwater and quantity of water along the tunnel alignment will significantly help in designing, constructing and maintaining the tunnels. Detailed investigations which will help to minimize the level of uncertainty encountered during tunnel excavation be carried out to consider:

- a. Strength and mechanical behaviour of rock
- b. Structures in rock mass
- c. Groundwater flow regimes
- d. Gaseous in rock

The design, construction, and operation will be depending on a full knowledge of the situation of the groundwater and quantity of water. Knowledge of rock, soil, geology and rock formation along and around the tunnel is very vital. The general geology of both alignment in Kelantan and Selangor is shown in **Table 6-1**.

**Table 6-1 : General geology along the proposed alignment**

Segment	Age	Rock Units and Lithology
Segment 1: Kelantan	Quaternary	Alluvium: consists of clay, silt, sand and gravel
Segment 2A: Gombak North - Serendah	Triassic Ordovician – Devonian	Acid intrusives Schist, phyllite, slate and limestone. Minor intercalations of sandstone and volcanics
Segment 2B: Serendah – Bandar Puncak Alam	Carboniferous – Permian Ordovician – Devonian	Schist, phyllite, slate, metasandstone, sandstone, shale and chert with minor intercalations of limestone/marble Schist, phyllite, slate and limestone. Minor intercalations of sandstone and volcanics
Segment 2C: Bandar Puncak Alam – Port Klang	Quaternary Carboniferous – Permian	Alluvium of marine and continental deposits: clay, silt, sand, peat with minor gravel Schist, phyllite, slate, metasandstone, sandstone, shale, mudstone siltstone, conglomerate, volcanics and chert with minor intercalations of limestone/ marble,

Source: Geological Map of Peninsular Malaysia, 9<sup>th</sup> Edition 2014

The soil investigation works carried out for the phase 2 consist of deep boreholes drilled along the proposed alignment. There are 4 boreholes in Segment 1 and 16 boreholes in Segment 2. Detailed geological logs and laboratory testing results are described in the Site Investigation Report (**Appendix B**).

All the drillings were carried out using wash-boring method for overburden subsoils and coring for rock. In-situ standard penetration tests (SPT) were carried out at every 1.5 m intervals in depth inside the boreholes as boring progresses until bedrock. Disturbed soil samples were collected in SPT split spoon sampler and description of samples together with sample photos were recorded in the Soil Investigation Report. Undisturbed soil samples were collected using thin wall sampling tube of 1000 mm length by 75 mm diameter or Mazier samplers at specified depths. 50 mm diameter rock core samples were also collected from core barrel for visual inspection and laboratory testing.

The boreholes have been drilled at the proposed stations to understand the geological conditions and nature of the ground along the rail alignment. The indicative boreholes range in depth from 9.50 m to 30.45 m.

#### **6.3.2.1 Segment 1 : Kelantan**

The alignment in Kelantan from Kota Bharu to Pengkalan Kubor is completely in Quaternary deposits (**Chart 6-5**). All the alignment is on undifferentiated alluvium and made up of clay, silt, sand and gravel layer especially in areas along Kota Bharu to Wakaf Bharu which is in the south of the project area. Alluvium made up of clay and silt is widespread in Pengkalan Kubor area in the north, and there is a short stretch of alignment sitting on sand of marine environment near Tumpat in Kg. Cherang and Kg. Bunohan in the middle of the project area.

Data from Jabatan Mineral dan Geosains Malaysia (JMG) for Tumpat, Pasir Mas and Kota Bharu shows that the alluvium is more than 125 m thick. Most of the time, the thickest sequence of the alluvium is the sand which is more than 20 m. Thickness of clay is usually in the range of 5 to 10 m and Standard Penetration Test (SPT) results normally indicate N-values in the range of 5 to 15 i.e. medium to stiff. The SPT N-values for sand layer is in the range of 20 to >50 i.e. medium to very dense. The sand and clay are commonly interlayering. In places, layers of silt are commonly being interfingering with the sand and clay.

The groundwater table is normally very shallow from near surface up to 6 m and depends very much on the elevation of the ground.

Drilling works from the ECRL Phase 1 in which boreholes were drilled in Pasir Mas and Tok Bali to a depth of 51.45 and 49.95 m respectively, show sand layer, and interlayering of clay and sand. The water table in the 2 boreholes are shallow up to 6.20 m.

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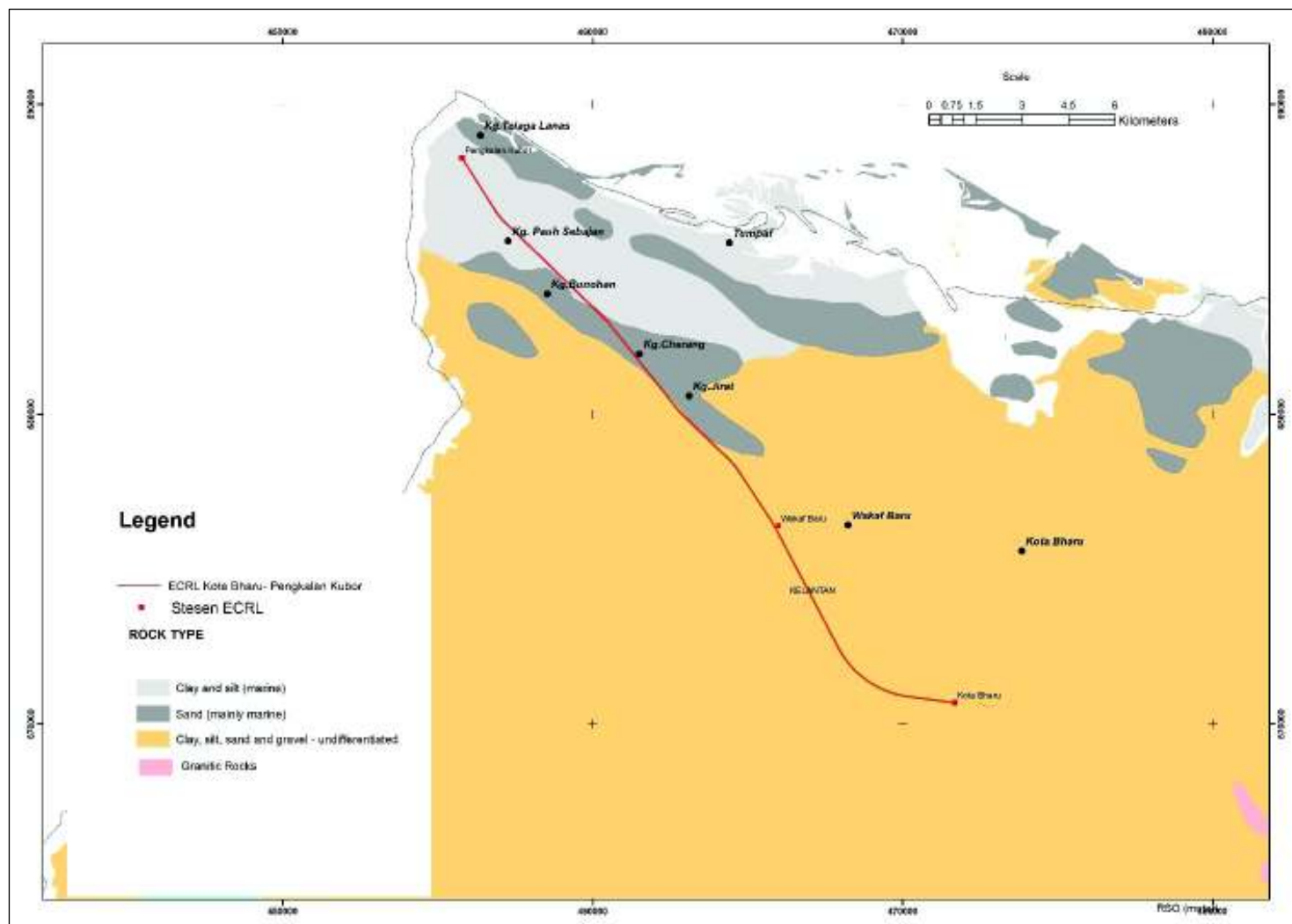


Chart 6-5 : Quaternary deposits in Kelantan

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### 6.3.2.2 Selangor

One of the main geological concerns for the project would be the alignment of Phase 2 in Selangor as it involves 12 number of short tunnelling totalling 17.2 km which will be stretching from Gombak to Puncak Alam. Granite of Mesozoic age, schist, phyllite and sandstone of various ages are dominant along the tunnel alignment of the rail project in Selangor. In Port Klang area, the alignment will be entirely in the alluvium of Quaternary age. **Chart 6-6** shows the geology of the alignment in Selangor.

The alignment in Selangor begins at Gombak North and to Serendah, from Serendah to Puncak Alam then to Port Klang. The alignment travel through varied geology and described according to segment 2A to 2C.

#### Segment 2A: Gombak North to Serendah

The alignment in this stretch is underlain mainly by the granite but in the area of Batu Dam and Templer Park, the alignment would be seating on the roof-pendant quartz-mica schist. In the Templer Park area, limestone outcrops in the form of Bukit Takun and Bukit Anak Takun are very visible, however, the railway line is not aligned on this very soluble rock which is also prone to sinkholes. Properties of various rock types along the alignment are discussed below.

##### Granites

The granites are in the form of porphyritic, biotite-, muscovite-, and pyroxene-bearing granites which intruded into older sedimentary sequences in Mesozoic times. A well-established joint pattern is present and generally there are three main sets of joints. Two of these joint sets trend east-southeast to east and north to northeast. The drill cores from the Site Investigation reports kept in JMG indicate most granites are jointed and the joints are open and iron-stained. At times joints are filled with clay. Small faults are visible in a well exposed bedrock or inferred from the aerial photographs or satellite imageries.

The bedrock granite is normally overlain by residual soil (Grade VI) and completely weathered granite which is very soft to firm silty clay up to 20 m deep. The thickness of the soil depends very much on the intensity of the weathering and structures in the granite itself. In the higher elevation, the soil is close to the surface. A typical cross-section of granitic area is shown in **Chart 6-7**. For the coarse-grained granite with more quartz, it is normally weathered to silty sand. In the sand, the SPT N-values are normally in the range of 20 to >50 (medium to very dense) whereas in the clay the SPT N-values range from 5 to 30 (medium stiff to hard).

##### Schists

At the Batu Dam and Templer Park area, quartz-mica schists and in certain localities are overlain by graphite-bearing schists form the important rock types. The schist is normally grey or green with the schistosity well developed. Weathering of schist is normally into silt or

clay. Streak of fine sand is often encountered within the silt or clay. The residual soil overlying the bedrock is of varying thickness most likely up to 35 m. However, in certain localities the bedrock is encountered at <10 m.

The SPT N-values of the silt are in the range of 5 to 40 (medium stiff to hard) but the values of >50 are usually encountered nearing the bedrock.

#### Quartz dykes

Vertical dykes of vein quartz occur within the granite and schist along the alignment. However, the most prominent of these later intrusions forms the Klang Gates Ridge which is breached by both the Gombak and the Klang River, however, the alignment of Phase 2 is not affected by the ridge which is protected by a legal instrument. The eastern end of the ridge is at Taman Seri Gombak in which tunnelling will be the major feature of the railway line, but unless detailed geological investigation is carried out, the actual extension of the quartz ridge is not ascertained.

Based on previous studies in Batu Dam, the quartz dykes are very permeable with high values of hydraulic conductivity in the range of  $1 \times 10^{-3}$  to  $10^{-2}$  cm/sec. It allows higher velocities of groundwater movement.

#### Limestones and dolomites

Limestone occur in a few places along and close to the alignment. It is known as the Kuala Lumpur Limestone. According to Gobbett (1964) they are Silurian in age and lie on top of the schists. The limestone forms a karstic plain beneath the alluvium in the structural basin of Kuala Lumpur and a residual form the prominent hill mass at Batu Caves in the north. Other exposures of limestone are in Templer Park and Serendah.

However, segment from Gombak to Serendah only encounter the limestone in Serendah town area. The limestone is famously known to develop karstic feature due to chemical dissolution process when groundwater circulates through the limestone. As the water percolates downward under the force of gravity, it dissolves and enlarges the pathways and over time, resulting in very jagged appearance, sometimes dissect vertically and deeply into the rock terrain. The thickness of alluvium sitting on top of the limestone varies very much from near surface to more than 80 m. Thicker alluvium consisting of inter layering of clay, silt or sand could also be the result of excavation during the mining operation. In certain location, the clay layer is thick and forming a soft ground above the limestone bedrock. The SPT N-values could be <5.

#### Former Mining Ground

Tin mining was very active Rawang and Serendah in the fifties to early seventies. The left behind former mining ground that have been reworked several times. The former mining ground is easily identified by the existence of ex-mining ponds that are scattered all over places. Other than the ponds, the former mining grounds are typically soft ground majority filled by soft clay. In many areas, the SPT N-values of the clay are <5. Based on previous

studies in Kuala Lumpur and many parts of the country, the soft clay will be one of the geological hazards. Part of the Segment 2A alignment are expected to be built above the ex-mining ponds, hence, the site investigation must be done very thoroughly to avoid any mistakes in the design of the related rail infrastructures, and problems related to construction above soft ground. **Chart 6-8** shows the ex-mining areas and **Chart 6-9** shows one example where the alignment is running on the ex-mining pond in southeast of Serendah. In this case, the ex-mining ground is in limestone.

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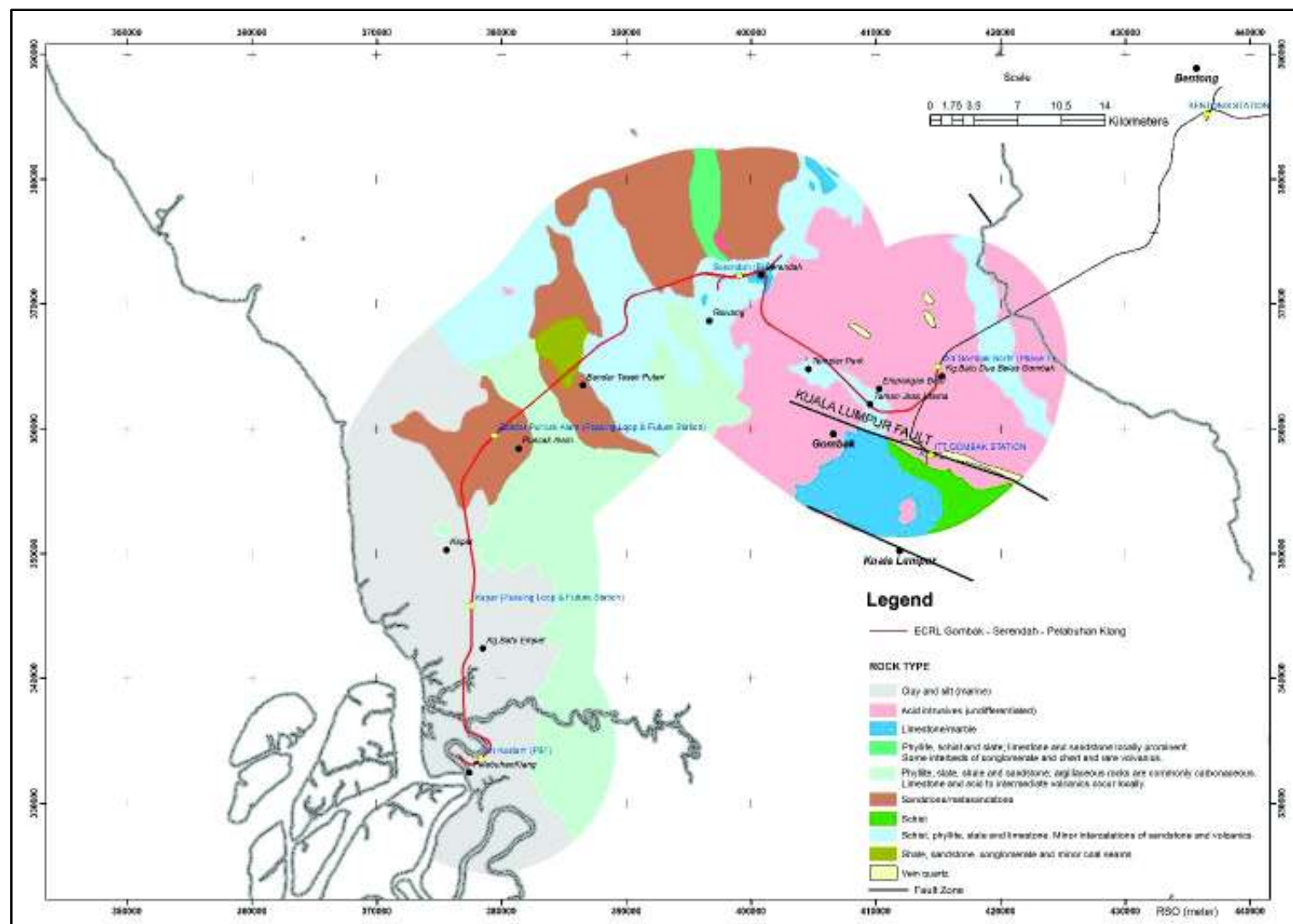


Chart 6-6 : Geology of the alignment in Selangor

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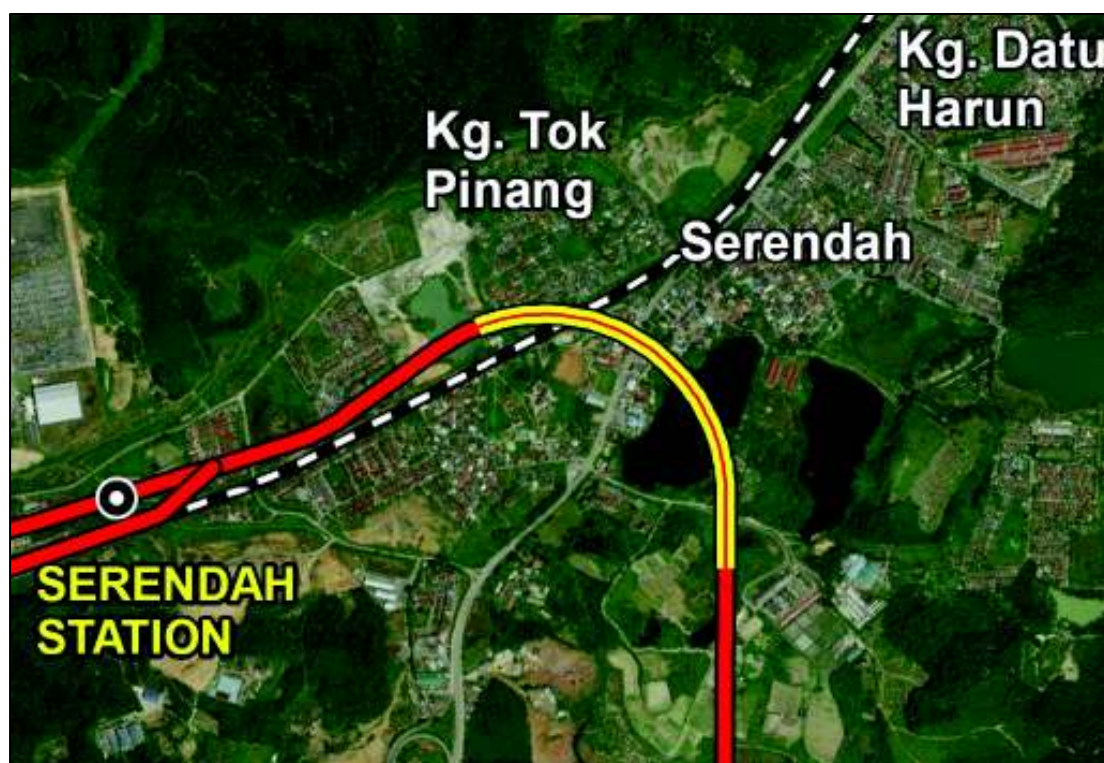


Chart 6-9: Alignment crossing ex-mining pond Serendah

### Segment 2B: Serendah to Bandar Puncak Alam

This Segment 2B stretch is underlain mainly by the schist, limestone, sandstone and shale. No granite is encountered in the segment. In Serendah, the alignment will be seating on the quartz-mica schist similar to the occurrence of schist in Batu Dam area, and also small body of limestone in the town area. Away to Bandar Puncak Alam, most of the alignment will also be in the schist but near to Bandar Tasik Puteri and in Puncak Alam, the area is underlain by sandstone. At the Bandar Tasik Puteri, sequence of shale, sandstone and conglomerate will be encountered. The schist will be the foundation between Bandar Tasik Puteri and Bandar Puncak Alam. Properties of the various rock types along the alignment are discussed below.

#### Schists

In the Segment 2B, majority of the foundation will be on quartz-mica schists similar to the occurrence in the segment 2A. The schist is normally grey or green with the schistosity well developed. Weathering of schist is normally into silt or clay. Streak of fine sand is often encountered within the silt or clay. The residual soil and weathered schist overlying the bedrock is of varying thickness up to most likely 35 m as in the Batu Dam area. However, not much subsurface data is available for this rock type in Segment 2B.

The SPT N-values of the silt are in the range of 5 to 40 (medium stiff to hard) but the values of >50 are usually encountered nearing the bedrock.

#### Sandstone

The sandstone underlain the alignment in a few localities, somewhere near Serendah, Bandar Tasik Puteri and approaching Bandar Puncak Alam. The sandstone composed of sand-size grains of mineral mainly of quartz, rock fragment, or organic material. It also contains a cementing material that binds the sand grains together and might contain a matrix of silt- or clay-size particles that occupy the spaces between the sand grains.

The sandstone is normally overlain by the residual soil resulted from weathering. In the weathering, the grains of sand in the sandstone which are usually particles of mineral, rock fragment, or organic material were reduced to sand size. Subsurface information from JMG indicated that the soil overlying the sandstone bedrock can reach up to 25 m with SPT N-values ranging from 5 to 35, and reached >50 nearing the bedrock. Exposure at a construction site at Bandar Puncak Alam indicates the bedrock is shallow (**Chart 6-10**).



**Chart 6-10 : Bedrock exposures at the construction sites in Bandar Puncak Alam**  
**Prominent joints could be seen on the exposure of the weathered sandstone**

#### Shale

Shale together with layers of sandstone and conglomerate occupies an area near the Bandar Tasik Puteri. The shale which is a fine-grained sedimentary rock that forms from the compaction of silt and clay-size mineral particles is normally fissile and laminated. The lamination displays that the rock is made up of many thin layers and it is also fissile which exhibit that the rock readily splits into thin pieces along the laminations.

The shale weathered into clay as the parent rock is made up of fine-grained particles. Subsurface information from JMG indicated that the soil overlying the shale bedrock can reach up to 30 m with SPT N-values ranging from 3 to 25, and reached >50 nearing the bedrock. Near surface N-values are very much lower indicating the softness of the clay layer.

#### Conglomerate

The conglomerate is normally found interlayering with shale and sandstone. The conglomerate along the alignment contains large rounded clasts. The space between the clasts is generally filled with smaller particles and cemented together. The particles as the clasts are mostly quartz, sandstone/quartzite, and shale rock fragments. The matrix that binds the large clasts is a mixture of sand and mud.

#### Former Mining Ground

Tin mining was very active Rawang in the fifties to early seventies. The former mining ground is easily identified by the existence of ex-mining ponds that are scattered all over places. Other than the ponds, the former mining grounds are typically soft ground majority filled by soft clay. In many areas, the SPT N-values of the clay are <5. The soft clay will be one of the geological hazards. Part of the Segment 2B alignment are expected to be built above the ex-mining ponds, hence, the site investigation must be done very thoroughly to avoid any mistakes in the design of the related rail infrastructures, and problems related to construction above soft ground.

### **Segment 2C: Bandar Puncak Alam to Port Klang**

The segment 2C is underlain by the sandstone and metasandstone in around Bandar Puncak Alam area. Towards the coast to Port Klang, alluvium is dominating the geology of the area. Properties of the various rock types and alluvium along the alignment of Segment 2C are discussed below.

#### Sandstone

The sandstone underlain the alignment in the surroundings of Bandar Puncak Alam. The sandstone composed of sand-size grains of mineral mainly of quartz, rock, or organic material. It also contains a cementing material that binds the sand grains together and may contain a matrix of silt- or clay-size particles that occupy the spaces between the sand grains.

The sandstone is normally overlain by the residual soil resulted from the weathering. In the weathering, the grains of sand in the sandstone which are usually particles of mineral, rock, or organic material were reduced to sand and silt size. Subsurface information from JMG indicated that the soil overlying the sandstone bedrock can

reach up to 25 m with SPT N-values ranging from 5 to 35, and reached >50 nearing the bedrock.

#### Alluvium

The alluvial deposits consisting mostly of unconsolidated sand, silt and clay of Quaternary age are occupying the low lying areas along the coast. The deposits are of Simpang Formation of Pleistocene and Gula and Beruas Formations of Holocene. The Quaternary layer, from the top to the bottom, consists of 0.5 to 5.5 m deep Beruas Formation with peat layer at the top, clayey Gula Formation and Kempadang Formation starting in the hardrock areas and having a 40 to 50 m depth near the coastal line. Underneath is the Simpang Formation of sand and gravel with thickness of several metres in the hardrock area and about 50 m to more than 100 m in the low flatlands. The Simpang Formation forms a good aquifer in many localities along the coast especially in the Langat Basin. However, Klang Basin is not known to have good aquifer.

In many localities along the alignment on the alluvium from Bandar Puncak Alam to Port Klang, the ground is expected to be typically soft ground with majority underlain by clayalities especially near the river, organic materials at the top of the layer are mixed with the soft clay. Data from JMG indicate that in many areas, the SPT N-values of the clay are <5 and thickness of clay up to 35 m. The soft clay will be one of the major geological challenges. **Chart 6-11** shows the typical alluvial soil near Kapar.

There are no major peat areas along the alignment Segment 2C (refer **Chart 6-12**), however, peaty soil will be encountered in low lying riverine areas especially along the Sg. Kelang near Port Klang areas where the Jalan Kastam end station is going to be situated. The peaty clay soil is very soft with SPT N -values <5. **Chart 6-12** shows the occurrences of major peat areas in Selangor.



Chart 6-11 : Typical alluvial soil near Kapar

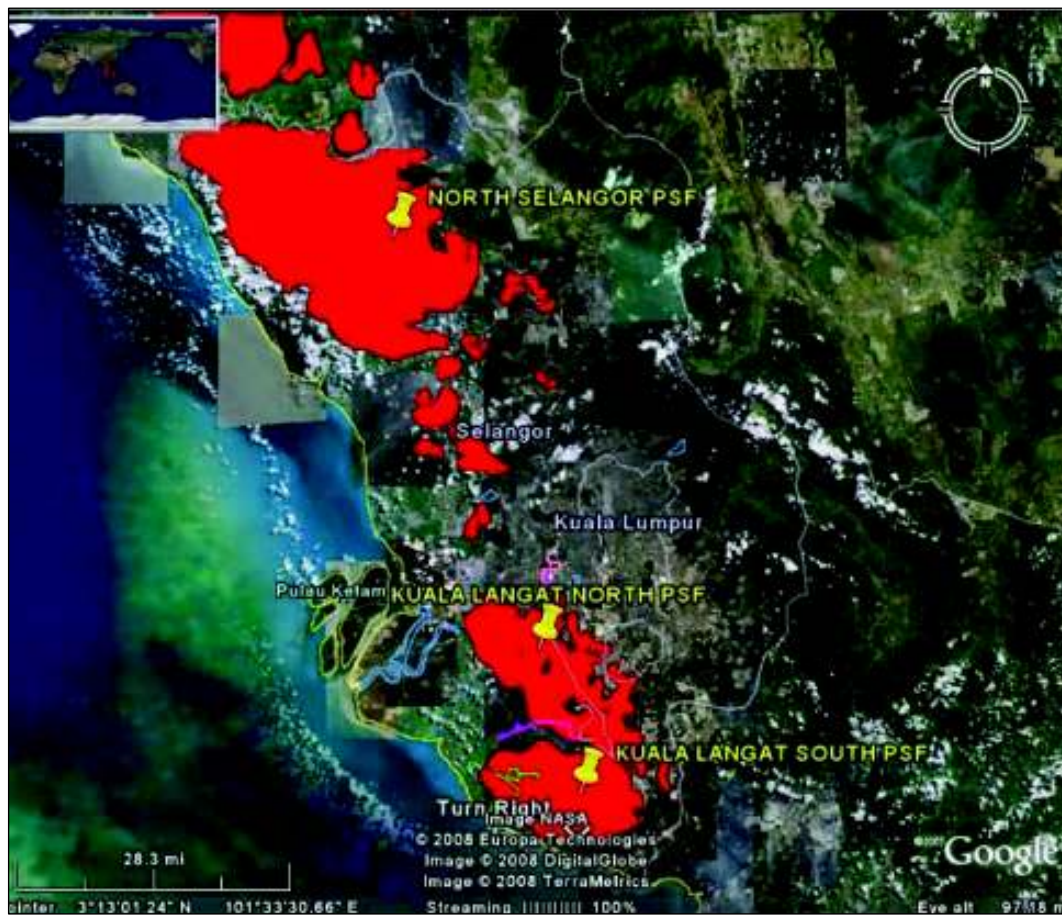
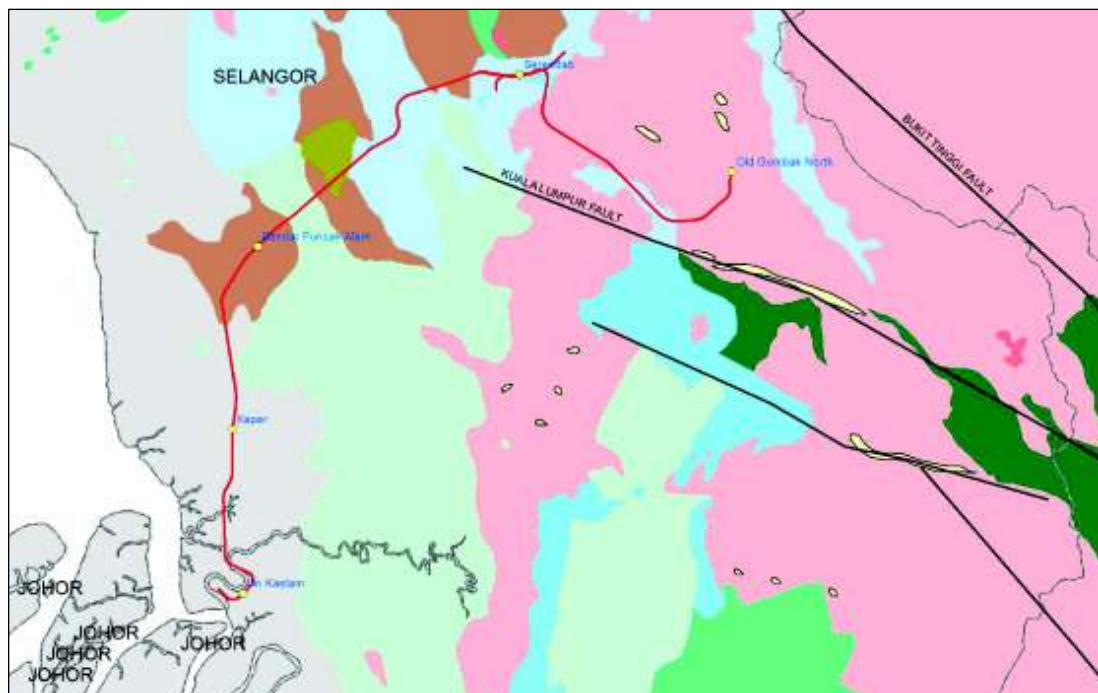


Chart 6-12 : The occurrence of major peat areas in Selangor (Wetlands International – Malaysia, 2010)

### Fault Line

Stability of the tunnel wall and railway track would be compromised with the presence of weak zone (a part or zone in the ground in which the mechanical properties are significantly lower than those of the surrounding rock mass). Weak zones can be faults, shears/shear zones, thrust zones, weak mineral layers, etc. (Norwegian Rock Mechanics Group, 2000). Basically, there are two main groups of weak zones: 1) those, which are formed from tectonic events, and 2) those consisting of weak materials formed by other processes, such as weathering, hydrothermal activity and alteration. However, the Kuala Lumpur and Bukit Tinggi Faults are away from the tunnel line in Segment 2 as shown by **Chart 6-13**.



**Chart 6-13 : Bukit Tinggi Fault and Kuala Lumpur Fault Lines**

## **6.3.3 Soil Investigation Works**

### **6.3.3.1 Segment 1 : Kelantan**

Four (4) boreholes were drilled along the Phase 2 Segment 1. Location of the boreholes is shown in **Figure 6.7-1**.

The alluvial layers are made up of layers of clay, sandy silt or clayey silt with intercalation of sand layers. The drilling summary is in **Table 6-2**.

**Table 6-2 : Summary of the boreholes along Segment 1**

Borehole	Coordinate	Location	Depth (m)	Water level (m)	Soil	SPT N-values
BH17	6° 6' 51.25" N, 102° 11' 3.18" E	Wakaf Bharu	30.45	1.00	Clay, Silt, Sand	Clay 4-23 Sand 11-22
BH18	6° 9' 58.35" N, 102° 8' 29.29" E	Kg. Cherang, Tumpat	30.45	1.20	Clay, Silt, Clay	Sand 6-18 Clay 7-22
BH19	6° 11' 40.9" N, 102° 6' 36.32" E	Kg. Baroh Kok Pauh, Tumpat	30.45	1.00	Silt, Sand, Clay	Clay 5-26 Sand 8
BH20	3° 13' 24.95" N, 102° 5' 32.84" E	Pengkalan Kubor	30.45	1.00	Sand, Silt, Clay	Sand 6-20 Clay 6-13

### 6.3.3.2 Selangor

Sixteen (16) boreholes along the Segment 2 were drilled along the alignment. The summary is given in **Table 6-3**. Two of the boreholes from Phase 1 is also included in the summary. Location of the boreholes is shown in **Figure 6.7-1**.

Boreholes drilled in Segment 2 in Selangor suggest a varied geological formation from granite to schist to young alluvium, however, bedrock of granite was reached only at BH15. The depth ranges from 9.50 m to 30.45 m. The young alluvium in Klang and Kapar generally show very soft characteristics. **Table 6-3** shows the summary of the boreholes drilled along the alignment.

**Table 6-3 : Summary of the boreholes along Segment 2**

Borehole	Coordinate	Location	Depth (m)	Water level (m)	Soil	Bedrock	Bedrock depth (m)
BH1	3° 0' 40.71'' N, 101° 24' 3.02'' E	Komuter Station, Jalan Kastam, Pelabuhan Klang	30.45	2.00	Clay, Silt (1 m of sand)	Not reached	-
BH2	3° 2' 9.25'' N, 101° 23' 24.18'' E	Beside Sg. Klang, near Bandar Sultan Suleiman, Pelabuhan Klang	30.45	2.50	Silt (thin clay layers)	Not reached	-
BH3	3° 4' 9.77'' N, 101° 23' 18.67'' E	Near Sg. Buloh, Pelabuhan Klang	30.45	3.00	Silt, Clay	Not reached	-
BH4	3° 5' 17.74'' N, 101° 23' 31.05'' E	Near Jalan Kapar, Klang	30.45	3.20	Clay, Silt, Sand	Not reached	-
BH5	3° 8' 10.25'' N, 101° 23' 46.08'' E	Persiaran Hamzah Alang, Kapar, Klang	30.45	3.65	Clay, Silt, Sand	Not reached	-
BH6	3° 11' 35.65'' N, 101° 23' 57.23'' E	Sime Darby Estate, near Kapar, Klang	30.45	3.00	Clay, Silt, Sand	Not reached (SPT N-value 50 from 27.00 m)	-
BH7	3° 14' 28.17'' N, 101° 24' 19.55'' E	Persiaran Puncak Alam, near Taman Ambang Suria	22.73	3.10	Sand, Silt, Clay, Gravel	Not reached (SPT N-value 50 from 16.50 m)	-
BH8	3° 15' 52.24'' N, 101° 25' 48.58'' E	Sime Darby Estate, near Kapar, Klang	30.01	4.30	Sand, Silt, Clay Gravel	Not reached (SPT N-value 50 from 19.50 m)	-
BH9	3° 16' 51.62'' N, 101° 26' 56.32'' E	Jalan Kuala Selangor, near Bandar Tasik Puteri	18.03	2.70	Sand, Silt, Clay, Gravel	Not reached (SPT N-value 50 from 12.00 m)	-

**Table 6-3 : Summary of the boreholes along Segment 2 (Cont'd)**

<b>Borehole</b>	<b>Coordinate</b>	<b>Location</b>	<b>Depth (m)</b>	<b>Water level (m)</b>	<b>Soil</b>	<b>Bedrock</b>	<b>Bedrock depth (m)</b>
BH10	3° 20' 32.90'' N, 101° 30' 32.44'' E	Jalan Batu Arang	16.51	2.90	Silt, Clay, Sand, Gravel	Not reached (SPT N-value 50 from 6.00 m)	-
BH11	3° 21' 58.16'' N, 101° 33' 47.10'' E	Near Taman Anugerah Suria, Rawang	15.03	4.35	Silt, Clay, Sand	Not reached (SPT N-value 50 from 6.00 m)	-
BH12	3° 20' 25.46'' N, 101° 35' 55.46'' E	Kg. Tok Pinang, Serendah	18.10	2.60	Sand	Not reached (SPT hammer rebound from 10.50 m)	-
BH13	3° 22' 8.13'' N, 101° 36' 21.52'' E	Sg. Choh, Rawang	30.45	2.22	Sand, Silt, Clay	Not reached (Highest SPT N- value of 31 at 27.00 m)	-
BH14	3° 18' 6.80'' N, 101° 38' 33.58'' E	Templer Park, Rawang	24.19	3.90	Sand, Silt	Not reached (SPT N-value 50 from 18.00 m)	-
BH15	3° 15' 31.59'' N, 101° 41' 49.33'' E	Sg. Tua, Gombak	9.50	4.30	Silt, Sand	Granite	3.50
BH16	3° 16' 16.05'' N, 101° 43' 3.22'' E	Kg. Sg. Salak, Gombak	18.25	4.80	Sand	Not reached Not reached (SPT N- value 50 from 12.00 m)	-

### 6.3.4 Hydrogeology

#### 6.3.4.1 Kelantan

In Peninsular Malaysia, Kelantan and Selangor are the two states actively pumping groundwater for various uses. The utilisation for industry is common in Selangor (Shah Alam and Bukit Raja) but the wells are not within the alignment of the proposed project area. Kelantan, especially Kota Bharu is very dependent on groundwater for potable water supply, as well as for agricultural and industrial purposes.

The northern Kelantan is underlain by Quaternary alluvium. The alluvium covers an estimated area of about 1,500 km<sup>2</sup>. According to MacDonald (1967), the alluvium may be of marine or fluvial origin, but it is not always possible to differentiate the two types of deposits. The alluvium is underlain by granitic and sedimentary or metasedimentary bedrock, the latter consisting mainly of shale, sandstone, phyllite and slate. The granitic bedrock occurs generally east and parallel to the northerly-flowing Kelantan River, while the sedimentary or metasedimentary rocks are confined essentially to the western part.

Saim Suratman (1997), has identified two main aquifer systems, the shallow and deep aquifer. The *shallow aquifer* is mostly unconfined but occasionally semi-confined, thickness normally 2-3 m and may reach up to 17.5 m. It is usually referred to as first aquifer, and the *deep aquifer* which is mainly confined, thickness usually more than 15 m. This deep aquifer comprises three different layers, separated from each other by semipermeable strata of silt, normally referred to as the second, third and fourth aquifer.

These two main aquifer systems are hydraulically interconnected especially the first and the second aquifer as they are only separated by semi-permeable strata of silt as demonstrated by pumping test of a test well with screen located at 14 to 31 m carried out by Noor (1980) at Kampung Chap, Bachok. The pumping test affected the drawdown of observation wells located 200 m away with screen set at different depth of 6, 36 and 96 m. So, it could be concluded that the interconnection between the shallow and deeper aquifers, or leakage from the lower or upper aquifers depends significantly on the lithology of the aquifer at that particular location.

The aquifers consist of interbedded medium-sized sand to medium-sized gravel as well as some coarse gravel and the scale of interbedding varies from place to place. The percentage of coarse materials generally increases with depth. The first aquifer is notably productive for exploitation; however, since it is shallow, it is threatened by pollution as the groundwater development is quite concentrated in the populated area of Kota Bharu town. The second aquifer is generally thin and does not contain significant amount of groundwater worth for large-scale exploitation even though in places it forms significantly thick aquifer layer. The third aquifer is the most promising in terms of production and also protection from potential pollution. The fourth aquifer is not distributed throughout the entire region of North Kelantan

Basin as it forms the contact with the underlying granite. Hydrogeology of North Kelantan is shown in **Chart 6-14**, while the fence diagram in **Chart 6-15** shows the layers of clay, sand and silt. In the northern part, the alluvium significantly thickened and provide significant source of groundwater supply to Kota Bharu.

Pfeiffer and Tiedemann (1986) observed that regionally the groundwater flows north to north-east. However, extensive study carried out to monitor the fluctuation of groundwater level in various layers of aquifer indicates that the various aquifer layers actually show distinct trend of groundwater flow direction.

Groundwater in the state of Kelantan is fully developed for potable use since 1935. The public water supply in Kelantan is operated by Air Kelantan Sdn. Bhd. (AKSB). The demand on groundwater for potable use has risen steadily over the last 30 years. The groundwater production was 36.37 MLD in 1981, increased to 45 MLD in 1984 and was 66 Ml/d in 1989. The production of the plant has dropped to 57 Ml/d in 1990 with the slight increase to 66 MLD in 1993. Under the Bekalan Air Kelantan Utara (BAKU) project implemented in 1993, 72 tube wells were constructed which had a total abstraction of 115.6 MLD. With these new tube wells constructed and taking into account the 51 existing tube wells in operations, the total capacity of these tube wells was 184.35 MLD in 2003, when the construction of new treatment plants during the 8<sup>th</sup> Malaysia Plan were implemented and completed, these new tube wells were fully utilised and groundwater were being abstracted are treated before supplied to the public. The production of groundwater in 2003 was 114 MLD. **Chart 6-16** shows the location of groundwater wellfields and treatment plants in North Kelantan area.

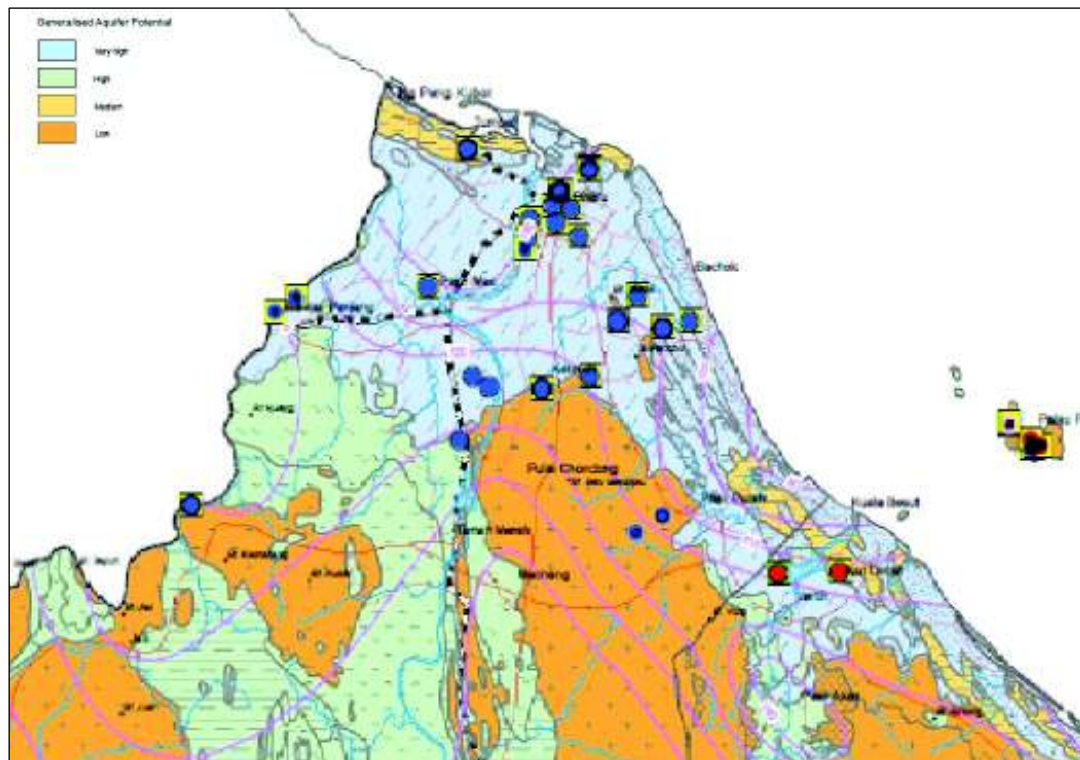


Chart 6-14 : Hydrogeological map of north Kelantan

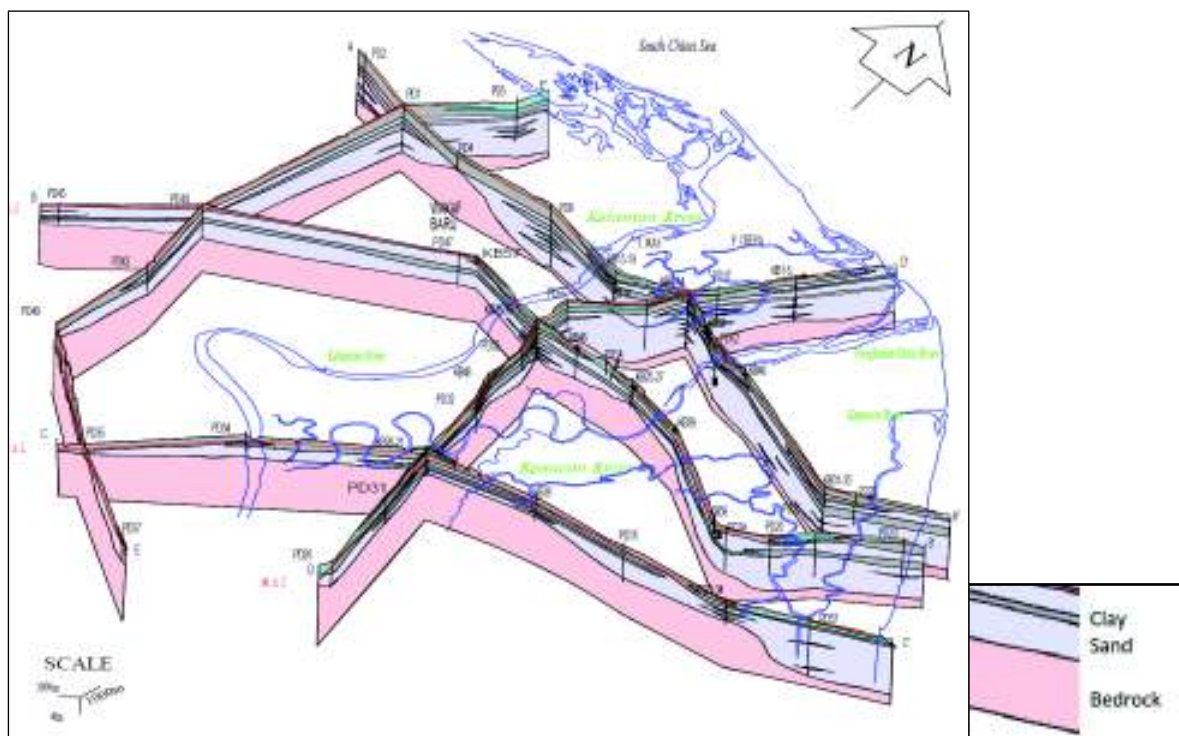
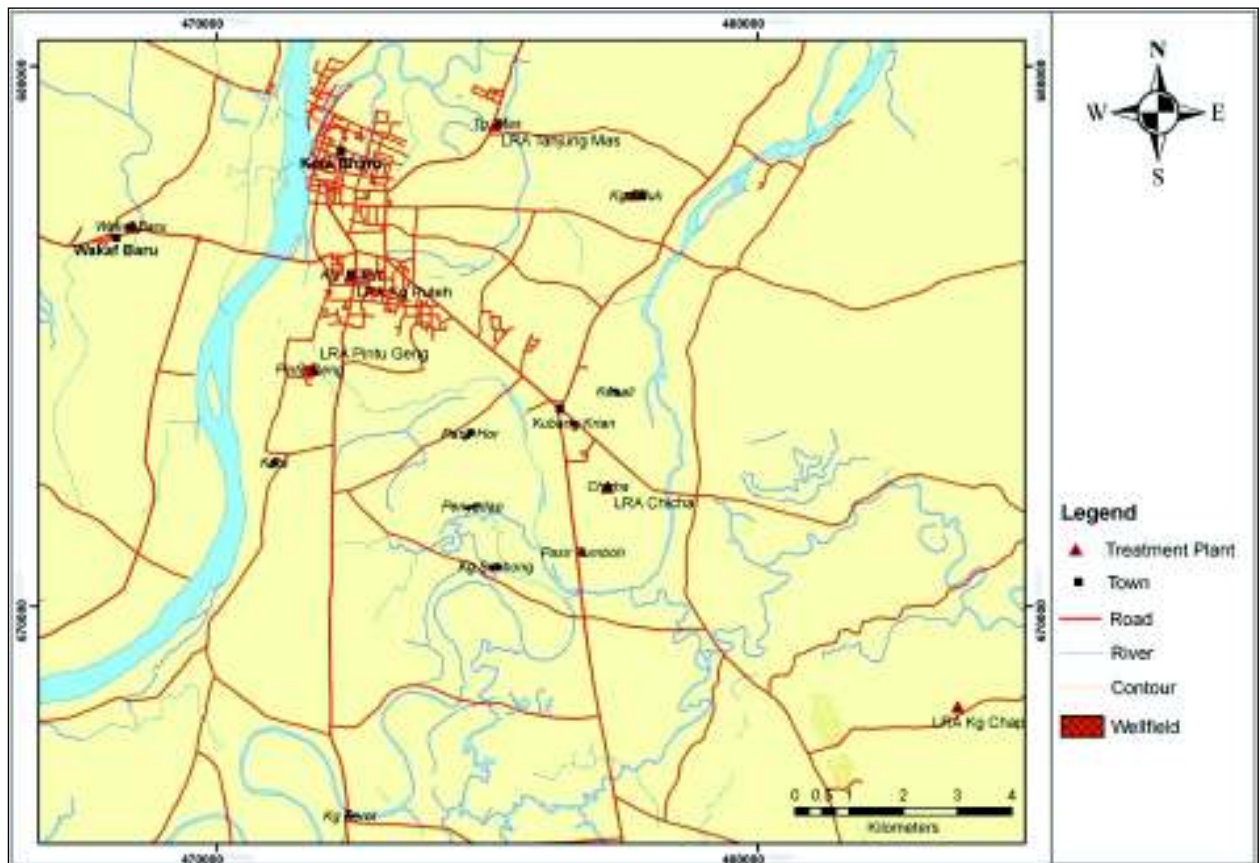


Chart 6-15 : Fence diagram of Kelantan aquifer



**Chart 6-16 : Location of groundwater wellfields and treatment plants**

Presently, fresh groundwater supply is obtained from 82 production wells located at 13 wellfields. Groundwater from these wellfields is drawn from shallow aquifer system except in Tanjung Mas and new wells at Pintu Geng and Kg. Puteh. In 2008, the total groundwater consumption is 134 MLD, which constitutes about 41% of the total water production in AKSB's water treatment plants. The demand for groundwater in potable use is estimated to be 165 MLD in 2010 and will increase at a pace of 2.5% per year (Ismail, 2009). **Table 6-4** shows the most recent available data on groundwater pumping in wellfields in Kota Bharu and surrounding areas. The groundwater consumption is obtained from 95 production wells at 14 wellfields and treated at 7 groundwater treatment plants.

**Table 6-4 : Current groundwater abstraction for water supply in Kelantan (data from AKSB)**

Bil.	Groundwater Treatment Plant	Wellfield	Nos. of Production Wells	Treatment Plant Capacity	Groundwater Abstraction (MI/d)
1.	Chicha			80.0	62.461
		<b>Zone 1</b>	(19)		34.605
		Pasir Hor	7		
		Penyadap	5		
		Seribong	5		
		Pasir Tumbuh	2		
		<b>Zone 2</b>	(10)		10.226
		Kubang Kerian	5		
		Kenali	5		
		<b>Zone 3</b>	(2)		8.911
		Chicha A	2		
		<b>Zone 4</b>	(2)		8.719
		Chicha B	2		
2.	Kg. Puteh		(28)	40.0	48.000
		Kg. Puteh	20		37.200
		Kota	8		10.800
3.	Pintu Geng	Pintu Geng	10	8.0	9.696
4.	Tanjung Mas	Tanjung Mas	8	10.0	9.875
5.	Wakaf Bharu	Wakaf Bharu	9	19.0	9.642
6.	Kg. Chap	Kg. Chap	4	4.9	3.498
7.	Perol	Perol	2	3.2	2.642
<b>TOTAL</b>			<b>94</b>	<b>168.9</b>	<b>145.814</b>

Along the Segment 1 of the rail alignment, the sand aquifer is considered to be very important to be conserved as there are 4 wellfields i.e. Tanjung Mas, Pintu Geng, Chicha and Wakaf Bharu very close to the alignment. Wakaf Bharu wellfield is in fact about 2 km from the alignment. **Chart 6-17** shows the location of water treatment plants close to the Segment 1 rail alignment.

Significant number of the semi urban and rural dwellers along the alignment use groundwater from the private wells constructed within their compound. No official records of the number of wells and volume of groundwater abstracted from these home owners.

Groundwater monitoring is being carried out by JMG at 69 locations in the North Kelantan River Basin in the alluvium. Groundwater monitoring at Tg. Mas wellfield (**Chart 6-18**) shows that the groundwater level has stabilised resulted from the pumping. Chloride monitoring to check the level of salt water intrusion is also being carried out and at the moment does not show any worrying trend.

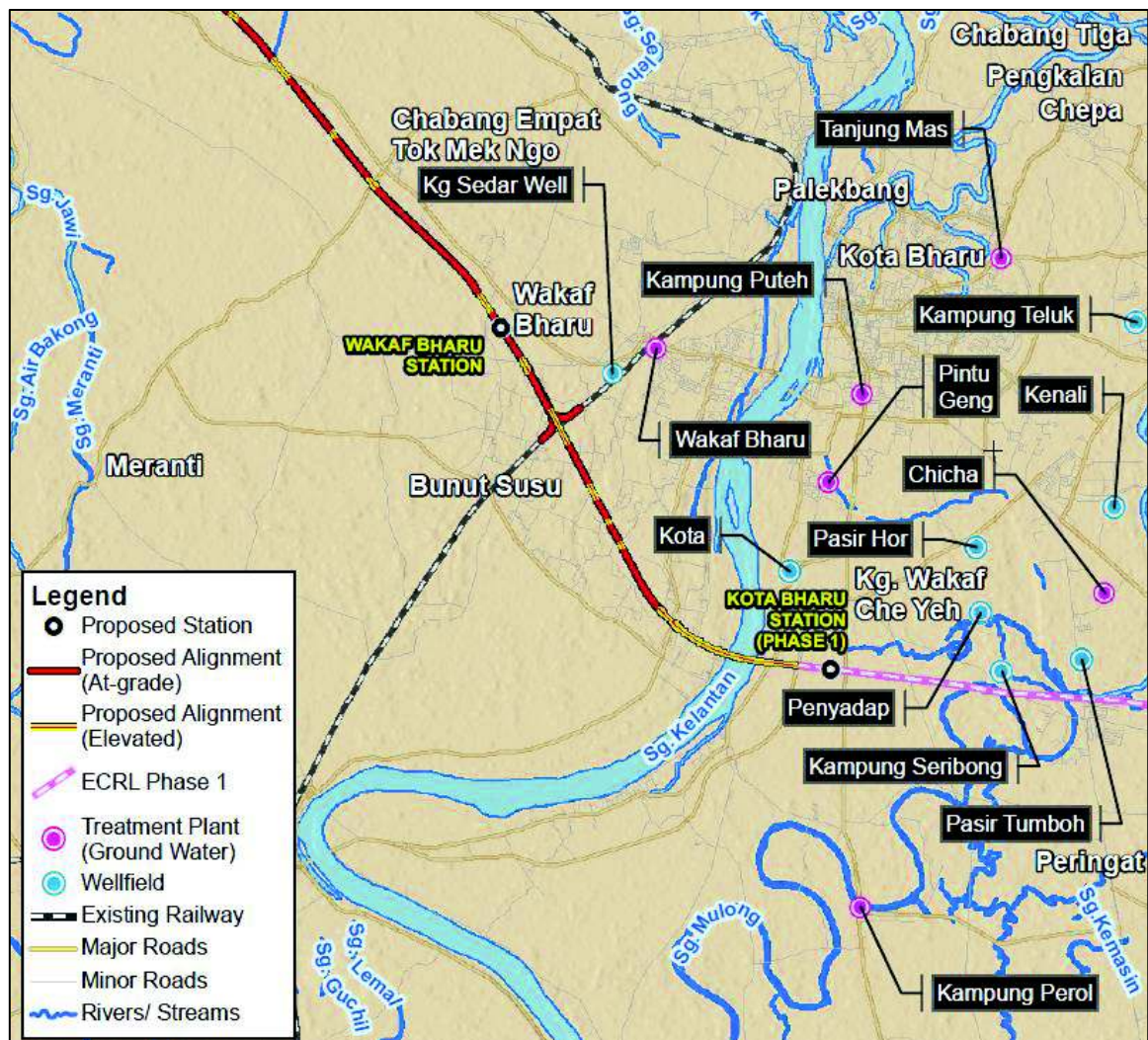


Chart 6-17 : Water treatment plants near Segment 1

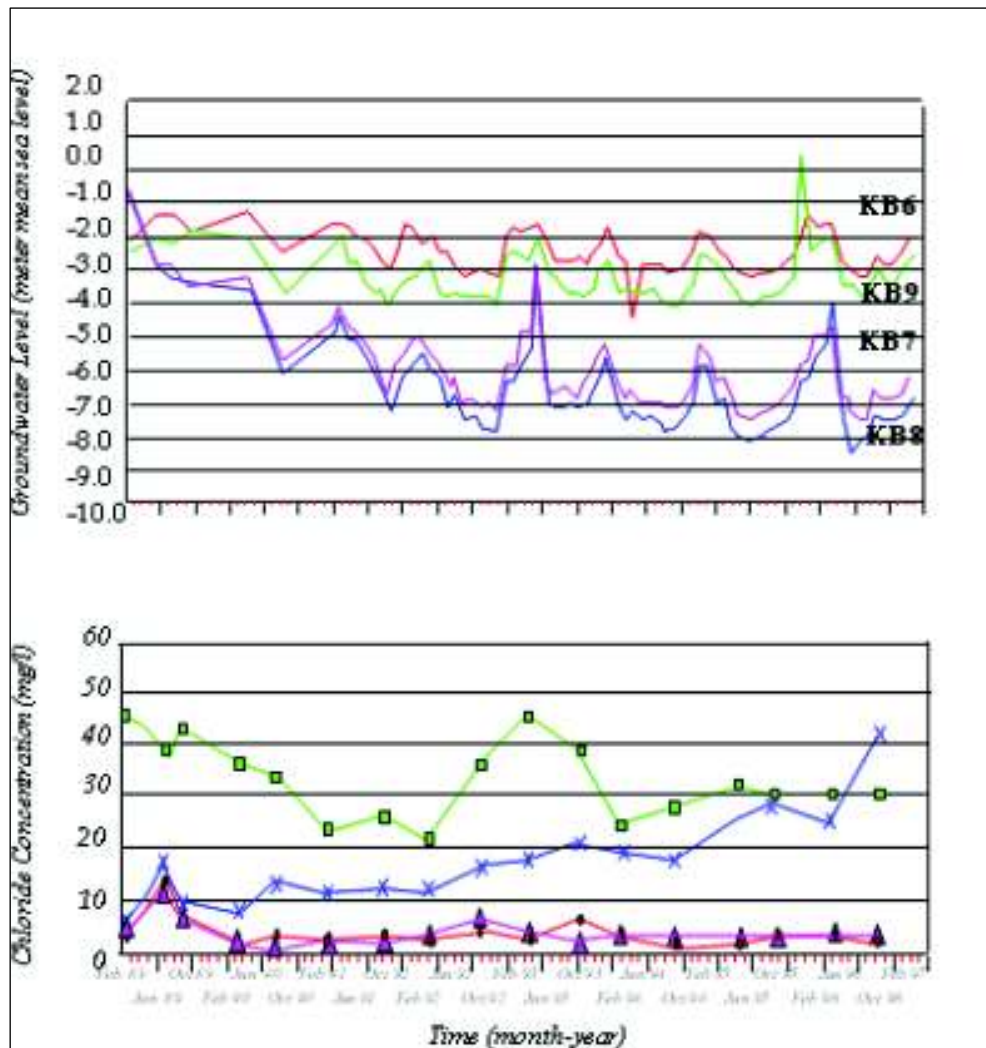


Chart 6-18: Groundwater level and chloride monitoring results at the Tg. Mas wellfield

#### 6.3.4.2 Selangor

The use of water from abandoned mining ponds under a hybrid off-river augmentation system (HORAS) has been initiated as an alternative water resource for raw water. HORAS obtained water from the river as well as discharges from the groundwater flow.

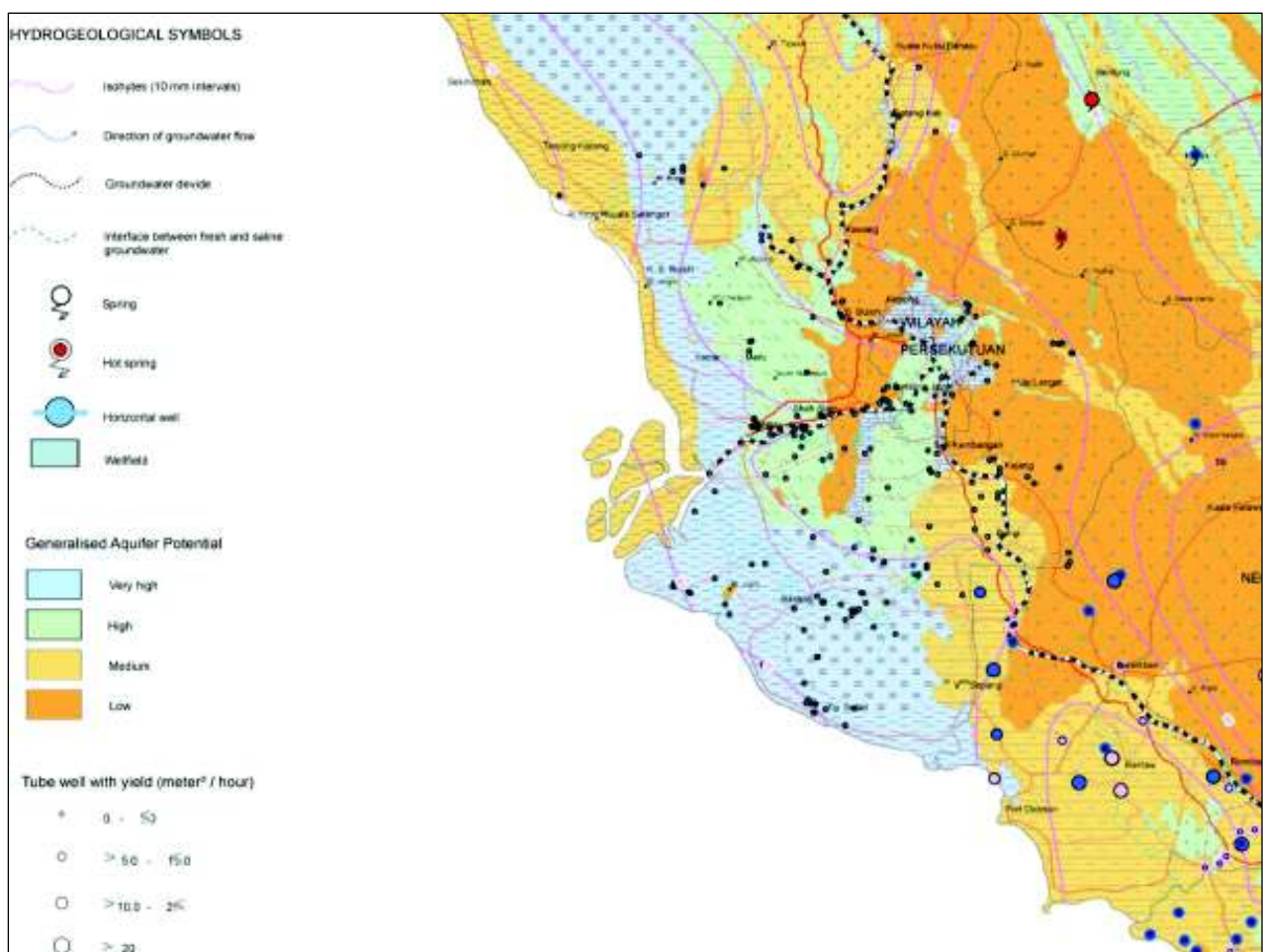
The use of groundwater wells to obtain groundwater supply is mainly in Teluk Datok, Sepang, Shah Alam and Klang. In Bukit Raja, Klang and Shah Alam, groundwater is used mainly for industries and abstracted from hard rock aquifer. They are concentrated in these 2 major industrial zones. In Teluk Datok and Sepang, groundwater is being abstracted from productive Langat River alluvial aquifer. This aquifer distributes continuously around 15-20 m below the ground with the depths of 20 to more than 100 m, and thus it is generally judged that groundwater can be developed economically in this area.

In Kapar and Port Klang area, no significant alluvial aquifer has been found to allow any significant groundwater abstraction. In other parts of Selangor where rail alignment is going to be constructed, no groundwater extraction is being developed.

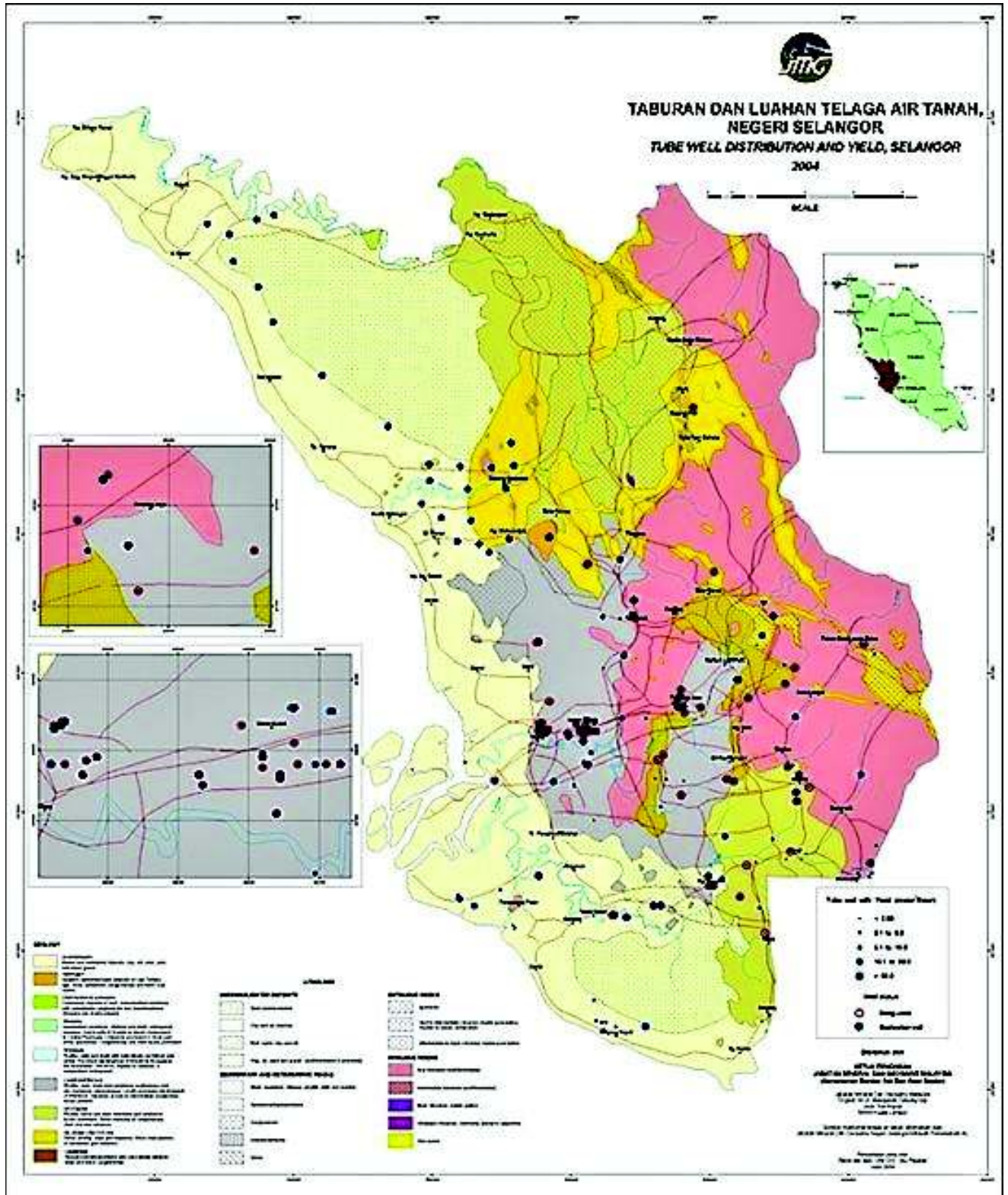
**Chart 6-19** shows the hydrogeological map of central Selangor and **Chart 6-20** shows the distribution of groundwater wells in Selangor and most of them are in Shah Alam and Bukit Raja industrial zones. However, these areas are away from the alignment.

Along the Segment 2, there is no known significant aquifer existed, however, the hydrogeological map of central Selangor (refer **Chart 6-19**) shows that the stretch of alluvium from Langat Basin in the south to Selangor Basin in the north has the potential for groundwater development. Hardrock aquifer has never been investigated in detail even though there are presence of sandstone layer (high groundwater potential in the map) which is known to form a good aquifer. Domestic use of groundwater is also very minimal. Shah Alam and Bukit Raja (not close to the alignment) remain to be the areas where groundwater is being utilised for industries.

Groundwater monitoring in Selangor by JMG is active only in Langat River Basin.



**Chart 6-19 : Hydrogeological map of central Selangor**



**Chart 6-20 : Distribution of groundwater wells in Selangor (JMG Malaysia)**

### 6.3.5 General Seismicity of Peninsular Malaysia

In Peninsular Malaysia, Kelantan and Selangor are the states actively pumping groundwater for various uses. The utilisation for industry is common in Selangor (Shah Alam and Bukit Raja) but the wells are not within the alignment of the proposed project area. Kelantan, especially Kota Bharu is very dependent on groundwater for potable water supply, as well as for agricultural and industrial purposes.

Malaysia is considered a country with relatively low seismicity except for the state of Sabah where earthquakes of local origin are known to occur. However, since it is bordered by Indonesia and the Philippines, which are two of the most seismically active countries in this region with frequent earthquakes, therefore, Malaysia faces a certain degree of earthquake risk from both distant earthquakes.

Peninsular Malaysia, which forms part of the Sunda Shield, is the spine of the Peninsula. Its Triassic fold-mountain belt continues from eastern Myanmar through Thailand, Peninsular Malaysia, the Banka and Billiton Islands, and eastwards into Indonesian Borneo. Tectonically, the entire Peninsular Malaysia is part of the Southeast Asian continental core of stable Sundaland. Most seismic sources of Malaysia is located relatively close to the boundary between Eurasian Plate in the northern side and Australian Plate in the southern side. Major earthquakes, with long period surface waves originating from Sumatra, Indonesia, have been felt in Malaysia, particularly along the west coast of Peninsular Malaysia.

In the previous study (Jabatan Meteorologi dan Akademi Sains 2009), Peninsular Malaysia was identified as having Zones 4 (in western Peninsular Malaysia with an MMI scale of V), 5 (along the inner western Peninsular Malaysia with an MMI scale of IV) and the lower Zones (along the central and eastern belts of the Peninsula with MMI scales of III and II). However, since the end of 2007, 40 tremors were recorded in Malaysia but the significant fact was that 37 incidences of these seismic activity occurred along the fault line in Bentong, Pahang. The three others recorded were in Manjung (Perak) and Jerantut (Pahang). **Chart 6-21** shows the occurrence of earthquake in Peninsular Malaysia between 2007 to 2010.

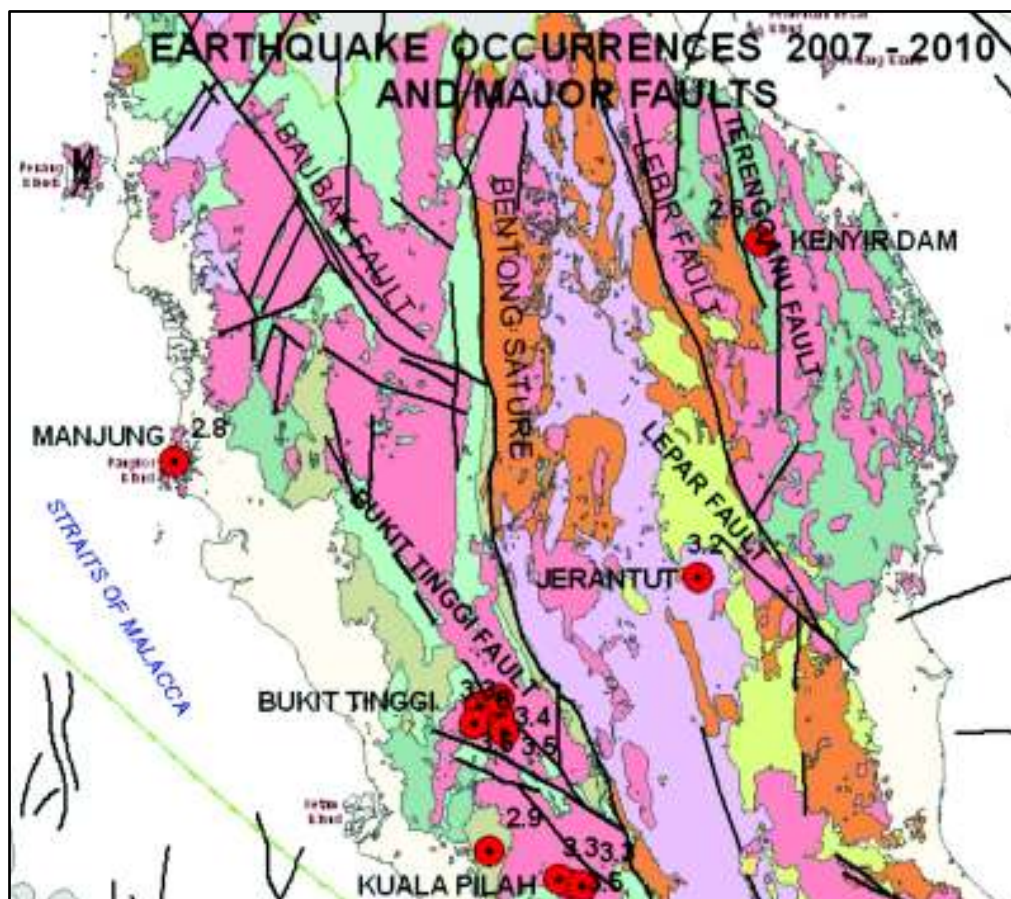


Chart 6-21 : Occurrence of earthquake in Peninsular Malaysia between 2007 to 2010  
(Alexander Yan, 2011)

According to data obtained from the Meteorological Department, from November 2007 until May 2009, Bentong recorded 29 cases of tremors, also known as 'temblors'. The latest tremors were recorded last 8 October 2009 where there were eight, that measured between 4.45am and 12.05 noon recorded between 1.1 and 2.8 in magnitude on the Richter scale. All of these tremors were detected at Bukit Tinggi and Janda Baik, along the Bukit Tinggi Fault line. However, only in one incident that the Meteorological Department detected a strong tremor of 3.5 in magnitude on the Richter scale. According to Meteorological Department even though the Bukit Tinggi and Janda Baik are located on the fault line, no earthquake will possibly surpass 5.0 in magnitude on the Richter scale which means if such an earthquake occurs, it will not cause damage to a structurally-strong building and any earthquake that measured 2.8 or less on the Richter scale is unlikely to cause damage and harm to life and infrastructures (Table 6-5).

**Table 6-5 : Damages by earthquake based on Richter Scale**

Richter Scale	Mercalli Intensity	Shaking	Description/Damage
1.0 - 3.0	I	Not felt	Not felt except by a very few under especially favorable conditions.
3.0 - 3.9	II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
	III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
4.0 - 4.9	IV	Light	Felt indoors by many, outdoors by few. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
	V	Moderate	Felt by nearly everyone. Some windows broken. Unstable objects overturned.
5.0 - 5.9	VI	Strong	Felt by all. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
	VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures.
6.0 - 6.9	VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, monuments, walls.
	IX	Violent	Damage considerable in specially designed structures. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
7.0 and higher	X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
	XI	Extreme	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
	XII	Extreme	Total damage. Lines of sight and level are distorted. Objects thrown into the air.

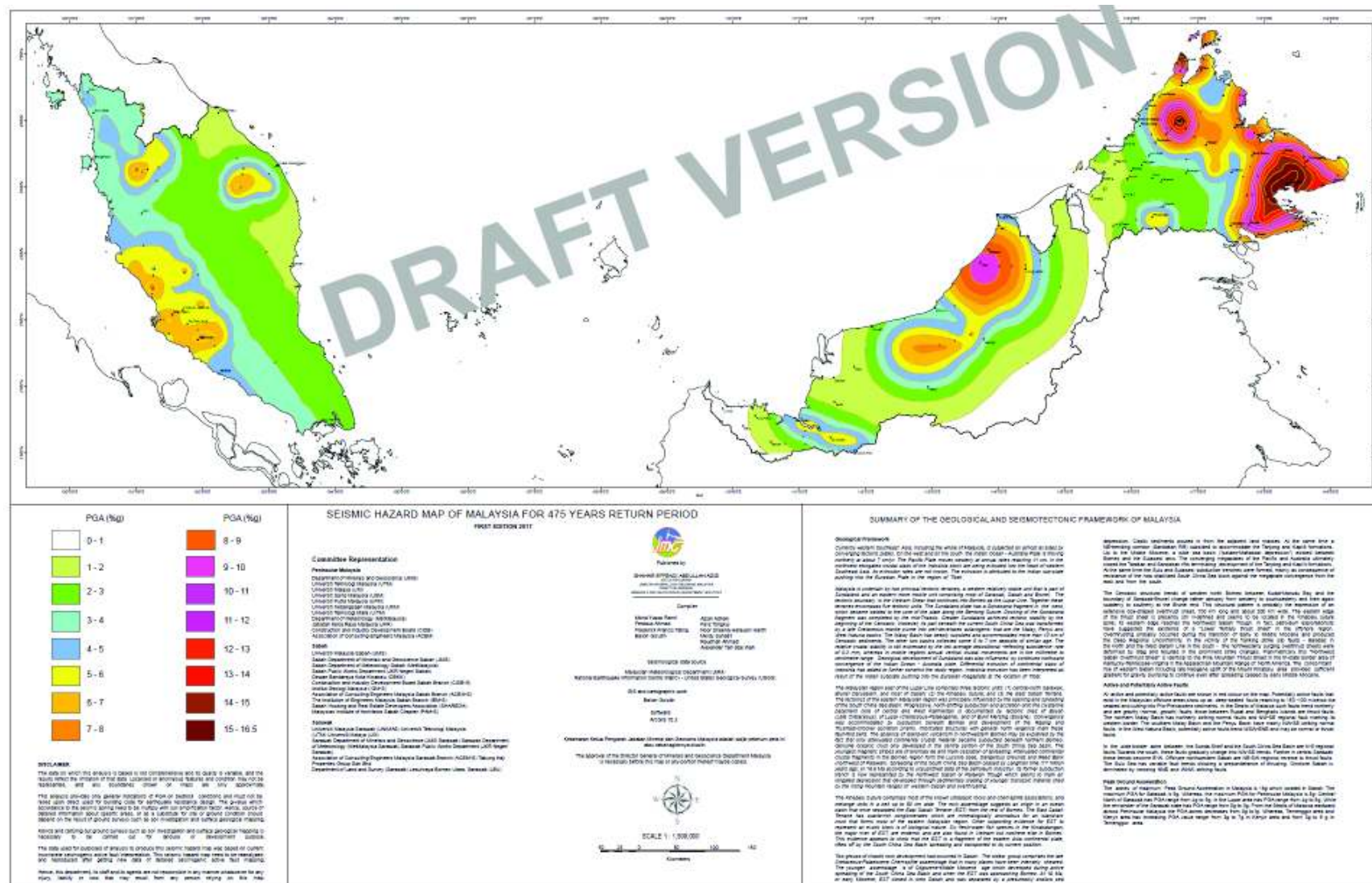
Currently Jabatan Mineral dan Geosains is conducting a study to determine the status of these faults and the possibility that they can be reactivated. The study will enable Malaysia to evaluate the risk of local earthquake.

#### Peak Ground Acceleration

The zones of maximum Peak Ground Acceleration in Malaysia is 16g which located in Sabah. The maximum PGA for Sarawak is 9g. Whereas, the maximum PGA for Peninsular Malaysia is 8g. Central-North of Sarawak has PGA range from 4g to 9g, in the Lupar area has PGA range from 4g to 6g, While the remainder of the Sarawak state has PGA range from 0g to 3g. From the Straits of Malacca eastward across Peninsular Malaysia the PGA zones decreases from 8g to 1g. Whereas, Temenggor area and Kenyir area has increasing PGA value range from 3g to 7g in Kenyir area and from 3g to 8 g in Temenggor area.

Seismic hazard map of Malaysia is shown in **Chart 6-22**. It is still in draft form, and was prepared based on the available current information on local earthquake and earthquake occurring in the neighbouring countries and still being updated. It is shown that the seismic hazard in Segment 1 in Kelantan is very low and whereas the Segment 2 has medium potential seismic hazard of 5-6%g due to the proximity to seismically active Sumatera.

Earthquake impact assessment is the basis for emergency planning, mitigation, response, and recovery. The realism of the outcome, such as the effect on infrastructure, economy, and societal activities, is the essential ingredients to developing plans that adequately protect vulnerable communities. It is therefore important to understand the impact of local earthquake to the project and the accuracy of the assessment dependent on the reliability of the fragility curves and hazard characterization.



**Chart 6-22 : Draft seismic hazard map of Malaysia (JMG Malaysia)**

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#### 6.3.5.1 Kelantan

Kelantan is most probably one of the quietest areas seismically in Peninsular Malaysia. The closest epicentre to the Segment 1 alignment was the Kenyir dam-induced earthquake on the 24 February 2016 with 2.7 magnitude. The epicentre of the quake was 16 km south-west of Kuala Berang at a depth of 10km.

Looking at seismic hazard map of Malaysia (refer to **Chart 6-22**), it is shown that the seismic hazard in Segment 1 in Kelantan is very low at 1-2%g due to the distance to any seismically active Sumatera or the Philippines.

#### 6.3.5.2 Selangor

**Chart 6-23** shows the proximity off the epicentres to the ECRL alignment and the magnitude of the earthquake. Most of the local earthquake are associated with the Bukit Tinggi Fault. The highest magnitude recorded so far is 4.2 on Richter Scale. Knowing that any magnitude of <5 might not cause any disturbance on infrastructures, hence the alignment across the fault lines will not likely be impacted by the earthquake except the feel of the tremor resulting from it. All the epicentres are away from the alignment of Segment 2 even though the Segment 2A alignment is close to Kuala Lumpur Fault.

From the seismic hazard map of Malaysia (refer to **Chart 6-22**). It is shown that the seismic hazard in the Segment 2 has medium potential of 5-6%g due to the proximity to seismically active Sumatera.

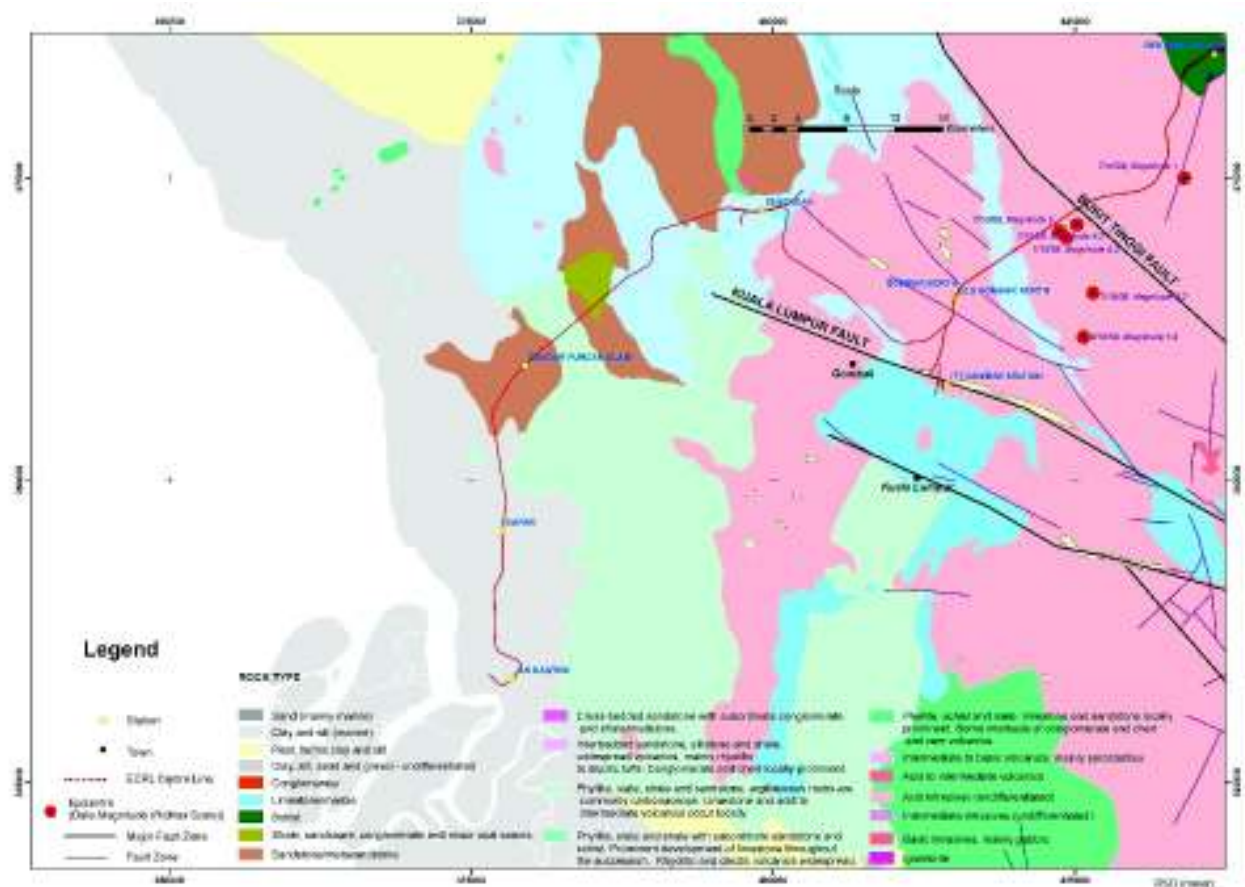


Chart 6-23 : Location of epicentres

## 6.4 CLIMATE

Generally, the climate of the Project Site for both states is similar. This is due to the homogenous climate condition in Peninsular Malaysia that is located at the equator with high annual rainfall and relatively uniform high humidity and temperature. Monsoon seasons are experienced throughout the year, as following:

- Northeast monsoon (November/early December to March)
- Inter-monsoonal or transitional season season (April to May)
- Southwest monsoon (June to September/early October)
- Inter- monsoonal or transitional season season (October to early November)

Despite the general uniformity of the climate, daily weather patterns along the railway alignment is subject to the prevailing monsoon season. The climate information obtained is based on data from the major meteorological stations in each State.

### 6.4.1 Kelantan

The baseline for climate conditions at the Project site in Kelantan is based on the data obtained from the Kota Bharu Meteorological Station (6° 09' 49" N, 102° 18' 02" E) from year 1985 to 2016, as shown in **Figure 6.4-1**.

The average annual 24-hour temperature recorded is 27.2 °C. The warmest month is April and May with 28.3 °C monthly average, while the coolest month is November and December with 26 °C monthly average.

The average annual rainfall recorded is 2,605.8 mm with the average of 164 rain days. November had the most rain days (22) and February had the least number of rain days (6).

The average annual 24-hour mean relative humidity recorded is 81.3%. November recorded the highest relative humidity at 86%, while April recorded the lowest relative humidity at 79.3%.

Based on wind rose records, the predominant wind blows from the east. The annual mean speed was recorded at 2.3 m/s. The calm period, when the wind speed is less than 0.3 m/s, was recorded at 12% of the time. The annual and seasonal wind roses for Kota Bharu are shown in **Figure 6.4-2** and **Figure 6.4-3**.

### 6.4.2 Selangor

The baseline for climate conditions at the Project site in Selangor is based on the data obtained from the Petaling Jaya Meteorological Station (3° 06' 00" N, 101° 39' 00" E) from year 1969 to 2016, as shown in **Figure 6.4-1**.

The average annual 24-hour temperature recorded is 27.8 °C. The warmest month is May and June with 28.4 °C monthly average, while the coolest month is November and December with 27 °C monthly average.

The average annual rainfall recorded is 3,239.3 mm. November had the most rain days (23), whereas June and July had the least number of rain days (13).

The average annual 24-hour mean relative humidity recorded is 77.6%. November recorded the highest relative humidity at 81.8%, while April recorded the lowest relative humidity at 75.4%.

Based on wind rose records, the predominant wind blows from the east. The annual mean speed was recorded at 1.1 m/s. The calm period, was recorded at 23.6% of the

time. The annual and seasonal wind roses are shown in **Figure 6.4-2** and **Figure 6.4-4**.

## 6.5 LANDUSE

Based on data obtained from PLANMalaysia (Jabatan Perancangan Bandar dan Desa) as well as land use verification site visits, existing and future land use along the project alignment is laid out in **Figure 6.5-1** to **Figure 6.5-4** and described in the following segments. The land use percentage breakdown for existing and future land use are shown in **Table 6-6** and **Table 6-7** respectively.

### 6.5.1 Segment 1: Kelantan

Land use along the Kelantan extension consist mainly of paddy plantations (agriculture land) interspersed with village areas (residential), as seen in **Figure 6.5-1**. **Table 6-6** can be referred for the existing land use percentage breakdown.

The railway extension begins at the proposed Kota Bharu station that is located at the south of the city centre. The land use in the surrounding area is mainly commercial, agricultural, residential and public infrastructure. The initial part of the alignment heads west, passing through agricultural plots and settlement of Kg. Gaung Pendek (**Plate 6-1**), before crossing Sg. Kelantan.

The alignment then travels northeast through local town of Tendong in the Pasir Mas district where it continues to pass through agricultural areas and rural settlements, namely Kg. Padang Embon and Kg. Alor Durian (**Plate 6-2**). In the midway, there is a proposed Wakaf Bharu station, which is located nearby the existing KTM railway station.

After Wakaf Bharu, the alignment continues northwest crossing Sg. Pengkalan Nangka (**Plate 6-3**) and Sg. Golok before ending at Pengkalan Kubor in the district of Tumpat. In between Wakaf Bharu and Pengkalan Kubor, the alignment traverses across several villages such as Kg. Kubang Gajah, Kg. Cherang and Kg. Pauh Sebanjan alongside important food production sites, which include national granary areas and paddy field (**Plate 6-4** and **Plate 6-5**). These sites cover an area of 25,910 hectares that are managed by Kemubu Agricultural Development Authority (KADA) and Department of Irrigation and Drainage (**Figure 6.5-1**).

For future land use, areas surrounding Wakaf Bharu Station and Kota Bharu Station have been demarcated for residential zoning as shown in **Figure 6.5-2**. Thus, there will be a significant increase in the residential land use percentages (**Table 6-7**). The overall land use zoning maps for the Kelantan segment is shown in **Figure 6.5-2**.



Plate 6-1: Kg. Gaung Pendek



Plate 6-2: Kg. Alor Durian



Plate 6-3: Sg. Pengkalan Nangka



Plate 6-4: Kg. Cherang



Plate 6-5: Kg. Pauh Sebanjan

### 6.5.2 Segment 2 : Selangor

The existing land uses surrounding the Selangor's segments are more varied and consist predominantly agriculture, followed by forests and residential areas (**Figure 6.5-3a-c**). The alignment also passes through built-up areas mainly in the towns, industrial areas and urban centers. The overall land use in Selangor are summarized in **Table 6-6**.

#### Segment 2A: Gombak North to Serendah

Land use along this segment consist mainly forests with some built up areas (residential and commercial) at both ends of the segment in Gombak and Serendah.

This segment commences at the proposed Gombak North Station, surrounded by largely rural settlements such as Kg. Sungai Rumpit and also Hospital Orang Asli Gombak (**Plate 6-6**). The alignment then crosses over the Kuala Lumpur – Gua Musang Expressway before encroaching into Selangor Heritage / State Park all the way to Serendah, where it traverses pass key areas namely, Taman Bukit Pemata, Taman Jasa Utama, Batu Dam and Templer Park (**Plate 6-7 to 6-9**).

The alignment then continues through small plots of agricultural land as it enters the town of Serendah, where it then turns west towards Rawang. The built-up land use here comprises of residential (Kg. Datuk Harun, Kg. Tok Pinang and Taman Desa Kiambang), commercial and religious places.

## Segment 2B: Serendah to Bandar Puncak Alam

Land use along this segment consist more built up areas as this segment starts from Serendah and continues to skirt pass other major towns such as Rawang, Batu Arang, and Puncak Alam. Land uses in between these settlements consist mainly oil palm and a patch of state land forest and the Rantau Panjang Permanent Reserved Forest (PRF).

From the proposed Serendah station, the alignment will continue westward where it passes by industrial areas such as Perodua Global Manufacturing (**Plate 6-10**) and Sg. Choh Industrial Zone, and several housing areas. The alignment then continues to cross the North South Expressway and hilly areas heading towards Saujana Rawang township.

Upon passing by Saujana Rawang (**Plate 6-11**), the alignment turns south west, cutting through the Rantau Panjang PRF and passes by Batu Arang. Then, the alignment crosses over the Kuala Lumpur – Kuala Selangor Expressway (LATAR Expressway) and Sg. Buloh river towards Bandar Puncak Alam (**Plate 6-12**). The land uses along this stretch are mostly oil palm plantations, forests, industries and mix of commercial and housing areas.

## Segment 2C: Bandar Puncak Alam to Port Klang

This segment will pass through mainly oil palm estates interspersed with industrial areas especially from Bandar Puncak Alam to Kapar. The alignment will also pass through some mangrove forests along Sg. Puloh and finally reaching built up areas (residential and commercial) in Port Klang.

This segment continues from Bandar Puncak Alam and will turn south cutting through mainly oil palm plantations while passing by housing areas, Taman Kapar Setia and Taman Jaya, in Kapar. The alignment then traverses through the middle of Sg. Kapar Indah Industrial Park.

From there, it continues passing through the mangrove forest of Sg. Puloh before crossing the Selat Klang Highway. The alignment then curves southeast crossing Sg. Klang as it enters into the the Kg. Delek (**Plate 6-13**) settlements.

Towards the end, the alignment turns southwest through Kg. Sireh Tambahan (**Plate 6-14**) and joins the existing KTM line, and finally ends at Jln. Kastam. The predominant land uses along this heavily populated stretch are residential, commercial and public infrastructures.

For future land use, areas demarcated for residential purposes are increasing across all segments (**Figure 6.5-4a-c**). There is also notable expansion of industrial zones in Klang as well as land conversion into agricultural areas in Kuala Selangor. Minor changes in other types of land use can be observed in the percentage breakdown as shown in **Table 6-7**.



**Plate 6-6: Hospital Orang Asli Gombak**



**Plate 6-7: Taman Jasa Utama**



**Plate 6-8: Batu Dam**



**Plate 6-9: Templer Park**



Plate 6-10: Perodua Global Manufacturing



Plate 6-11: Saujana Rawang



**Plate 6-12: Bandar Puncak Alam**



**Plate 6-13: Kg. Delek**



**Plate 6-14: Kg. Sireh Tambahan**

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**Table 6-6 : Existing Land Use Breakdown Along the Alignment by Local Authority (1 km corridor)**

Land Use Category	Kelantan						Selangor							
	MDK		MDPM		MPT		MPS		MDHS		MDKS		MPK	
	Hectare	%	Hectare	%	Hectare	%	Hectare	%	Hectare	%	Hectare	%	Hectare	%
Residential	260.10	13.87	266.41	12.72	1321.69	17.75	740.63	6.30	1050.41	17.79	626.82	10.61	3687.56	28.88
Commercial	23.37	1.25	16.99	0.81	41.61	0.56	46.00	0.39	80.01	1.35	131.82	2.23	281.75	2.21
Industry	4.98	0.27	13.23	0.63	24.85	0.33	180.88	1.54	705.76	11.95	167.95	2.84	720.62	5.64
Institution and Public Amenities	19.53	1.04	51.81	2.47	110.20	1.48	311.79	2.65	100.18	1.70	141.93	2.40	153.18	1.20
Open Space and Recreational	0.86	0.05	0.00	0.00	12.03	0.16	460.97	3.92	88.36	1.50	230.23	3.90	151.65	1.19
Vacant Land	0.00	0.00	166.05	7.93	278.26	3.74	1124.94	9.58	0.00	0.00	0.00	0.00	857.02	6.71
Transportation	96.08	5.12	61.81	2.95	255.14	3.43	699.62	5.96	502.15	8.50	364.33	6.17	1189.91	9.32
Infrastructure and Utilities	0.00	0.00	27.98	1.34	101.74	1.37	195.53	1.66	50.80	0.86	131.91	2.23	45.48	0.36
Agriculture	1305.37	69.60	1347.56	64.36	4941.67	66.38	2934.23	24.98	2231.64	37.79	3960.81	67.07	3913.38	30.65
Forest	0.00	0.00	0.00	0.00	0.00	0.00	4634.75	39.45	940.83	15.93	0.00	0.00	1347.39	10.55
Water Bodies	165.37	8.82	141.90	6.78	357.37	4.80	418.38	3.56	155.87	2.64	149.82	2.54	419.28	3.28
<b>TOTAL</b>	<b>1875.66</b>	<b>100</b>	<b>2093.75</b>	<b>100</b>	<b>7444.54</b>	<b>100</b>	<b>11747.72</b>	<b>100</b>	<b>5906.02</b>	<b>100</b>	<b>5905.60</b>	<b>100</b>	<b>12767.23</b>	<b>100</b>

**Table 6-7: Future Land Use Breakdown Along the Alignment by Local Authority (1 km Corridor)**

Land Use Category	Kelantan						Selangor							
	MDK		MDPM		MPT		MPS		MDHS		MDKS		MPK	
	Hectare	%	Hectare	%	Hectare	%	Hectare	%	Hectare	%	Hectare	%	Hectare	%
Residential	847.74	45.20	499.63	23.86	2859.11	38.41	2632.75	22.41	1845.26	31.24	455.10	7.71	4359.66	34.15
Commercial	95.22	5.08	18.68	0.89	82.17	1.10	190.53	1.62	41.24	0.70	18.53	0.31	315.93	2.47
Industry	80.82	4.31	28.64	1.37	47.59	0.64	245.74	2.09	978.51	16.57	157.92	2.67	5395.61	42.26
Institution and Public Amenities	91.10	4.86	42.70	2.04	233.11	3.13	438.79	3.74	108.07	1.83	14.60	0.25	177.22	1.39
Open Space and Recreational	80.13	4.27	2.62	0.13	30.36	0.41	485.62	4.13	58.45	0.99	54.04	0.92	208.50	1.63
Vacant Land	0.00	0.00	0.42	0.02	16.14	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	134.23	7.16	60.07	2.87	269.25	3.62	802.29	6.83	544.33	9.22	402.22	6.81	1160.18	9.09
Infrastructure and Utilities	80.45	4.29	42.08	2.01	156.47	2.10	216.83	1.85	24.41	0.41	21.76	0.37	212.30	1.66
Agriculture	233.43	12.45	1202.88	57.45	3533.18	47.46	1898.10	16.16	1380.07	23.37	4754.78	80.51	133.96	1.05
Forest	0.00	0.00	0.00	0.00	0.00	0.00	4457.60	37.94	814.26	13.79	0.00	0.00	360.54	2.82
Water Bodies	232.53	12.40	196.05	9.36	217.12	2.92	379.46	3.23	111.41	1.89	26.67	0.45	443.32	3.47
<b>TOTAL</b>	<b>1875.65</b>	<b>100</b>	<b>2093.78</b>	<b>100</b>	<b>7444.50</b>	<b>100</b>	<b>11747.72</b>	<b>100</b>	<b>5906.02</b>	<b>100</b>	<b>5905.63</b>	<b>100</b>	<b>12767.23</b>	<b>100</b>

Table 6-8 : Major Land Uses along the Alignment in Kelantan

KELANTAN				
Left		Jajahan & Stations	Right	
200m - 500m	0m - 200m		0m - 200m	200m - 500m
<b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Masjid Hajjah Fatimah</li> </ul>	<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Gaung Pendek</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Kompleks Jabatan Pendidikan Negeri Kelantan</li> </ul>	<b>Ketereh</b>  Kota Bharu Station (Phase 1)	<b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Madrasah Mahmudiah</li> </ul> <b>Agricultural</b> <ul style="list-style-type: none"> <li>Paddy Field</li> </ul>	<b>Public Facilities/Institutions</b> Jabatan Audit Negara
<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Tok Buak</li> <li>Kg. Perengkap Benut Susu</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Masjid Mukim Tendong</li> <li>Pusat Kesihatan Tendong</li> <li>SMK Tendong</li> <li>SK Bechah Durian</li> </ul> <b>Agricultural</b> <ul style="list-style-type: none"> <li>Kawasan Penanaman Padi KADA</li> </ul>	<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Padang Embon</li> </ul> <b>Agricultural</b> <ul style="list-style-type: none"> <li>Kawasan Penanaman Padi KADA</li> </ul>	<b>Pasir Mas</b>  No station	<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Tendong</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>SK Bechah Durian</li> </ul> <b>Agricultural</b> <ul style="list-style-type: none"> <li>Kawasan Penanaman Padi KADA</li> </ul>	<b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Klinik Kesihatan Tendong</li> <li>Pejabat KADA Jajahan Pasir Mas</li> <li>Pertubuhan Peladang Kawasan Kubang Sepat</li> </ul>
<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Perupok</li> <li>Kg. Talak</li> <li>Kg. Telaga Bata</li> <li>Kg. Bunohan</li> <li>Kg. Pauh Sebanjan</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Masjid At Taqwa</li> <li>SK Kampung Delima</li> <li>Masjid Mukim Delima</li> <li>Hospital Kubang Batang</li> <li>Wat Sukhontharam</li> </ul>	<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Wakaf Delima</li> <li>Kg. Kubang Panjang</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Madrasah Lebai Loman</li> <li>Masjid Al Itqan Telaga Bata</li> </ul> <b>Agricultural</b> <ul style="list-style-type: none"> <li>Kawasan Penanaman Padi KADA</li> </ul> <b>Utilities</b> <ul style="list-style-type: none"> <li>LRA Wakaf Bharu</li> </ul>	<b>Tumpat</b>  Wakaf Bharu Station Pengkalan Kubor Station	<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Alor Durian</li> <li>Kg. Lati</li> <li>Taman Kasturi</li> <li>Kg. Kubang Batang</li> <li>Taman Murni</li> <li>Kg. Kubang Gajah</li> <li>Kg. Telok</li> <li>Kg. Cherang</li> <li>Kg. Nechang</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>SMU (A) Mardziah Kubang Batang</li> <li>SK Kubang Batang</li> </ul> <b>Industrial</b> <ul style="list-style-type: none"> <li>Kilang Baja Kumpulan Pertanian Kelantan Bhd.</li> </ul> <b>Transportation</b> <ul style="list-style-type: none"> <li>Stesen Keretapi Wakaf Bharu</li> </ul>	<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Kubang Mas</li> <li>Taman Sri Kulim</li> <li>Taman Sri Delima</li> <li>Kg. Jirat</li> <li>Kg. Pasir Puteh</li> <li>Kg. Kok Semru</li> <li>Kg. Gabus</li> </ul> <b>Commercial</b> <ul style="list-style-type: none"> <li>Wisma MDT</li> <li>Pasar Besar Wakaf Bharu</li> <li>Wisma Puteri Saadong</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Masjid Mukim Alor Durian</li> <li>Surau Al Muttaqim</li> <li>Masjid Mukim Kubang Batang Baru</li> <li>Masjid Bustanul Maarif</li> <li>SMU (A) Tarbiah Islamiah</li> <li>Masjid Khairiah Chabang Empat</li> <li>SK Chabang Empat</li> <li>SMK Chabang Empat</li> <li>SK Pengkalan Kubur (2)</li> <li>Klinik Kesihatan Wakaf Bharu</li> <li>SK Wakaf Bharu</li> </ul>

Table 6-9 : Major Land Uses along the Alignment in Selangor

SELANGOR				
Left		District & Stations	Right	
200m - 500m	0m - 200m		0m - 200m	200m - 500m
<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Sungai Rumpit</li> <li>Kg. Baru Sebelas</li> <li>Taman Selayang Mulia</li> <li>Taman Jasa Perwira</li> <li>Taman Bandar Baru Selayang</li> <li>Templer Park</li> <li>Saujana Rawang</li> <li>Bandar Tasik Puteri</li> </ul>	<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Batu Dua Belas Gombak</li> <li>Taman Bukit Permata</li> <li>Taman Jasa Utama</li> <li>M-Residence</li> <li>Rantau Panjang PRF</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Hospital Orang Asli Gombak</li> <li>Surau Silaturrahim</li> </ul>	<b>Selayang</b>  Gombak North Station (Phase 1)	<b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Masjid Al Jannah</li> <li>Rantau Panjang PRF</li> </ul>	<b>Residential</b> <ul style="list-style-type: none"> <li>Taman Damai Batu Arang</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Batu Dam</li> <li>Batu Arang Chinese Cemetery</li> </ul>
<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Damai</li> <li>Taman Serendah Indah</li> <li>Taman Kosaso</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Pusat Komuniti Serendah</li> </ul>	<b>Residential</b> <ul style="list-style-type: none"> <li>Taman Anugerah Suria</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Masjid Nurul Iman</li> <li>Balai Polis Serendah</li> <li>Poliklinik Serendah</li> <li>SJK (C) Serendah</li> </ul>	<b>Hulu Selangor</b>  Serendah Station	<b>Residential</b> <ul style="list-style-type: none"> <li>Taman Melati</li> <li>Taman Desa Kiambang</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Goddess Mazu Temple</li> <li>Leng Keng Temple</li> <li>Gurdwara Sahib Serendah</li> <li>SJK (T) Sg. Choh</li> </ul>	<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Datuk Harun</li> <li>Kg. Tok Pinang</li> <li>Taman Bukit Teratai</li> </ul> <b>Industrial</b> <ul style="list-style-type: none"> <li>Perodua Global Manufacturing</li> </ul>
<b>Industrial</b> <ul style="list-style-type: none"> <li>Kawasan Perindustrian Batu 22</li> </ul>	<b>Residential</b> <ul style="list-style-type: none"> <li>Seksyen 10 Bandar Baru Puncak Alam</li> </ul> <b>Agricultural</b> <ul style="list-style-type: none"> <li>Bukit Cherakah Estate (Sime Darby Plantation)</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Depoh Pusat Peluru Batu Arang</li> </ul>	<b>Kuala Selangor</b>  Puncak Alam Station	<b>Residential</b> <ul style="list-style-type: none"> <li>Taman Ambang Suria</li> </ul> <b>Agricultural</b> <ul style="list-style-type: none"> <li>Caledonia Estate (KL Kepong Plantation)</li> </ul>	
<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Bukit Kerayong</li> <li>Taman Kelana Batu 5</li> <li>Taman Sri Rantau</li> <li>Kg. Rantau Panjang Dalam</li> <li>Taman Sri Delek</li> <li>Kg. Raja Uda</li> <li>Kg. Kastam</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>SRK Methodist Port Klang</li> </ul>	<b>Residential</b> <ul style="list-style-type: none"> <li>Taman Kapar Setia</li> <li>Taman Jaya</li> <li>Kg. Delek</li> <li>Kg. Sireh</li> <li>Kg. Sungai Sireh Tambahan</li> <li>Taman Raja Uda</li> </ul> <b>Public Facilities/Institutions</b> <ul style="list-style-type: none"> <li>Thiruvalluvar Hall</li> <li>Masjid Kg. Raja Uda</li> <li>Lembaga Pelabuhan Klang</li> </ul> <b>Agricultural</b> <ul style="list-style-type: none"> <li>Sg. Kapar Estate (Sime Darby Plantation)</li> <li>Jln. Acob Estate (Sime Darby Plantation)</li> </ul>	<b>Klang</b>  Kapar Station (future) Jalan Kastam Station	<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Sementa</li> <li>Pangsapuri Seri Perantau</li> <li>Kg. Keretapi</li> </ul> <b>Agricultural</b> <ul style="list-style-type: none"> <li>Sg. Kapar Estate (Sime Darby Plantation)</li> </ul> <b>Industrial</b> <ul style="list-style-type: none"> <li>Worldwide Industrial Park</li> <li>Sg. Kapar Indah Industrial Park</li> </ul> <b>Transportation</b> <ul style="list-style-type: none"> <li>Jln. Kastam KTM Station</li> </ul>	<b>Residential</b> <ul style="list-style-type: none"> <li>Kg. Kapar</li> <li>Taman Putra</li> <li>Bandar Sultan Sulaiman</li> </ul>

## 6.6 HYDROLOGY & DRAINAGE

### 6.6.1 River Catchments

The proposed alignment will traverse 10 river catchment areas – four river catchments in Kelantan and six river catchments in Selangor (**Figure 6.6-1** and **Figure 6.2-2**), of which 10 of the rivers are considered as major rivers (excluding tributaries) (**Table 6-10**).

**Table 6-10 : Rivers Catchment Areas along the Proposed Alignment**

State	Catchment	Size (km <sup>2</sup> )
Kelantan	Sg. Kelantan	12981
	Sg. Golok	1011
	Sg. Pengkalan Nangka	25
	Sg. Tapan	6
Selangor	Sg. Selangor	1936
	Sg. Klang	1297
	Sg. Buloh	451
	Sg. Sembilang	51
	Sg. Puloh	27
	Sg. Tambak Jawa Besar	27

In addition to the river crossings, the alignment will also cross tributaries, irrigation canals, earth drains within plantation estates and ponds as tabulated in **Table 6-11** to **Table 6-14** and shown in **Figure 6.6-1** and **Figure 6.6-2**.

#### 6.6.1.1 Segment 1 : Kelantan

The alignment in Kelantan passes through four river catchments and crosses major rivers such as Sg. Kelantan, Sg. Mentua, Sg. Pengkalan Nangka and irrigation canals (**Table 6-11** and **Figure 6.6-1**).

**Table 6-11 : River Crossings along the Proposed Alignment in Kelantan**

Chainage	Crossing	Main River	Catchment
CH 38	Irrigation canal	Sg. Kelantan	Sg. Kelantan
CH 945	Irrigation canal	Sg. Kelantan	Sg. Kelantan
CH 1700	Sg. Kelantan	Sg. Kelantan	Sg. Kelantan
CH 3116	Irrigation canal	Sg. Kelantan	Sg. Kelantan
CH 3521	Irrigation canal	Sg. Kelantan	Sg. Kelantan
CH 3635	Irrigation canal	Sg. Kelantan	Sg. Kelantan

**Table 6-11: River Crossings along the Proposed Alignment in Kelantan (Cont'd)**

Chainage	Crossing	Main River	Catchment
CH 5622	Irrigation canal	Sg. Kelantan	Sg. Kelantan
CH 6221	Irrigation canal	Sg. Kelantan	Sg. Kelantan
CH 9205	Irrigation canal	Sg. Kelantan	Sg. Kelantan
CH 10322	Irrigation canal	Sg. Kelantan	Sg. Kelantan
CH 10710	Irrigation canal	Sg. Kelantan	Sg. Kelantan
CH 13824	Irrigation canal	Sg. Mentua	Sg. Golok
CH 14920	Irrigation canal	Sg. Mentua	Sg. Golok
CH 16792	Sg. Peng. Nangka	Sg. Peng. Nangka	Sg. Peng. Nangka
CH 17922	Irrigation canal	Sg. Peng. Nangka	Sg. Peng. Nangka
CH 19353	Irrigation canal	Sg. Peng. Nangka	Sg. Peng. Nangka
CH 21658	Irrigation canal	Sg. Tapan	Sg. Tapan
CH 22400	Irrigation canal	Sg. Mentua	Sg. Golok
CH 22492	Sg. Mentua	Sg. Mentua	Sg. Golok
CH 22617	Irrigation canal	Sg. Mentua	Sg. Golok
CH 23098	Irrigation canal	Sg. Mentua	Sg. Golok

### 6.6.1.2 Segment 2 : Selangor

#### Segment 2A: Gombak North to Serendah

The alignment in this segment passes through two river catchments and crosses major rivers such as Sg. Batu, Sg. Kanching and its tributaries (**Table 6-12** and **Figure 6.6-2a** and **Figure 6.6-2b**).

**Table 6-12 : River Crossings along the Proposed Alignment from Gombak North to Serendah**

Chainage	Crossing	Main River	Catchment
CH 2385	Sg. Salak	Sg. Gombak	Sg. Klang
CH 4323	Sg. Semampus	Sg. Gombak	Sg. Klang
CH 7375	Sg. Batu	Sg. Batu	Sg. Klang
CH 10905	Sg. Udang	Sg. Kanching	Sg. Selangor
CH 11169	Sg. Udang	Sg. Kanching	Sg. Selangor
CH 11626	Sg. Kanching	Sg. Kanching	Sg. Selangor
CH 12348	Sg. Kasau	Sg. Kanching	Sg. Selangor
CH 12941	Sg. Kasai	Sg. Kanching	Sg. Selangor
CH 13107	Sg. Rangkap	Sg. Kanching	Sg. Selangor
CH 13933	Sg. Terusan	Sg. Kanching	Sg. Selangor
CH 14836	Sg. Baharu	Sg. Kanching	Sg. Selangor
CH 19468	Sg. Chui	Sg. Kanching	Sg. Selangor

### Segment 2B: Serendah to Bandar Puncak Alam

The alignment in this segment passes through two river catchments and crosses major rivers such as Sg. Serendah, Sg. Garing, Sg. Kundang, Sg. Buloh, ponds and plantation drains (**Table 6-13** and **Figure 6.6-2c** and **Figure 6.6-2d**).

**Table 6-13 : River Crossings along the Proposed Alignment from Serendah to Bandar Puncak Alam**

Chainage	Crossing	Main River	Catchment
CH 22240	Pond	Sg. Serendah	Sg. Selangor
CH 25809	Pond	Sg. Serendah	Sg. Selangor
CH 25942	Sg Serendah	Sg Serendah	Sg. Selangor
CH 26218	Sg Serendah	Sg Serendah	Sg. Selangor
CH 27318	Sg Serendah	Sg Serendah	Sg. Selangor
CH 32814	Sg. Garing	Sg. Garing	Sg. Selangor
CH 33054	Sg. Garing	Sg. Garing	Sg. Selangor
CH 33163	Sg. Garing	Sg. Garing	Sg. Selangor
CH 33312	Pond	Sg. Selangor	Sg. Selangor
CH 33711	Pond	Sg. Selangor	Sg. Selangor
CH 34313	Sg. Kundang	Sg. Kundang	Sg. Selangor
CH 34906	Pond	Sg. Kundang	Sg. Selangor
CH 35135	Pond	Sg. Kundang	Sg. Selangor
CH 35456	Pond	Sg. Kundang	Sg. Selangor
CH 40227	Plantation drain	Sg. Kundang	Sg. Selangor
CH 40629	Plantation drain	Sg. Kundang	Sg. Selangor
CH 40844	Pond	Sg. Kundang	Sg. Selangor
CH 41034	Pond	Sg. Kundang	Sg. Selangor
CH 41244	Drain	Sg. Kundang	Sg. Selangor
CH 45828	Sg. Buloh	Sg. Buloh	Sg. Buloh

### Segment 2C: Bandar Puncak Alam to Port Klang

The alignment in this segment passes through two river catchments and crosses major rivers such as Sg. Puloh, Sg. Klang and its tributaries as well as ponds and numerous plantation drains (**Table 6-14** and **Figure 6.6-2e** and **Figure 6.6-2f**).

**Table 6-14 : River Crossings along the Proposed Alignment from Bandar Puncak Alam to Port Klang**

<b>Chainage</b>	<b>Crossing</b>	<b>Main River</b>	<b>Catchment</b>
CH 51755	Pond	Sg. Buloh	Sg. Buloh
CH 53572	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 53670	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 54205	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 54386	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 54723	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 55010	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 55118	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 55130	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 55486	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 55588	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 55774	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 55978	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 56191	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 56306	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 56325	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 57629	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 57657	Plantation drain	Sg. Sembilang	Sg. Sembilang
CH 57984	Plantation drain	Sg. Tambak Jawa Besar	Sg. Tambak Jawa Besar
CH 58269	Plantation drain	Sg. Tambak Jawa Besar	Sg. Tambak Jawa Besar
CH 58421	Plantation drain	Sg. Tambak Jawa Besar	Sg. Tambak Jawa Besar
CH 59643	Plantation drain	Sg. Tambak Jawa Besar	Sg. Tambak Jawa Besar
CH 60537	Plantation drain	Sg. Tambak Jawa Besar	Sg. Tambak Jawa Besar
CH 60575	Plantation drain	Sg. Tambak Jawa Besar	Sg. Tambak Jawa Besar
CH 60937	Plantation drain	Sg. Buloh	Sg. Buloh
CH 61005	Plantation drain	Sg. Buloh	Sg. Buloh
CH 61209	Plantation drain	Sg. Buloh	Sg. Buloh
CH 62142	Plantation drain	Sg. Buloh	Sg. Buloh
CH 62693	Plantation drain	Sg. Buloh	Sg. Buloh
CH 62756	Plantation drain	Sg. Buloh	Sg. Buloh
CH 62817	Plantation drain	Sg. Buloh	Sg. Buloh
CH 62877	Plantation drain	Sg. Buloh	Sg. Buloh
CH 62940	Plantation drain	Sg. Buloh	Sg. Buloh
CH 63002	Plantation drain	Sg. Buloh	Sg. Buloh
CH 63063	Plantation drain	Sg. Buloh	Sg. Buloh
CH 63126	Plantation drain	Sg. Buloh	Sg. Buloh
CH 63193	Plantation drain	Sg. Buloh	Sg. Buloh
CH 64340	Plantation drain	Sg. Buloh	Sg. Buloh
CH 68481	Sg. Batu Enam	Sg. Puloh	Sg. Puloh

**Table 6- 14: River Crossings along the Proposed Alignment from Bandar Puncak Alam to Port Klang (cont'd)**

Chainage	Crossing	Main River	Catchment
CH 69314	Drain	Sg. Puloh	Sg. Puloh
CH 69730	Drain	Sg. Puloh	Sg. Puloh
CH 69926	Sg. Pulai	Sg. Puloh	Sg. Puloh
CH 70068	Sg. Pulai	Sg. Puloh	Sg. Puloh
CH 70620	Sg. Puloh	Sg. Puloh	Sg. Puloh
CH 72210	Sg. Bering	Sg. Puloh	Sg. Puloh
CH 73458	Sg. Che Awang	Sg. Puloh	Sg. Puloh
CH 73500	Pond	Sg. Puloh	Sg. Puloh
CH 74400	Drain	Sg. Klang	Sg. Klang
CH 74653	Sg. Klang	Sg. Klang	Sg. Klang
CH 76868	Sg. Tk. Gadong Besar	Sg. Klang	Sg. Klang

## 6.6.2 FLOOD RISK

Situated in the east coast of Peninsular Malaysia, Kelantan is prone to flooding during the northeast monsoon period between November and March. Selangor in the west coast, on the other hand, is mainly affected by the inter-monsoon period from September to November, when convectional thunderstorms become frequent. Such storms bring short but intense rainfall, which severely overloads the drainage systems, causing localised flash floods.

The breakdown of the annual rainfall and the extent of flood prone areas in Kelantan and Selangor are tabulated in **Table 6-15**.

**Table 6-15: Annual Rainfall**

State	<sup>1,2</sup> Annual Precipitation (mm)	<sup>3</sup> Estimated Flood Prone Area (km <sup>2</sup> )
Kelantan	2,551.7	1,640.0
Selangor	2,670.0	1,788.7

Source: <sup>1</sup>Laporan Pemeriksaan Rancangan Struktur Negeri Kelantan 2003 -2020

<sup>2</sup>Rancangan Struktur Negeri Selangor 2035

<sup>3</sup>Review of National Water Resources Study (2000-2050)

The locations of flood prone areas and the causes of flooding have been extracted from the Flood Reports (from year 2013 to year 2017) published by Division of Water Resources and Hydrology, Department of Irrigation and Drainage. The main findings in Kelantan and Selangor are outlined below.

### 6.6.3 Segment 1: Kelantan

Flooding in Kelantan is mainly due to continuous rainfall especially during monsoon season, which causes the major rivers to overflow. Sg. Kelantan is the largest river in the state with a catchment area of approximately 13,000 km<sup>2</sup>, occupying about 85% of the state land. Besides Sg. Kelantan, other rivers contributing to floods are Sg. Golok and Kemasin/Semerak river system.

Tumpat and Kota Bharu districts have high flooding potential due to their respective locations at the downstream of Sg. Golok and Sg. Kelantan catchments. The alignment will be traversing through mostly flood prone areas in Kelantan, namely the stretch from Kota Bharu to Wakaf Bharu and from Kampung Belukar to Pengkalan Kubor. Details of flood occurrence in Kelantan extracted from the Flood Reports are tabulated in **Table 6-16**. The depth of floodwaters ranges from 0.3 to 12.0 m, whereas the size of flood areas ranges from 0.1 to 15.0 km<sup>2</sup>. The flood map of Kelantan is shown in **Figure 6.6-3**. The list of flood mitigation measures programs in Kelantan are as described in **Table 6-17**.

In general, the most common contributing factors of flooding in Kelantan are:

- a. Widespread and prolonged rainfall during north-east monsoon often lasting several days.
- b. Sedimentation and erosion resulting in shallow rivers that are prone to overflow during continuous rainfall events.

### 6.6.4 Segment 2 : Selangor

Flooding in Selangor is mainly attributed to flash floods, escalated by inadequate and clogged local drainage system, during inter-monsoon period. A total of 539 of flash flood events have been recorded between 2013 and 2016 in Selangor. The railway will run along some flood hotspots in the urban and rural areas along Sg. Selangor and Sg. Klang catchment. Details of flood occurrence in Selangor extracted from the Flood Reports are tabulated in **Table 6-18**. The depth of floodwaters ranges from 0.1 to 1.6 m, and depending on areas, the size of flood areas ranges from as low as 0.1 acres up to 1000 acres. The flood map of Selangor is shown in **Figure 6.6-4**. The list of flood mitigation measures programs in Selangor are as described in **Table 6-19**.

In general, the most common contributing factors of flooding in Selangor are:

- a. Rapid development (residential, industry and infrastructure) which causes flash floods.
- b. Sedimentation and erosion resulting in shallow rivers that are prone to overflow during continuous rainfall events.
- c. Insufficient and clogged local drainage system in urban areas.
- d. Continuous rainfall and high tide phenomenon in Klang

Table 6-16 : Summary of Flood Occurrence in Kelantan

District	River Catchment	Area of Flood Occurrence (Km <sup>2</sup> )	Depth of Flood (m)	Affected Villages / Area
Kota Bharu	Sg. Pengkalan Datu Sg. Kelantan	3.0 – 15.0	0.3 – 2.0	Kg. Tini, Kg. Pasir Hor, Kg. Pasir Jelatang, Kg. Tiong, Kg. Chicha, Kg. Limbat, Kg. Parit, Kg. Tikat, Kg. Penambang, Kg. Bunga Mas
	Sg. Pengkalan Datu Sg. Kelantan	8.0 – 15.0	0.5 – 2.0	Mukim Mulong, Mukim Pendek
	Sg. Kelantan	15.0	0.3 – 2.0	Mukim Pasir Hor, Mukim Kota Jelasin, Mukim Padang Enggang, Kg. Kedai Buloh, Jalan Pantai Cahaya Bulan, Jalan Salor – Pasir Mas, Kg. Banggol Kulim, Kg. Banggol Kong
	Sg. Kemasin	-	0.5	Mukim Gong Dermin
		4	1.0	Kg. Pulau Panjang
	Sg. Pengkalan Chepa	2.0 – 10.0	1.0 – 2.5	Kg. Baung, Kg. Tanjung Chat, Kg. Beting, Kg. Tapang, Kg. Belukar, Kg. Teluk, Kg. Landak, Kg. Pulau Belancang
Tumpat	Sg. Pengkalan Datu Sg. Pengkalan Datu	8.0 – 10.0 0.3	0.5 -1.5 0.5 -12.0	Kg. Parit, Kg. Kota Jembal Kg. Salor
	Sg. Kelantan	0.1 - 1.0	1.6	Pasir Pekan, SK Seri Wakaf Baru, Kg. Laut, Kg. Sungai Pinang, Kg. Kok Majid, Kg. Mak Neralang, Kg. Chat, Kg. Gerong, Kg. Palekbang, Kg. Morak, Kg. Berangan, Kg. Padang Tembesu, Kg. Paloh, Kg. Kok Keli, Kg. Kok Pasir, Pasir Pekan, Bandar Tumpat, Kg. Alor Mengkuang, Kg. Kubang Sawa, Kg. Alor Mengkuang, Kg. Kubang Sawa, Kg. Bendang Pak Yong, Kg. Kajang Sebidang, Kg. Jejuluk, Kg. Teluk Jering, Pulau Beluru, Kg. Kok Keli
	Sg. Kelantan	1.0	0.1 – 0.3	Kg Siram, Kg Pade Pak Atap Bukit Lata, Kg Tokdeh, Kg Lachang, Tersang, Kg Siram, Kg Jeram Perdah, Kg Kubang Hitam, Kg Sapi, Kg Kelawar, Kg Jejawi, Kg Bonggor dan Kg. Bendang Nyor. Kg. Kubang Kual

**Table 6-17 : List of Flood Mitigation Plans / Studies in Kelantan**

Plan / Study	Major issues	Flood Mitigation Components
Study on Kelantan River Basin – Wide Flood Mitigation	Flooding and drainage problems: Heavy rainfall, approximately 2,700 mm from October to December	<ul style="list-style-type: none"> <li>• A levee of 7m high</li> <li>• Construction of Lebir and Kemubu Dam</li> </ul>
Kelantan River Flood Mitigation Plan – Feasibility Study	Flooding and drainage problems: <ul style="list-style-type: none"> <li>• The river drains 85% of State’s total land area on flat and generally low-lying coastal plain</li> <li>• River sections downstream of Pasir Mas have limited capacity</li> <li>• Flatness of the terrain, flows exceeding bank-full stage in the lower reach of Sg. Kelantan</li> </ul>	<ul style="list-style-type: none"> <li>• Construction of Lebir Dam</li> <li>• Upgrading of Kelantan River</li> <li>• Provision of flood bypass</li> <li>• Reconstruct town drainage</li> </ul>
Sungai Kemasin Channel Improvement and Mentuan Diversion	Flooding and drainage problems: <ul style="list-style-type: none"> <li>• Flat terrain and flooded to various degrees each year</li> </ul>	<ul style="list-style-type: none"> <li>• Sg. Kemasin river mouth improvement</li> <li>• Sg. Kemasin channel improvement</li> <li>• Provision of tidal gate to prevent backflow from the sea</li> <li>• Widening and deepening of the existing Mentuan drain</li> </ul>
Projek Pembangunan Lembangan Sungai Bersepadu Sg. Kelantan Fasa 1	Flooding and drainage problems	<u>RTB Kelantan</u> <ul style="list-style-type: none"> <li>• Construction of 3 km levee from Kg. Tikat to kg. Kedai Buloh, Kota Bharu</li> <li>• Construction of 5.6 km levee from Palekbang to Kok Majid, Tumpat</li> <li>• Construction of flood wall in Kg. Laut, Tumpat.</li> <li>• Construction of control gate at Sg. Pinang (2 bays) and Sg. Tikat (1 Bay)</li> </ul> <u>Living River</u> <ul style="list-style-type: none"> <li>• Riverbank improvement works: <ul style="list-style-type: none"> <li>– Pasir Mas: Kg. Pasir Parit</li> </ul> </li> </ul>

Table 6-17 : List of Flood Mitigation Plans / Studies in Kelantan (Cont'd)

Plan / Study	Major issues	Flood Mitigation Components
		<ul style="list-style-type: none"> <li>– Tumpat: Kg. Teluk Renjuna, Kg. Pasir Pekan -Palekbang</li> <li>– Tanah Merah: Kg. Paloh /Kg. Belimbing, Kg. Kusial Baru</li> <li>– Machang: Sg. Kemubu, Sg. Sat, Kg. Mata Air, Kg. Temangan, kg. Paloh Rawa</li> <li>– Kota Bharu: Kg. Tikat, Kg. Banggol, Kg. Tg. Chat</li> <li>• Riverbank deepening works: <ul style="list-style-type: none"> <li>– Machang: Sg. Bagan, Sg. Kweng Hitam, Sg. Pulau Chondong, Sg. Dewan</li> <li>– Tumpat: Kg. Pulau Beluru, Kg. Palekbang, Sg. Rullah, Kg. Teluk Renjuna, Kg. Sg. Tumpat</li> <li>– Kuala Krai: Kg. Nal</li> <li>– Tanah Merah: Sg. Maka, Sg. Kapat, Sg. Kusial, Sg. Jerangau, Sg. Panjang, Sg. Sokor</li> </ul> </li> <li>• River water treatment (Sg. Pengkalan Chepa): <ul style="list-style-type: none"> <li>– Installation of 3 units of gross pollutant traps (GPT)</li> <li>– Construction of sediment pond</li> </ul> </li> <li>• <i>Saliran Mesra Alam</i> (SMA) <ul style="list-style-type: none"> <li>– River training works at: <ul style="list-style-type: none"> <li>– Bandar baru Tunjung (Branch 8, Branch 9, detention storage at Seribong)</li> <li>– Alor Kada: Branch 16, Branch 17 and detention storage at Alor KADA</li> </ul> </li> </ul> </li> <li>• Construction of 800 m concrete drain (behind Kota Lama)</li> </ul>
Eleventh Malaysia Plan	Flooding and drainage problems	<ul style="list-style-type: none"> <li>– Construction of Lebir Dam</li> <li>– Construction of Nenggiri Dam</li> </ul>

**Table 6-17 : List of Flood Mitigation Plans / Studies in Kelantan (Cont'd)**

Plan / Study	Major issues	Flood Mitigation Components
		<ul style="list-style-type: none"> <li>– Flood Mitigation Plan especially in Pasir Mas, Tanah Merah and Kota Bharu), construction of detention ponds in Sg. Galas and Sg. Ketil basin</li> <li>– Construction of flood wall and levee (40 km) for both sides of Sg. Kelantan river bank</li> <li>– Flood diversion at Sg. Ketereh, Sg. Seribong, Sg. Lubok Mulong, Sg. Pengkalan Datu and Sg. Raja Gali (70km)</li> <li>– Dry pond at paddy field in district of Machang</li> <li>– Deepening of Sg. Kelantan (100 km)</li> <li>– Silt dam at Sg. Lebir and Sg. Galas</li> </ul>
		<u>RTB Sg. Golok</u> <ul style="list-style-type: none"> <li>- Flood Bund</li> <li>- Rantau Panjang Flood Wall</li> <li>- Flood Wall Sg. Lemal – Lancang, Channel Improvement, Flood Diversion</li> <li>- River Improvement (Sg. Golok, Sg. Lanas, Sg. Jedok, Sg. Alor Mengkuang), Main Collection Drain, Bridges, and M&amp;E works</li> <li>- Retention pond Tok Uban</li> </ul>

Table 6-18 : Summary of Flood Occurrence in Selangor

District	River Catchment	Area of Flood Occurrence (acre)	Depth of Flood (m)	Affected Villages / Area
Gombak	Sg. Buloh	15 – 20	0.1-1.0	Behind UIA, UIA Area, Kg. Sg. Pusu area
		1.0	0.4	Roads, nearby Kolej Vokasional, surroundings of MRR2 road,
		0.5	0.1	Kg. Sungai Pusu
		1.1	0.1-0.3	Surroundings of MRR2 road
		0.5	0.3	Flood Area of Sg. Kertas
		9.9	0.1-0.3	Persimpangan Bukit Botak
		0.5	0.3-0.6	Kg. Nakhoda, Kg. Laksamana
		30	0.1-0.3	Kampung India Settlement
		2.5	0.1-0.3	Persekitaran Sek. Keb. 1 Taman Selayang
		1.0	0.3	Jalan masjid Al-Taqwa
		10.9	0.1-0.5	Persekitaran Selayang Sejati
		2.0	0.7	Taman Selayang Sejati
		22.2	0.1-0.4	Autocity, Taman Templer
		18.5	0.1-0.6	Jalan Maxwell and Jalan Market
		3.7	0.1-0.3	Surroundings of Jalan Batu Arang (near Jusco Rawang)
		10	0.1-0.6	Persekitaran Kg. Sungai Bakau
	Sg. Selangor	22.2	0.1-0.6	Taman Tun Perak
		0.4	0.1-0.3	Taman Garing
		0.5	0.3	Kg. Chempedak(Kuang) / Persimpangan Emerald East (Jln Batu Arang-Rawang), Pekan Batu Arang

**Table 6-18 : Summary of Flood Occurrence in Selangor (Cont'd)**

District	River Catchment	Area of Flood Occurrence (acre)	Depth of Flood (m)	Affected Villages / Area
Gombak	Sg. Klang	0.5	0.6	Area of Jalan batu arang heading towards Kundang
		8.4	0.3	Persekitaran Blok 26 Green Valley
		10.4	0.1-0.5	Jalan Kg. Simpang 3 Greenwood,
		7.4	0.1-0.6	Kampung Kerdas 2
		2	0.7	Persimpangan lampu isyarat Jalan Sg. Tua
		9.88	0.1-0.2	Taman Sierra One
		4.63	0.1-0.5	Lot 1683 & 413 Kampung Changkat
		1.5	0.3	Kg. Sungai Terentang
		247	0.3	Persekitaran Bakau Country Homes (Sungai Bakau)
Hulu Selangor	Sg. Selangor	44.5	0.1-0.3	Jalan Kuala Lumpur-Ipoh @ Serendah
	Sg. Bernam	14.8	0.1-1.0	Mat Taib industrial area, Hulu Selangor
Kuala Selangor	Sg. Buloh	553.5	0.1-0.45	Kg. Parit Mahang
		300	0.1-1.6	Kg. Bukit Hijau
		150	0.1-0.4	Kg. Bkt. Kucing, Kg. Bkt Kucing Tengah. Kg. Bkt Cherakah
		50-100	0.1-1.3	Kg. Sentosa and Sri Aman
		42	-	Puncak Alam housing areas
		988	0.3	Taman Seri Meru
Klang	Sg. Klang	865	0.3	Pandamaran Jaya
		247	0.3	Kg. Bukit Kapar
		180.4	0.3-0.5	Taman Bandar Sultan Suleiman, Klang
		100	0.3-0.6	Jalan Aur
		98.8	0.1-0.6	Taman Palm Grove & Taman Chi Liung
		61.8	0.1-0.3	Kampung Sungai Pinang

**Table 6-18 : Summary of Flood Occurrence in Selangor (Cont'd)**

District	River Catchment	Area of Flood Occurrence (acre)	Depth of Flood (m)	Affected Villages / Area
Klang		61.8	0.1-0.5	Taman Tengku Bendahara Azman (Pekan Pandamaran)
		37.1	0.1-0.3	Jalan Bakti Kg Rantau Panjang
		29.7	0.3	Kg. Sungai Udang
		29.7	0.1-0.3	Pekan Pandamaran
		24.7	0.1-0.6	Jalan Kempas, Jalan Setia Jaya
		12.4	0.1-0.3	Areas of Hospital Tengku Ampuan Rahimah
		12.3	0.1-0.3	Kg. Batu Empat
		9.3	0.1-0.3	Areas of SMK Tengku Ampuan Rahimah
		7.41	0.1-0.3	Areas of Taman Bayu Perdana
		5	0.3-0.5	Kg Delek Baru, Kg Sg Sireh
		5	0.2-0.3	Taman Seri Andalas (Jalan Sri Sarawak)
		2.6	0.1-0.3	Kampung Batu Belah
		0.61	0.1-0.6	Jalan Mawar, Kg. Bukit Kerayong
		10-14.8	0.3-0.5	Taman Melawis, Taman Melawis Teluk Pulau
		-	0.3-0.6	Taman Cempaka Sari, Klang Utama
		-	0.3-0.6	Taman Seri Puteri, Meru
Klang	Sg. Klang	135.9	0.1-0.5	Persiarian Hamzah Alang (Meru town)
	Sg. Kapar Besar			
	Sg. Kapar	-	0.3-0.6	Sg. Kapar Indah
	Sg. Puloh	69.1	0.1-0.9	Kampung Sg Pinang, Kampung Batu 4

**Table 6-19 : List of Flood Mitigation Plans / Studies in Selangor**

<b>Plan / Study</b>	<b>Major issues</b>	<b>Flood Mitigation Components</b>
Klang River Basin Environmental Improvement and Flood Mitigation Project	<ul style="list-style-type: none"> <li>• Catchment area of Klang river is the most urbanized region in Malaysia</li> <li>• Flooding problems escalated by urbanization, industrialization, and population growth</li> <li>• Area in Klang is prone to flooding due to high tide phenomenon</li> </ul>	<ul style="list-style-type: none"> <li>i. Integrated river basin management</li> <li>ii. Solid waste management,</li> <li>iii. Sediment trapping,</li> <li>iv. Tributary river corridor improvement, and</li> <li>v. Flood forecasting and warning system</li> </ul>
Rancangan Tebatan Banjir Selangor	<ul style="list-style-type: none"> <li>• Flooding and drainage problem due to heavy rainfall and insufficient drainage</li> </ul>	<ul style="list-style-type: none"> <li>• Riverbank improvement works: <ul style="list-style-type: none"> <li>- Klang: Sg. Rasau, Sg. Keramat, Sg. Kapar Besar "Borrow Pit", Sg. Binjai</li> <li>- Hulu Selangor: Sg. Bernam</li> <li>- Kuala Selangor: Sg. Tinggi, Sg. Selangor,</li> <li>- Gombak: Sg. Manchong, Sg. Kundang</li> </ul> </li> <li>• Sewerage and drainage improvement works: <ul style="list-style-type: none"> <li>- Klang: Teluk Menegun Fasa 1 &amp; 2, Sekolah TAR drain, Jalan Hj Sirat/Klang Utama, Pintu Air Sg. Keramat, Pam Pintu Sg. Daun, Taman Sentosa, Taman Maznah, Kg. Kuantan, Kg. Johan Setia Fasa 2, Jalan Kebun-Dalam, Jalan Kempas, Jalan Setia Jaya, Meru Tambahan, Laluan Bertingkat Klang Sentral</li> <li>- Hulu Selangor: Kg. Sungai Buah</li> <li>- Kuala Selangor: Kg. Sungai Serdang, Kg. Sungai Sembilang</li> </ul> </li> <li>• Installation of permanent pump at Kg. Kuantan, Kg. Bukit Kuda, Klang town</li> <li>• Flood Mitigation Pond at Teluk Gadong, MPK, Sungai Aur Fasa 5, Sg. Kapar Besar, Kg. Budiman (Klang)</li> <li>• Installation of Flood Wall and Flapgate in Klang</li> <li>• Community relocation of Kg. Sentosa</li> </ul>

**Table 6-19 : List of Flood Mitigation Plans / Studies in Selangor (Cont'd)**

Plan / Study	Major issues	Flood Mitigation Components
		<ul style="list-style-type: none"> <li>• Instillation of TSG Tidal Control Gate in Kuala Selangor</li> <li>• Installation of 'Mobile Pump' at Sg. Rajah in Gombak, 'Pump Sump' at Jalang Tokong</li> <li>• Cleaning of "Trash Screen" in nearby pump house</li> <li>• Fixing and enlargement of culvert pipes in Gombak</li> </ul>
Pelan Induk Sistem Saliran Bandar	<ul style="list-style-type: none"> <li>• Flooding and drainage problems at critical catchment areas.</li> </ul>	<ul style="list-style-type: none"> <li>• Sepang: Kajian Makro Pelan Induk Saliran Untuk Multimedia Super Corridor (MSC).</li> <li>• Klang: Kajian Pelan Induk Saliran Untuk Bandar Klang</li> <li>• Gombak: Kajian Pelan Induk Saliran Untuk Sungai Buloh</li> <li>• KL &amp; Petaling: Kajian Pelan Induk Saliran Untuk Bandar Sungai Besi, Kuala Lumpur dan Seri Kembangan, Selangor</li> <li>• Hulu Langat: Kajian Pelan Induk Saliran bagi Majlis Perbandaran Kajang.</li> </ul>
Eleventh Malaysia Plan	<ul style="list-style-type: none"> <li>• Flooding and drainage problems</li> </ul>	<ul style="list-style-type: none"> <li>• Flood Mitigation Plan for Teluk Gadong, Pandamaran, Sungai Rasau, Sg. Kandis-Dlm, Sg. Bernam, Fasa 2, Batangkali, Sg. Buloh</li> </ul>

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## 6.7 WATER QUALITY

### 6.7.1 Approach & Methodology

The river water quality sampling at 33 locations was conducted from 8<sup>th</sup> to 11<sup>th</sup> August 2017. One water sample was collected from each station using the grab sampling technique. During each sampling, in-situ measurement of pH, temperature and dissolved oxygen was carried out. The samples were stored in a cooler box before being transported to the laboratory for analysis.

All water samples were analysed for pH, temperature, dissolved oxygen (DO), turbidity, Biological Oxygen Demand (BOD<sub>5</sub>), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Mercury (Hg), Cadmium (Cd), Chromium hexavalent (Cr<sup>6+</sup>), Arsenic (As), Cyanide (Cn), Lead (Pb), Chromium Trivalent (Cr<sup>3+</sup>), Copper (Cu), Manganese (Mn), Nickel (Ni), Zinc (Zn), Iron (Fe), Oil and grease (O&G), Ammoniacal Nitrogen (NH<sub>3</sub>-N), E. coli, Aluminium (Al), Selenium (Se), Nitrite (NO<sub>2</sub>), Nitrate (NO<sub>3</sub>), Phosphate (PO<sub>4</sub>) as well as the flow velocity at the sampling point. The hydraulic measurements for 11 sampling locations in Selangor (Sg. Serendah) were also obtained. The results from the water quality analysis will be compared to the Class II of the DOE Water Quality Index (WQI). The parameters, measurement units and the analytical methodologies are shown in **Table 6-20**.

**Table 6-20 : Water Quality Parameters and Analysis Methods**

Parameters	Measurement Unit	Method
pH (in-situ reading)	-	APHA 4500-H <sup>+</sup> B,2005
*Temperature (in-situ reading)	°C	APHA 2550 B,2005
Dissolved Oxygen (DO) (in-situ reading)	mg/l	APHA 4500-O G,2005
Turbidity	NTU	APHA 2130 B,2005
Biological Oxygen Demand (BOD <sub>5</sub> )	mg/l	APHA 5210 B,2005 APHA 4500-O G,2005
Chemical Oxygen Demand (COD)	mg/l	APHA 5220 B,2005
Total Suspended Solids (TSS)	mg/l	APHA 2540 D,2005
Mercury (Hg)	mg/l	APHA 3112 B,2005
Cadmium (Cd)	mg/l	APHA 3120 B,2005
Chromium hexavalent (Cr <sup>6+</sup> )	mg/l	APHA 3500-Cr B,2005
Arsenic (As)	mg/l	APHA 3114 C,2005
Cyanide (Cn)	mg/l	APHA 4500-CN C & F,2005
Lead (Pb)	mg/l	APHA 3120 B,2005
Chromium Trivalent (Cr <sup>3+</sup> )	mg/l	APHA 3111 B & APHA 3500-Cr B, 2005

**Table 6-20 : Water Quality Parameters and Analysis Methods (Cont'd)**

Parameters	Measurement Unit	Method
Copper (Cu)	mg/l	APHA 3120 B,2005
Manganese (Mn)	mg/l	APHA 3120 B,2005
Nickel (Ni)	mg/l	APHA 3120 B,2005
Zinc (Zn)	mg/l	APHA 3120 B,2005
Iron (Fe)	mg/l	APHA 3120 B,2005
Oil and grease (O&G)	mg/l	APHA 5520 B,2005
Ammoniacal Nitrogen (NH <sub>3</sub> -N)	mg/l	APHA 4500-NH <sub>3</sub> B&C,1992
*E.Coli	Count /100ml	APHA 9222 G,2005
Aluminium (Al)	mg/l	APHA 3120 B,2005
Selenium (Se)	mg/l	APHA 3120 B,2005
Nitrite (NO <sub>2</sub> )	mg/l	APHA 4500-NO <sub>2</sub> B,2005
Nitrate (NO <sub>3</sub> )	mg/l	APHA 4500-NO <sub>3</sub> B,2005
Phosphate (PO <sub>4</sub> )	mg/l	APHA 4500- P D,2005

Note: APHA means Standard Methods for Examination of Water and Wastewater by APHA (American Public Health Association), AWWA (American Water works Association) and WEF (Water Environment Federation)

## 6.7.2 Location of Water Quality Monitoring Stations

### 6.7.2.1 Segment 1 : Kelantan

A total of 15 samples were collected from river crossings along the proposed alignment, including Sg. Mentua (tributary of Sg. Golok), Sg. Pengkalan Nangka, Sg. Kelantan and irrigation canals. The locations are as described in **Table 6-21** and shown in **Figure 6.7-1a** to **Figure 6.7- 1c**.

**Table 6-21 : Location of Water Quality Monitoring Stations in Kelantan**

Station	Crossings	River Catchment	Coordinates
WK1	Irrigation Canal (Kg. Baru Kok Pauh)	Sg. Golok	6° 13' 08.56"N, 102° 5' 40.20"E
WK2	Irrigation Canal (Bendang Mentua)	Sg. Golok	6° 12' 54.02"N, 102° 5' 52.03"E
WK3	Upstream of Sg. Mentua	Sg. Golok	6° 12' 29.69"N, 102° 6' 05.70"E
WK3A	Sg. Mentua (between WK3 and WK3B)	Sg. Golok	6° 12' 26.35"N, 102° 5' 38.60"E
WK3B	Downstream of Sg. Mentua	Sg. Golok	6° 13' 23.37"N, 102° 5' 20.60"E
WK4	Irrigation Canal	Sg. Golok	6° 12' 24.17"N, 102° 6' 04.39"E
WK5	Upstream of Sg. Peng. Nangka	Sg. Peng. Nangka	6° 10' 14.28"N, 102° 6' 04.39"E
WK5A	Sg. Peng. Nangka between WK5 and WK5B	Sg. Peng. Nangka	6° 10' 37.03"N, 102° 8' 22.33"E

**Table 6-21 : Location of Water Quality Monitoring Stations in Kelantan (Cont'd)**

Station	Crossings	River Catchment	Coordinates
WK5B	Downstream of Sg. Peng. Nangka	Sg. Peng. Nangka	6° 11' 34.43"N, 102° 8' 47.70"E
WK6	Irrigation Canal (Kg. Cherang)	Sg. Kelantan	6° 09' 22.64"N, 102° 9' 08.84"E
WK7	Irrigation Canal (Kg. Kubang Batang Barat)	Sg. Kelantan	6° 07' 50.72"N, 102° 10' 26.50"E
WK8	Irrigation Canal (Kg. Belukar)	Sg. Kelantan	6° 07' 07.26"N, 102° 10' 51.97"E
WK9	Irrigation Canal (Jalan Kebang Mas)	Sg. Kelantan	6° 05' 25.45"N, 102° 11' 48.06"E
WK10	Sg. Kelantan	Sg. Kelantan	6° 03' 21.95"N, 102° 12' 46.29"E
WK11	Sg. Kelantan	Sg. Kelantan	6° 06' 55.09"N, 102° 13' 40.54"E

### 6.7.2.2 Segment 2 : Selangor

#### Segment 2A: Gombak North to Serendah

A total of 2 samples were collected from river crossings along this segment. The locations are as described in **Table 6-22** and shown in **Figure 6.7-2a** and **Figure 6.7-2b**.

**Table 6-22 : Location of Water Quality Monitoring Stations from Gombak North to Serendah**

Station	Crossings	River Catchment	Coordinates
WS1	Sg. Gombak	Sg. Klang	03° 17' 32.00"N, 101° 43' 48.00"E
WS2	Sg. Batu	Sg. Klang	03° 16' 13.00"N, 101° 41' 9.00"E

#### Segment 2B: Serendah to Bandar Puncak Alam

A total of 12 samples were collected from river crossings along this segment of the proposed alignment, including Sg. Serendah, Sg. Garing, Sg. Kundang, Sg. Selangor and Sg. Buloh. The locations are as described in **Table 6-23** and shown in **Figure 6.7-2c** and **Figure 6.7-2d**.

**Table 6-23 : Location of Water Quality Monitoring Stations from Serendah to Bandar Puncak Alam**

Station	Crossings	River Catchment	Coordinates
WS3	Sg. Serendah	Sg. Selangor	03° 22' 37.00"N, 101° 36' 57.00"E
WS4	Sg. Serendah	Sg. Selangor	03° 22' 19.00"N, 101° 36' 14.00"E
WS5	Sg. Serendah	Sg. Selangor	03° 21' 39.00"N, 101° 33' 38.00"E
WS6	Sg. Serendah	Sg. Selangor	03° 20' 43.00"N, 101° 31' 44.00"E
WS7	Sg. Garing	Sg. Selangor	03° 21' 2.00"N, 101° 30' 13.00"E
WS8	Sg. Kundang	Sg. Selangor	03° 20' 30.00"N, 101° 30' 24.00"E

**Table 6-23: Location of Water Quality Monitoring Stations from Serendah to Bandar Puncak Alam (cont'd)**

Station	Crossings	River Catchment	Coordinates
WS9	Sg. Sembah	Sg. Selangor	03° 21' 48.00"N, 101° 29' 42.00"E
WS10	Sg. Sembah	Sg. Selangor	03° 22' 41.00"N, 101° 28' 43.00"E
WS11	Sg. Selangor	Sg. Selangor	03° 23' 53.00"N, 101° 27' 41.00"E
WS12	Sg. Selangor	Sg. Selangor	03° 24' 7.00"N, 101° 26' 31.00"E
WS13	Sg. Selangor	Sg. Selangor	03° 23' 2.00"N, 101° 24' 56.00"E
WS14	Sg. Buloh	Sg. Buloh	03° 17' 12.00"N, 101° 25' 54.00"E

## Segment 2C: Bandar Puncak Alam to Port Klang

A total of 4 samples were collected from river crossings along this segment of the proposed alignment at Sg. Puloh and Sg. Klang. The locations are as described in **Table 6-24** and shown in **Figure 6.7-2e** and **Figure 6.7-2f**.

**Table 6-24 : Location of Water Quality Monitoring Stations from Bandar Puncak Alam to Port Klang**

Station	Crossings	River Catchment	Coordinates
WS15	Sg. Puloh	Sg. Puloh	03° 04' 5.00"N, 101° 23' 7.00"E
WS16	Sg. Klang	Sg. Klang	03° 2' 8.00"N, 101° 23' 27.00"E
WS17	Sg. Klang	Sg. Klang	03° 01' 11.00"N, 101° 24' 10.00"E
WS18	Sg. Klang	Sg. Klang	03° 0' 56.00"N, 101° 22' 39.00"E

## 6.7.3 Baseline Sampling Results

### 6.7.3.1 Segment 1: Kelantan

The water quality at river crossings along the proposed alignment in Kelantan falls within Class II and Class III, i.e. Clean and Slightly Polluted, with the WQI ranging from 64.71 to 82.40. The pH levels ranged from 5.23 to 6.89 while the temperature readings of the water samples were between 27.6 °C and 33.2 °C. The potential pollution sources in this area are mostly sullage from villages and small towns, sewage and agriculture runoff from paddy fields. Most of the sampling points are from irrigation canals, with the exception of Sg. Mentua, Sg. Pengkalan Nangka and Sg. Kelantan. The flow velocity in all waterways range between 0.1 m/s to 0.3 m/s.

#### Dissolved Oxygen, Biochemical Oxygen Demand and Chemical Oxygen Demand

The concentration of dissolved oxygen (DO) reflects the aeration level of the water. The 15 monitoring stations recorded DO levels ranging from 3.11mg/L to 4.53mg/L

which falls within Class III limits. The Biological Oxygen Demand (BOD<sub>5</sub>) concentration ranged from less than 2mg/L to 6mg/L, all within Class II limits with the exception at WK8 which at Class III limits. COD levels ranged from 5mg/L to 36mg/L and are within Class II and Class III limits.

#### Ammoniacal Nitrogen and *E. coli*

Ammoniacal nitrogen was present in a range of 0.1 mg/L to 0.9 mg/L, within Class III limits. Nitrite (NO<sub>2</sub>) levels were below 0.1 mg/L at all stations while nitrate (NO<sub>3</sub>) ranged from 0.1 mg/L to 1.1 mg/L. *E. coli* is often used as an indicator of faecal contamination. The *E. coli* concentrations were found to be between 6 count/100mL and 2,900 count/100ml. The highest concentration was found at WK2 (Irrigation Canal at Bentang Mentua). This could indicate the discharge of raw sewage from the surrounding settlement or the presence of livestock along the irrigation canals as observed in **Plate 6-15**.



**Plate 6-15 : Cattle grazing along the irrigation canal near WK2**

#### Total Suspended Solids

Total suspended solids (TSS) concentration at all monitoring stations ranged from less than 6 mg/L to 148 mg/L. Suspended solids are usually made up of fine particles of sand, silt, clay and organic matter that have been weathered from the upstream watershed. Turbidity is affected by the number of particles suspended in the water column. As such, turbidity and total suspended solids are related. This was reflected based on the highest TSS and turbidity reading at point WK10 (Sg. Kelantan) where the highest levels of TSS concentration and turbidity level was detected, at 148 mg/l and 138 NTU respectively.

High levels of suspended solids are mostly due to non-point sources of pollution, mainly from land use alteration where vegetation coverage is removed (from logging activities or land clearing for other development). Cleared lands that are exposed will contribute to sediment runoff during storm events, transporting particles of sand, silt, clay and organic matter into the nearest water bodies. **Plates 6-16 and 6-17** illustrate waterways that have high levels of suspended solids.



**Plate 6-16 : Canal at Jalan Kebang Mas, sampling point WK9**



**Plate 6-17 : Sg. Kelantan from Jalan Tendong-Mulong, Pasir Mas.**

### Other Pollutants

Almost all the heavy metal parameters were below the minimum detectable level. Other heavy metal parameters will include manganese (Mn) with readings ranging from less than 0.005 mg/L to 0.186 mg/L and iron (Fe) with readings ranging from 0.052 mg/L to 7.06 mg/L. The higher levels of Mn and Fe are typical of freshwater bodies in the country and are most likely from natural occurrences.

Other water quality parameters assessed were either not detected or detected at very low levels in some samples. The water quality results for the Kelantan segment are shown in **Table 6-25** while the laboratory results are attached in **Appendix C**.

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**Table 6-25 : Water Quality Analysis Results for the Kelantan Segment**

Parameters	Units	Stations						
		WK1	WK2	WK3	WK3A	WK3B	WK4	WK5
Date	-	10/8/17	10/8/17	10/8/17	10/8/17	10/8/17	9/8/17	8/8/17
Time	-	1358	1320	1045	1131	1228	1529	1701
pH (in-situ reading)	-	5.62	5.82	6.89	6.81	6.57	5.23	5.55
*Temperature (in-situ reading)	°C	33.2	27.6	29.9	30.8	30.6	29.5	29.0
Dissolved Oxygen (DO) (in-situ reading)	mg/L	3.87	3.54	3.67	4.49	4.53	3.43	3.64
Turbidity	NTU	21	46	9	6	7	36	76
Biological Oxygen Demand (BOD <sub>5</sub> )	mg/L	<2	<2	<2	<2	<2	<2	2
Chemical Oxygen Demand (COD)	mg/L	30	36	25	20	20	26	29
Total Suspended Solids (TSS)	mg/L	16	25	8	6	6	20	32
Mercury (Hg)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium (Cd)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium hexavalent (Cr <sup>6+</sup> )	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic (As)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cyanide (Cn)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead (Pb)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium Trivalent (Cr <sup>3+</sup> )	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper (Cu)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Parameters	Units	Stations						
		WK1	WK2	WK3	WK3A	WK3B	WK4	WK5
Manganese (Mn)	mg/L	0.133	0.106	0.066	0.027	0.041	0.177	0.128
Nickel (Ni)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (Zn)	mg/L	0.040	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Iron (Fe)	mg/L	1.28	4.62	0.468	0.052	0.082	3.54	3.43
Oil and grease (O&G)	mg/L	<1	<1	<1	<1	<1	<1	<1
Ammoniacal Nitrogen (NH <sub>3</sub> -N)	mg/L	0.3	0.2	0.1	0.1	0.2	0.4	0.9
<i>E.coli</i>	Count /100ml	160	2900	100	60	320	6	200
Aluminium (Al)	mg/L	0.77	0.82	0.37	0.34	0.38	0.49	3.68
Selenium (Se)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite (NO <sub>2</sub> )	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate (NO <sub>3</sub> )	mg/L	0.8	0.6	0.9	0.4	0.3	0.3	0.7
Phosphate (PO <sub>4</sub> )	mg/L	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1
Velocity	m/s	0.1	0.1	0.3	0.2	0.2	0.1	0.1
Water Quality Index (WQI)	Index	72.51	71.47	82.36	82.40	80.81	68.38	67.49
	Class	III	III	II	II	II	III	III
	Status	Slightly Polluted	Slightly Polluted	Clean	Clean	Clean	Slightly Polluted	Slightly Polluted

Note: < means less than the minimum detectable limit or “not detected”

\* means Not SAMM accredited

**Table 6-25 : Water Quality Analysis Results for the Kelantan Segment (cont'd)**

Parameters	Units	Stations							
		WK5A	WK5B	WK6	WK7	WK8	WK9	WK10	WK11
Date	-	8/8/17	8/8/17	8/8/17	8/8/17	9/8/17	8/8/17	9/8/17	9/8/17
Time	-	1555	1440	1249	1227	1303	1032	1131	1103
pH (in-situ reading)	-	5.49	5.56	5.42	5.48	6.21	6.22	6.72	6.62
*Temperature (in-situ reading)	°C	28.9	30.3	30.8	29.9	30.1	29.7	29.8	29.9
Dissolved Oxygen (DO) (in-situ reading)	mg/L	3.11	3.77	3.93	3.34	3.98	3.33	3.94	3.61
Turbidity	NTU	85	68	17	27	20	106	138	97
Biological Oxygen Demand (BOD <sub>5</sub> )	mg/L	2	<2	<2	<2	6	<2	<2	<2
Chemical Oxygen Demand (COD)	mg/L	32	30	19	14	12	9	9	5
Total Suspended Solids (TSS)	mg/L	32	19	8	20	16	114	148	87
Mercury (Hg)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium (Cd)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium hexavalent (Cr <sup>6+</sup> )	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic (As)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cyanide (Cn)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead (Pb)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium Trivalent (Cr <sup>3+</sup> )	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper (Cu)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	0.006	0.005

Parameters	Units	Stations							
		WK5A	WK5B	WK6	WK7	WK8	WK9	WK10	WK11
Manganese (Mn)	mg/L	0.115	0.153	0.005	0.076	0.069	0.186	0.085	0.060
Nickel (Ni)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (Zn)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Iron (Fe)	mg/L	2.88	3.13	1.53	2.11	1.79	7.06	6.29	4.32
Oil and grease (O&G)	mg/L	<1	<1	<1	<1	<1	<1	<1	<1
Ammoniacal Nitrogen (NH <sub>3</sub> -N)	mg/L	0.7	0.8	0.6	0.7	0.3	0.4	0.2	0.2
<i>E.coli</i>	Count /100ml	120	20	50	120	570	440	880	70
Aluminium (Al)	mg/L	2.11	3.03	0.50	0.56	0.40	3.97	2.53	2.51
Selenium (Se)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite (NO <sub>2</sub> )	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate (NO <sub>3</sub> )	mg/L	0.6	0.7	0.7	0.1	0.2	1.0	0.1	1.1
Phosphate (PO <sub>4</sub> )	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Water Quality Index (WQI)	Index	64.71	69.35	72.27	69.66	74.51	70.06	74.44	74.60
	Class	III	III	III	III	III	III	III	III
	Status	Slightly Polluted	Slightly Polluted	Slightly Polluted	Slightly Polluted	Slightly Polluted	Slightly Polluted	Slightly Polluted	Slightly Polluted

Note: < means less than the minimum detectable limit or “not detected”

\* means Not SAMM accredited

### 6.7.3.2 Segment 2 : Selangor

#### Segment 2A: Gombak North to Serendah

The water quality at river crossings along this segment of the proposed alignment in Selangor falls within Class II and is categorized as Clean. The WQI for Sg. Gombak here is 84.91 while Sg. Batu is 82.48. The pH levels ranged from 6.72 to 6.84 while the temperature readings of the water samples were between 27.4 °C and 27.8 °C.

For Sg. Gombak (WS1), the sampling location is within the upstream reaches of the river and is not exposed to many sources of pollution. The sampling result indicates that the river is clean with most parameters within Class I and Class II levels. However, *E.coli* count is slightly high at 3,200 count/100mL. This could be due to the jungle lodges upstream of this point which may be utilizing septic tanks for their sewerage needs.

At Sg. Batu (WS2), the water quality is generally clean except for the ammoniacal nitrogen level recorded was 0.6 mg/L which is Class III. *E.coli* count is very low at this location (18 count/100mL). Pollution occurrences is not expected at this point as it is directly after the spillway of Batu Dam and the water supply intake.

At both stations, almost all the heavy metal parameters were below the minimum detectable level. Heavy metal parameters detected include manganese (Mn) with readings of 0.008 mg/L and 0.057 mg/L, while iron (Fe) recorded concentrations of 0.334 mg/L and 1.02 mg/L. Other water quality parameters assessed were either not detected or detected at very low levels in some samples. The water quality results for this segment are shown in **Table 6-26** while the laboratory results are attached in **Appendix C**.

**Table 6-26 : Water Quality Analysis Results for the Gombak North to Serendah Segment**

Parameters	Units	Stations	
		WS1	WS2
Date	-	14/8/17	14/8/17
Time	-	1251	1156
pH (in-situ reading)	-	6.84	6.72
*Temperature (in-situ reading)	°C	27.4	27.8
Dissolved Oxygen (DO) (in-situ reading)	mg/L	5.11	5.05
Turbidity	NTU	11	20
Biological Oxygen Demand (BOD <sub>5</sub> )	mg/L	<2	2
Chemical Oxygen Demand (COD)	mg/L	5	8
Total Suspended Solids (TSS)	mg/L	6	7
Mercury (Hg)	mg/L	<0.001	<0.001
Cadmium (Cd)	mg/L	<0.005	<0.005
Chromium hexavalent (Cr <sup>6+</sup> )	mg/L	<0.01	<0.01
Arsenic (As)	mg/L	<0.005	<0.005
Cyanide (Cn)	mg/L	<0.02	<0.02
Lead (Pb)	mg/L	<0.01	<0.01
Chromium Trivalent (Cr <sup>3+</sup> )	mg/L	<0.01	<0.01
Copper (Cu)	mg/L	<0.005	<0.005
Manganese (Mn)	mg/L	0.008	0.057
Nickel (Ni)	mg/L	<0.005	<0.005
Zinc (Zn)	mg/L	<0.005	<0.005
Iron (Fe)	mg/L	0.334	1.02
Oil and grease (O&G)	mg/L	<1	<1
Ammoniacal Nitrogen (NH <sub>3</sub> -N)	mg/L	0.3	0.6
<i>E.coli</i>	Count /100ml	3200	18
Aluminium (Al)	mg/L	0.29	0.29
Selenium (Se)	mg/L	<0.01	<0.01
Nitrite (NO <sub>2</sub> )	mg/L	0.1	<0.1
Nitrate (NO <sub>3</sub> )	mg/L	4.2	0.6
Phosphate (PO <sub>4</sub> )	mg/L	<0.1	<0.1
Water Quality Index (WQI)	Index	84.91	82.48
	Class	II	II
	Status	Clean	Clean

Note: < means less than the minimum detectable limit or “not detected”

\* means Not SAMM accredited

## Segment 2B: Serendah to Bandar Puncak Alam

Within this segment, water quality samples were obtained for two river catchments: streams within Sg. Selangor catchment (WS3 to WS13) and one sample from Sg. Buloh (WS14). Generally, the WQI for WS3 to WS13 range from Class II (upstream at Sg. Serendah) to Class III (further downstream at Sg. Selangor). The WQI for WS14 is 43.95 which is Class IV and categorized as Polluted.

### Sg. Selangor (WS3 to WS13)

From the water quality results, the general water quality trend deteriorates from Class II to Class III from the upper tributaries to Sg. Selangor where water supply intakes are located. The major pollutants detected were suspended solids and ammoniacal nitrogen where the highest concentration found were 262 mg/L (WS8) and 2.9 mg/L (WS10) respectively. Currently, the water quality at Sg. Selangor where the raw water intakes are located (WS11 to WS13) is generally within Class III. However, at some stations, suspended solids and ammoniacal nitrogen levels are in Class IV levels.

The potential pollution sources in this area are mostly from land use clearing from forested areas to agriculture land, and from agriculture land to residential and industrial development (e.g. Taman Regensi Rawang, Saujana Techno Park Rawang and Rawang Memorial Park). These activities contribute to the sediment runoff into the rivers. The area also has numerous inland aquaculture activities and plantations (mostly oil palm) which may contribute to the ammoniacal nitrogen and nitrate levels in the receiving streams.

### Sg. Buloh (WS14)

The water quality sampling results for Sg. Buloh at WS14 indicated that the river is polluted with WQI of 43.95 (Class IV). High levels of BOD, COD and Ammoniacal Nitrogen were recorded at 35 mg/L, 74 mg/L and 1.8 mg/L respectively. These are all at Class IV levels. *E.coli* level at the point is also high at 94,000 count/100 mL.

The sampling location is surrounded by oil palm plantations with the nearest built-up areas are approximately 3km south east (Alam Perdana, Bandar Puncak Alam and Kawasan Perindustrian Batu 22). There is a sewage treatment plant (STP) servicing this area about 4 km upstream of this sampling location.

The water quality results for this segment are shown in **Table 6-27** while the laboratory results are attached in **Appendix C**.

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**Table 6-27 : Water Quality Analysis Results for the Serendah to Bandar Puncak Alam Segment**

Parameters	Units	Stations											
		WS3	WS4	WS5	WS6	WS7	WS8	WS9	WS10	WS11	WS12	WS13	WS14
Date	-	11/8/17	11/8/17	11/8/17	11/8/17	11/8/17	11/8/17	11/8/17	10/8/17	10/8/17	10/8/17	10/8/17	10/8/17
Time	-	1619	1549	1441	1244	1133	1204	1024	1404	1313	1228	1128	1045
pH (in-situ reading)	-	7.38	7.22	7.26	7.28	7.26	7.31	6.24	6.48	6.32	6.21	6.32	6.2
*Temperature (in-situ reading)	°C	28.2	28.1	27.4	29.6	29	29.8	28.9	29.9	29.8	29	28.7	29.9
Dissolved Oxygen (DO) (in-situ reading)	mg/L	5.24	5.78	5.23	4.92	4.83	4.83	4.87	4.28	4.07	4.98	4.23	4.12
Turbidity	NTU	16	66	91	56	61	159	88	95	74	114	40	44
Biological Oxygen Demand (BOD <sub>5</sub> )	mg/L	<2	<2	2	3	3	5	<2	9	4	4	2	35
Chemical Oxygen Demand (COD)	mg/L	12	8	8	13	17	28	16	27	18	15	18	74
Total Suspended Solids (TSS)	mg/L	16	54	154	115	118	262	162	228	99	183	39	86
Mercury (Hg)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium (Cd)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium hexavalent (Cr <sup>6+</sup> )	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic (As)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cyanide (Cn)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead (Pb)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium Trivalent (Cr <sup>3+</sup> )	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Parameters	Units	Stations											
		WS3	WS4	WS5	WS6	WS7	WS8	WS9	WS10	WS11	WS12	WS13	WS14
Copper (Cu)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese (Mn)	mg/L	0.008	0.057	0.08	0.052	0.075	0.066	0.073	0.152	0.069	0.089	0.089	0.103
Nickel (Ni)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (Zn)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.018	<0.005	<0.005	<0.005	0.016
Iron (Fe)	mg/L	0.334	1.02	0.595	1.59	3.68	1.8	2.24	5.18	2.86	4.56	1.78	2.7
Oil and grease (O&G)	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ammoniacal Nitrogen (NH <sub>3</sub> -N)	mg/L	0.3	0.6	0.3	0.4	1	1	1	2.9	1.7	1.2	1.2	1.8
<i>E.coli</i>	Count /100 ml	1800	2900	7000	7300	9800	48000	7800	1500	3000	4400	640	94000
Aluminium (Al)	mg/L	0.29	0.29	0.27	1.64	3.91	1.55	2.32	4.02	2.18	4.39	1.58	1.5
Selenium (Se)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite (NO <sub>2</sub> )	mg/L	0.1	<0.1	<0.1	<0.1	0.4	0.7	0.7	0.6	0.3	0.4	0.4	<0.1
Nitrate (NO <sub>3</sub> )	mg/L	4.2	0.6	3	2.5	4.1	4.6	5.2	5.8	4.1	4.2	5.3	1
Phosphate (PO <sub>4</sub> )	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Water Quality Index (WQI)	Index	81.96	78.84	78.79	79.46	73.18	73.20	71.85	55.97	64.38	69.19	71.56	43.95
	Class	II	II	III	III	III	III	III	III	III	III	III	IV
	Status	82.83	82.49	74.96	72.56	71.31	61.94	69.64	55.97	64.38	69.19	71.56	43.95

Note: < means less than the minimum detectable limit or “not detected”

\* means Not SAMM accredited

## Segment 2C: Bandar Puncak Alam to Port Klang

Sampling was carried out for two rivers in this segment where the alignment crosses: Sg. Puloh (WS15) and Sg. Klang (WS16 to WS18). The WQI for both rivers are generally within Class III and categorized as Slightly Polluted. Being close to the downstream reaches, both rivers are tidally affected and brackish in nature. COD concentrations are expected to be higher due to the saline interference.

### Sg. Puloh

For Sg. Puloh, BOD and COD levels are within Class III (4 mg/L and 48 mg/L respectively) while the concentration of suspended solids is relatively low at 32 mg/L. However, the ammoniacal nitrogen level is 2.2 mg/L at Class IV. The surroundings of this sampling location are mostly mangroves. The nearest settlements upstream are Rantau Panjang and Kampung Sementa.

### Sg. Klang

The water quality at the downstream of Sg. Klang is generally Class III however BOD, COD and suspended solids levels are mainly within Class IV while ammoniacal nitrogen levels are at Class V. WS17 is particularly polluted compared to the other two sampling locations at Sg. Klang as it is close to the outfall of Port Klang and Kampung Sireh.

The three monitoring stations had DO levels ranging from 4.88 to 5.01 mg/L. The BOD levels ranged from 6 mg/L to 9 mg/L and COD levels were between 39 mg/L to 52 mg/L. TSS concentrations at the monitoring stations ranged from 230 to 352 mg/L. Turbidity was recorded between 84 and 183 NTU. Ammoniacal nitrogen levels were present between 5.5 mg/L to 8.2 mg/L while *E.coli* concentrations ranged from 56 count/100mL to 4200 count/100ml at the monitoring stations.

Heavy metal parameters detected include manganese (Mn) with readings of between 0.125 to 0.139 mg/L, zinc (Zn) ranging from 0.062 mg/L to 0.188 mg/L and iron (Fe) with readings between 4.59 mg/L to 6.88 mg/L. In Sg. Klang, aluminium (Al) levels were extremely high compared to elsewhere, ranging from 3.68 mg/L to 7.05 mg/L. The water quality results for this segment are shown in **Table 6-28** while the laboratory results are attached in **Appendix C**.

**Table 6-28 : Water Quality Analysis Results for the Serendah to Bandar Puncak Alam Segment**

Parameters	Units	Stations			
		WS15	WS16	WS17	WS18
Date	-	9/8/2017	9/8/2017	9/8/2017	9/8/2017
Time	-	1616	1303	1234	1118
pH (in-situ reading)	-	6.95	6.6	6.38	6.32
*Temperature (in-situ reading)	°C	30.3	31.8	31.2	29.9
Dissolved Oxygen (DO) (in-situ reading)	mg/L	5.13	5.01	4.88	4.96
Turbidity	NTU	21	84	183	87
Biological Oxygen Demand (BOD <sub>5</sub> )	mg/L	4	6	9	7
Chemical Oxygen Demand (COD)	mg/L	48	52	52	39
Total Suspended Solids (TSS)	mg/L	32	230	352	215
Mercury (Hg)	mg/L	<0.001	<0.001	<0.001	<0.001
Cadmium (Cd)	mg/L	<0.005	<0.005	<0.005	<0.005
Chromium hexavalent (Cr <sup>6+</sup> )	mg/L	<0.01	<0.01	<0.01	<0.01
Arsenic (As)	mg/L	<0.005	<0.005	<0.005	<0.005
Cyanide (Cn)	mg/L	<0.02	<0.02	<0.02	<0.02
Lead (Pb)	mg/L	<0.01	<0.01	<0.01	<0.01
Chromium Trivalent (Cr <sup>3+</sup> )	mg/L	<0.01	<0.01	<0.01	<0.01
Copper (Cu)	mg/L	<0.005	<0.005	0.022	0.022
Manganese (Mn)	mg/L	0.053	0.125	0.136	0.139
Nickel (Ni)	mg/L	<0.005	<0.005	<0.005	<0.005
Zinc (Zn)	mg/L	<0.005	0.062	<0.005	<0.005
Iron (Fe)	mg/L	0.237	4.59	0.188	0.079
Oil and grease (O&G)	mg/L	<1	<1	1	<1
Ammoniacal Nitrogen (NH <sub>3</sub> -N)	mg/L	2.2	8.2	7.6	5.5
<i>E.Coli</i>	Count /100ml	40	470	4200	56
Aluminium (Al)	mg/L	0.89	3.68	4.95	7.05
Selenium (Se)	mg/L	<0.01	<0.01	<0.01	<0.01
Nitrite (NO <sub>2</sub> )	mg/L	0.3	0.2	0.1	0.2
Nitrate (NO <sub>3</sub> )	mg/L	1.9	1	0.9	1.3
Phosphate (PO <sub>4</sub> )	mg/L	<0.1	0.3	0.3	0.2
Water Quality Index (WQI)	Index	67.38	55.62	50.89	56.27
	Class	III	III	IV	III
	Status	Slightly polluted	Polluted	Polluted	Polluted

Note: < means less than the minimum detectable limit or “not detected”

\* means Not SAMM accredited

#### 6.7.4 Water Supply

There are two types of water supply schemes found within the vicinity of the project sites. In Kelantan (Segment 1), water supply is dominantly from groundwater sources. For Selangor, water supply are from river water supply intakes which are found within Segment 2A (Gombak to Serendah) and Segment 2B (Serendah – Bandar Puncak Alam).

##### 6.7.4.1 Segment 1 : Kelantan

Water supply in Kelantan is predominantly from groundwater (**Figure 6.7-3**) and has been described in-depth in in **Section 6.3.4.1 Hydrogeology**.

##### 6.7.4.2 Segment 2 : Selangor

###### Segment 2A: Gombak North to Serendah

The alignment at this segment passes downstream of Batu Dam and Sg. Batu water intake. Batu Dam is a flood control and water supply dam constructed under the Kuala Lumpur Flood Mitigation Project in 1987. Water from this dam is extracted, piped and treated at the Sg. Batu Water Treatment Plant, which is located about 1 km from the dam (**Figure 6.7-4**). The treated water is supplied to some parts of Kuala Lumpur for domestic and industrial use. The water supply scheme is currently operated by Pengurusan Air Selangor Sdn. Bhd.

**Table 6-29 : Water Intake Point Downstream of Proposed Alignment Segment 2A**

State	Water Intake Point	Intake River	Coordinates	Capacity (MLD)	Area Served
Selangor	Empangan Batu	Sg. Batu	3°16'05.0"N 101°41'10.0"E	114	Gombak

###### Segment 2B: Serendah to Bandar Puncak Alam

The alignment intersects Sg. Garing and Sg. Kundang, tributaries of Sg. Selangor, at the sections listed below. Sg. Selangor has four water supply intakes: Rantau Panjang Water Intake and Sg. Selangor Phase 1, Phase 2, and Phase 3 (SSP1, SSP2, SSP3) Water Intakes.

These intakes are located about 11 km – 16 km downstream of where the alignment intersects the tributaries of Sungai Selangor (**Figure 6.7-5**). These water supply schemes have a combined treatment capacity of about 2,981.5 MLD in total and supply water to the districts of Hulu Selangor, Gombak, Kuala Selangor and Petaling

(Table 6-30). The water supply schemes in thi area are operated by both Pengurusan Air Selangor Sdn. Bhd. and Syarikat Pengeluar Air Sungai Selangor Sdn Bhd (Splash).

**Table 6-30: Water Intake Point Downstream of Proposed Alignment Segment 2B**

State	Water Intake Point	Intake River	Coordinates	Capacity (MLD)	Area Served
Selangor	Rantau Panjang	Sg. Selangor	3°23'57.74"N 101°26'45.21"E	31.5	Kuala Selangor
	SSP1	Sg. Selangor	3°23'11.00"N 101°25'12.48"E	950.0	Klang Valley, Kuala Selangor, Hulu Selangor
	SSP2	Sg. Selangor	3°23'10.66"N 101°25'18.09"E	950.0	Klang Valley, Kuala Selangor, Hulu Selangor
	SSP3	Sg. Selangor	3°23'21.00"N 101°25'24.85"E	1050.0	Klang Valley, Kuala Selangor, Hulu Selangor

Source: Lembaga Urus Air Selangor

### **Segment 2C: Bandar Puncak Alam to Port Klang**

There are no water supply intakes or schemes found downstream of the proposed alignment between Bandar Puncak Alam to Port Klang.

## **6.7.5 Downstream Fisheries and Aquaculture Activities**

In both Kelantan and Selangor, brackish and freshwater fishing or aquaculture activities are being carried out. Generally, there are two locations for aquaculture activities, which are in the river itself by means of floating cage culture, and off-river where fish/shrimps are reared in excavated ponds or cement tanks. Aquaculture has the potential to meet the demand for fish as well as providing raw material for downstream industries. The location of fishing and aquaculture activities are shown in **Figure 6.7-5** and **Figure 6.7-6**.

### **6.7.5.1 Segment 1 : Kelantan**

There is a number of freshwater aquaculture activities downstream of Sg. Pengkalan Nangka and Sg. Mentua (tributary of Sg. Golok) in Tumpat district. The aquaculture sites along Sg. Peng Nangka are located about 3 km from where the Proposed

Alignment crosses the river at CH. 16800 whereas those along Sg. Golok are located about 1 km from the Proposed Alignment at CH. 24250.

There is also a fishing village, Kampung Pulau Ular, along Sg. Mentua downstream of the alignment. The main type of fish that is cultivated is catfish, specifically keli (*Chlorias batrachus* or *C. macrocephalus*) and patin (*Pangasianodon hypophthalmus*), which are bred in-situ on floating cages. Other types of fish cultivated include tilapia (*Oreochromis mossambicus* or *O. niloticus*), barramundi or siakap (*Lates calcarifer*), and grouper or kerapu (*genus Epinephelinae*) (DOF Kelantan, 2017; pers.comm.). **Tables 6-31 and 6-32** show the list of caged fish breeders in Sg. Pengkalan Nangka and Sg. Mentua respectively, as provided by the Department of Fisheries (DOF) Kelantan.

**Table 6-31 : Caged Freshwater Fish Breeders in Sg. Pengkalan Nangka**

No.	Name	Fish Species	Area (m <sup>2</sup> )	Total no. of squares	Total produce (m/t) year
1	Tg Amat Faisa Tg Arsad	Keli, Patin	1010.75	85	5.323
2	Ehsi A/L Eh Kiu	Keli	285.38	24	2.531
3	Muhd Razali bin Hamid	Keli, Patin	535.05	45	18.819
4	Mat Daud Adam	Keli, Patin, Tilapia	418.05	45	5.633
5	Muhd Nasirudin Mat Daud	Tilapia	297.28	50	2.435
6	Mohamad Abdullah Mohamad	Keli, Patin, Tilapia	95.12	16	2.822
7	Zulkifli Dollah	Keli	195.09	21	2.085
8	Mohd Bustaman bin Yusuf	Keli, Patin, Tilapia	464.5	26	7.734
9	Mohd Razimi Mat Noor	Keli	178.36	15	13.752
10	Mohd Faizal Mat Daud	Tilapia	356.73	60	6.884
11	Razali Dollah	Keli, Patin	353.76	21	3.452
12	Thavi Sak Sirirak A/L Chan	Keli, Patin	130.06	14	- (started 2017)
<b>Total</b>			<b>4320.14</b>	<b>422</b>	<b>71.47</b>

Source: Department of Fisheries Kelantan, 2017

**Table 6-32 : Caged Brackish Water Fish Breeders in Sg. Mentua**

No.	Name	Fish Species	Area (m <sup>2</sup> )	Total no. of squares	Total produce (m/t) year
1	Mazuan bin Mohamad	Siakap	380.89	41	7
2	Klairung A/L Ching Tia*	Siakap	107.02	9	1
3	Yauzi bin Mat*	Siakap	241.54	13	1.5
4	Yusrizal bin Yauzi*	Siakap	130.06	7	1
<b>Total</b>			<b>859.51</b>	<b>70</b>	<b>10.5</b>

\*Inactive breeders Source: Department of Fisheries Kelantan, 2017

### 6.7.5.2 Segment 2 : Selangor

Most of the aquaculture and fishing activities in Selangor are concentrated in Segment 2B, which is between Serendah and Bandar Puncak Alam. The information on the fish breeders are listed in **Table 6-33**. The locations of the fish ponds are mainly provided by Department of Fisheries (DOF) Selangor including unregistered fish ponds. The distance of the fish ponds relative to the alignment was then determined. The main types of freshwater fish that are bred at aquaculture farms along Segments 2A and 2B are *tilapia*, *keli* and *patin* (En. Fariz, DOF Selangor, 2017; *pers. comm.*). The aquaculture farms along Sg. Klang are primarily brackish/saline water fish ponds.

#### Segment 2A: Gombak North to Serendah

There are a few isolated fishing ponds along this segment. Two fish ponds are located southwest of the alignment about 1 km and 4 km away respectively between CH. 8500 and CH. 11200. The alignment directly crosses Serendah Tilapia fish pond and Kay Sha Aquaculture at CH. 20600 and CH. 22100 respectively.

**Table 6-33 : Fish Breeders in Segment 2A**

No.	Name	Type of fish	Area (m <sup>2</sup> )
1	Harun bin Munta	Freshwater	4600
2	Mohd Farid Ab Ghazali	Freshwater	1000
3	Serendah Tilapia	Freshwater	66400
4	Kay Sha Aquaculture	Freshwater	-
<b>Total</b>			<b>72000</b>

Source: Department of Fisheries Selangor, 2017

#### Segment 2B: Serendah to Bandar Puncak Alam

A total of 19 fish ponds were found along this segment. Two of the off-river fish ponds are situated at the upper reaches of Sg. Selangor between 5 km to 10 km downstream of where the alignment intersects the river at CH. 34300. It is known that Kuala Selangor, which is located at the river mouth of Sg. Selangor, plays a significant role in freshwater aquaculture production of fish species such as *keli* (*C. batrachus* or *C. macrocephalus*), *tilapia* (*O. mossambicus* or *O. niloticus*) and *patin* (*P. hypophthalmus*) in the state of Selangor.

The alignment directly crosses parts of the fish ponds of Thai Sang Trading and Koi Plus at CH. 35000 and CH. 35400 respectively. There are also fish ponds in Batu Arang approximately 3 km away from the proposed alignment at CH. 40000 that are part of the Permanent Food Production Park (TKPM) Batu Arang. Two unregistered fish ponds are also found about 1 km away from the alignment at CH. 40700 as well as an unregistered fish pond less than 1 km away from the alignment at CH. 42400.

Table 6-34 : Fish Breeders in Segment 2B

No.	Name	Type of fish	Area (m <sup>2</sup> )
1	Aquaculture Resources Centre (En. Hafiz Nordin)	Freshwater	4200
2	Unregistered	Freshwater	-
3	Lim Peng @ Zin Phang Tai	Freshwater	73000
4	Cheong Yoon Choon	Freshwater	-
5	Yen Aquaculture Sdn. Bhd.	Freshwater	-
6	Lee Yoke Keong	Freshwater	15100
7	Thai Sang Trading (Goh Weng Yew)	Freshwater	-
8	Jaya Ikan Aquatech (Mr. Teh)	Freshwater	23900
9	Koi Plus – Ah San	Ornamental	26100
10	San Sui (Trading) Tropical Fish	Freshwater	-
11	Three Ocean Fish Pond and Trading	Freshwater	-
12	Unknown	Freshwater	12900
13	Zulfita bin Monel (TKPM)	Freshwater	700
14	Mohd Yusof bin Mokhtar (TKPM)	Freshwater	4700
15	Neutral Biotechnology Enterprise	Freshwater	7300
16	Unknown	Freshwater	-
17	Ijok fish pond (unregistered)	Freshwater	-
18	Unregistered fish pond	Freshwater	-
<b>Total</b>			<b>167900</b>

Source: Department of Fisheries Selangor, 2017

**Segment 2C: Bandar Puncak Alam to Port Klang**

There is a brackish/saline water fish pond located along Sg. Klang approximately 2 km downstream of where the alignment intersects the river at CH. 74900. The pond, Kolam Pancing Kampung Delek, caters for fishing enthusiasts who pay an hourly fee to fish for groupers (genus *Epinephelinae*) and snappers (family *Lutjanidae*). There is also a fishing village, Kampung Delek (**Plate 6-18**), next to the fish pond. Another fishing village, Kampung Sg. Udang, is located 3 km upstream of where the alignment intersects the river. Kolam Pancing Wak Ali, a fishing pond located next to the village, breeds two main types of fish i.e. *patin* (*P. hypophthalmus*) and *rohu* (*Labeo rohita*) for either recreation or game fishing.

Towards the river mouth of Sg. Klang about 8.5 km downstream of where the alignment intersects the river is PK Sea Lion Aquaculture Sdn. Bhd. Also known as Kolam Pancing Sea Lion, it is an enclosed fishing park containing various saltwater fish species such as pomfret (family *Bramidae*), red seabream (family *Sparidae*), barramundi, groupers and golden snapper. The park attracts recreationists who pay hourly fees to fish. The operator also harvests the saltwater fish themselves.

There are two fishing villages situated along Sungai Puloh namely Pengkalan Nelayan Rantau Panjang and Pengkalan Sayang. The villages are located about 1 km upstream from where the alignment intersects the river.



Plate 6-18 : Jetty at Kg. Delek.

## 6.7.6 Irrigation Scheme

### 6.7.6.1 Segment 1: Kelantan

In Kelantan, the Kemubu irrigation scheme covers approximately 31,464 ha under the jurisdiction of KADA (Kemubu Agriculture Development Authority) and comprises 5 sub-areas located in the northern part of Kelantan (**Table 6-35**). Water supply for the irrigation areas is provided by pumping from Sg. Kelantan. The proposed alignment will predominantly traverse through the irrigation scheme in Pasir Mas, Sg. Lemal and Alor Pasir (**Figure 6.7-7**).

**Table 6-35: Sub-scheme of Kemubu Irrigation Scheme**

Sub-area	Source of water
Kemubu	Sg. Kelantan
Salor	Sg. Kelantan
Pasir Mas	Sg. Kelantan
Sg. Lemal	Sg. Kelantan
AlorPasir	Sg. Kelantan

Source: Review of the National Water Resources Study (2020-2050)

#### **6.7.6.2 Segment 2 : Selangor**

The alignment will not traverse any irrigation schemes in Selangor. There is only one granary area in Selangor, the Barat Laut Selangor (BLS) Irrigation Scheme managed by Integrated Agriculture Development Area (IADA) and is located about 37 km northwest from the proposed alignment.

#### **6.7.7 Recreation**

Apart from fishing, other recreational activities such as swimming in natural pools and hiking to waterfalls occur in amenity/recreational forests.

##### **6.7.7.1 Segment 1 : Kelantan**

There are no recreational water uses downstream of the proposed alignment in the state of Kelantan.

##### **6.7.7.2 Segment 2 : Selangor**

###### **Segment 2A: Gombak North to Serendah**

Templer Park is an 817 ha forest reserve in Rawang, Gombak district. It is located north of Batu Caves and about 20 km from central Kuala Lumpur. There are multi-tiered waterfalls, jungle streams and trails in the Park (**Figure 6.7-8**). The Templer Falls is situated within the Templer Forest Reserve about 2 km from the main entrance of Templer Park. The waterfall, which is at 195 meters above sea level, is located approximately 241 meters downstream of the Proposed Alignment at CH. 12000 where the alignment at this section will be tunneled. There is also a 'swimming pool' that is filled with river water along the trail to the waterfall, about 550 meters from the main entrance of the Park. There are also two reservoirs along the trail as well as a water storage tank, Kolam Rehang, within the area.

Another nearby waterfall attraction is situated in the Kanching Recreational Forest, which is a 500-ha forest reserve located approximately 3 km northeast of Templer Park. There is a series of seven waterfalls collectively known as Kanching Falls with the highest waterfall situated at about 140 meters above sea level. This waterfall is located approximately 1.85 km downstream of the Proposed Alignment at CH. 15500 and this section of the alignment is tunneled. The recreational activities are similar to that at Templer Park with hiking to the waterfalls and swimming in streams or natural pools being the main attractions.



**Plate 6-19 : Waterfall in Kanching Recreational Forest**

### **Segment 2B: Serendah to Bandar Puncak Alam**

There are no recreational activities involving water use downstream of the Proposed Alignment between Serendah and Bandar Puncak Alam.

### **Segment 2C: Bandar Puncak Alam to Port Klang**

There are no recreational activities involving water use downstream of the Proposed Alignment between Bandar Puncak Alam to Port Klang.

## **6.8 AIR QUALITY**

### **6.8.1 Approach & Methodology**

Ambient air quality monitoring was conducted by a SAMM's accredited lab from 7<sup>th</sup> August 2017 to 10<sup>th</sup> August 2017. The monitoring was conducted to establish the baseline ambient air quality prior to the construction and operation of the Project.

The monitoring was carried out for six pollutants, namely particulate matter less than 10 microns (PM<sub>10</sub>), particulate matter less than 2.5 microns (PM<sub>2.5</sub>), Sulphur Dioxide (SO<sub>2</sub>), Nitrogen Dioxide (NO<sub>2</sub>), Carbon Monoxide (CO) and Ozone (O<sub>3</sub>). In addition, wind measurements were taken to determine the wind direction and wind speed during the monitoring period.

The detailed description of the methodology is given in **Appendix C**.

**Table 6-36 : Air Quality Parameters and Monitoring Methods**

Parameters	Measurement Unit	Sampling Duration	Method
Particulate Matter (PM <sub>10</sub> )	µg/m <sup>3</sup>	24-Hour	ASTM D4096, 1993
Particulate Matter (PM <sub>2.5</sub> )	µg/m <sup>3</sup>	24-Hour	MiniVol™ TAS Sampler
Sulphur Dioxide (SO <sub>2</sub> )	µg/m <sup>3</sup>	24-Hour	ASTM D2914, 1993
Nitrogen Dioxide (NO <sub>2</sub> )	µg/m <sup>3</sup>	1-Hour/24-Hour	ASTM D1607, 1991
Carbon Monoxide (CO)	mg/m <sup>3</sup>	8-Hour	ASTM D4599-14
Ozone (O <sub>3</sub> )	µg/m <sup>3</sup>	8-Hour	ISC 411
Wind Measurement (direction and velocity)	m/s	24-Hour	Automatic Wind Sensor

## 6.8.2 Monitoring Locations

The ambient air monitoring was carried out at 12 locations in Kelantan and Selangor (Table 6-17, Figure 6.7-1a to Figure 6.7-2f). The monitoring locations were selected based on the proximity of air sensitive receptors (ASRs) to the stations which are deemed to be the most prominent areas to be potentially affected from the construction activities.

**Table 6-37 : Locations of Ambient Air Quality Monitoring Points**

No.	Station	Description	Coordinates
<b>Kelantan</b>			
1.	A1	Kg. Teliar	N 06°06'44.48" E 102°10'56.52"
2.	A2	Kg. Talak	N 06°08'58.16" E 102°09'15.48"
3.	A3	Kg. Mentua	N 06°13'03.08" E 102°05'32.86"
<b>Selangor</b>			
4.	A4	Taman Jasa	N 03°16'15.64" E 101°40'55.41"
5.	A5	Taman Desa Kiambang	N 03°21'55.90" E 101°35'28.91"
6.	A6	Taman Anugerah Suria	N 03°21'45.22" E 101°34'04.09"
7.	A7	Saujana Rawang	N 03°20'37.62" E 101°30'30.04"
8.	A8	Batu Arang	N 03°18'28.36" E 101°28'30.95"
9.	A9	Bandar Baru Puncak Alam	N 03°14'25.15" E 101°24'22.29"
10.	A10	Taman Kapar Setia	N 03°08'02.67" E 101°23'38.23"
11.	A11	Kg. Sementa	N 03°05'0.97" E 101°23'19.40"
12.	A12	Sri Perantau Apartment	N 03°0'52.32" E 101°24'04.83"

### 6.8.3 Monitoring Results

The monitoring results are tabulated in **Table 6-38** and compared against the Malaysian Ambient Air Quality Standard (MAAQS) 2013, Interim Target 1 (IT-1), 2015. Discussions of the results for the respective segment can be referred in the following sub-section.

**Table 6-38 : Baseline Ambient Air Quality Results**

No.	Point	Location	Parameter (µg/m <sup>3</sup> )					
			PM <sub>10</sub>	PM <sub>2.5</sub>	SO <sub>2</sub>	NO <sub>2</sub>	CO*	O <sub>3</sub>
Kelantan								
1.	A1	Kg. Teliar	36	17	<5	<5	<0.5	<20
2.	A2	Kg. Talak	42	25	<5	<5	0.7	<20
3.	A3	Kg. Mentua	43	25	<5	<5	<0.5	<20
Selangor								
4.	A4	Taman Jasa	54	27	<5	<5	<0.5	<20
5.	A5	Taman Desa Kiambang	62	39	<5	<5	0.7	<20
6.	A6	Taman Anugerah Suria	58	27	<5	<5	<0.5	<20
7.	A7	Saujana Rawang	46	19	<5	<5	<0.5	<20
8.	A8	Batu Arang	25	12	<5	<5	<0.5	<20
9.	A9	Bandar Baru Puncak Alam	48	16	<5	<5 <sup>#</sup>	0.7	<20
10.	A10	Taman Kapar Setia	53	29	<5	21 <sup>#</sup>	0.7	<20
11.	A11	Kg. Sementa	38	18	<5	<5 <sup>#</sup>	0.7	<20
12.	A12	Sri Perantau Apartment	36	14	<5	<5 <sup>#</sup>	0.7	<20
IT-1 (2015) of MAAQS			150	75	105	320/75 <sup>#</sup>	10	120
IT-2 (2018) of MAAQS			120	50	90	300/75 <sup>#</sup>	10	120
Standard (2020) of MAAQS			100	35	80	280/70 <sup>#</sup>	10	100

Notes:

\* CO reading in  $\text{mg}/\text{m}^3$

<sup>#</sup> means 24-hour averaging period

#### 6.8.3.1 Segment 1 : Kelantan

Ambient air quality monitoring results for the three (3) locations within the Kelantan segment (A1 to A3) are summarised as follows:

- PM<sub>10</sub> readings ranged from 36 to 43  $\mu\text{g}/\text{m}^3$ , with the highest concentrations recorded at point A3 (Kg. Mentua).
- PM<sub>2.5</sub> readings ranged from 17 to 25  $\mu\text{g}/\text{m}^3$ , with the highest concentrations recorded at both point A2 (Kg. Talak) and A3 (Kg. Mentua).
- SO<sub>2</sub> and NO<sub>2</sub> were below the detection limit (<5  $\mu\text{g}/\text{m}^3$ ).
- CO was recorded at A2 (0.7  $\text{mg}/\text{m}^3$ ).

- $O_3$  was below the detection limit ( $<20 \mu\text{g}/\text{m}^3$ ).
- Concentrations of all parameters were well below the stipulated limits of IT-1 (2015) of the MAAQS throughout the monitoring period.

#### 6.8.3.2 Segment 2 : Selangor

Ambient air quality monitoring results for nine (9) locations within the Selangor segment (A4 to A12) are summarised as follows:

- $PM_{10}$  readings ranged from 25 to  $62 \mu\text{g}/\text{m}^3$ , with the highest concentrations recorded at point A5 (Taman Desa Kiambang).
- $PM_{2.5}$  readings ranged from 12 to  $39 \mu\text{g}/\text{m}^3$ , with the highest concentrations recorded at point A5 (Taman Desa Kiambang).
- $SO_2$  readings were below the detection limit ( $<5 \mu\text{g}/\text{m}^3$ ).
- $NO_2$  readings were below the detection limit ( $<5 \mu\text{g}/\text{m}^3$ ) at all locations except at A10 (Taman Kapar Setia) where a concentration of  $21 \mu\text{g}/\text{m}^3$  was recorded.
- CO was below the detection limit ( $<0.5 \text{mg}/\text{m}^3$ ) at all locations except for A5 (Taman Desa Kiambang), A9 (Bandar Baru Puncak Alam), A10 (Taman Kapar Setia), A11 (Kg. Sementa) and A12 (Sri Perantau Apartment), where concentrations of  $0.7 \text{mg}/\text{m}^3$  were detected.
- $O_3$  was below the detection limit ( $<20 \mu\text{g}/\text{m}^3$ ).
- Concentrations of all parameters during the monitoring period were well below the stipulated limits of IT-1 (2015) of MAAQS.

#### 6.8.3.3 Summary

Generally, the ambient air quality at the monitoring locations during the monitoring period was below the stipulated limit of IT-2 (2015) of the MAAQS. The concentrations of two pollutants, i.e.  $SO_2$  and  $O_3$  were recorded below the detection limits of  $<5 \mu\text{g}/\text{m}^3$  and  $<20 \mu\text{g}/\text{m}^3$  respectively at all monitoring locations.

### 6.9 NOISE

The assessment of any potential noise and vibration impact requires the existing noise and vibration conditions to be quantified. Baseline noise and vibration monitoring were undertaken in this EIA to be used as a basis of assessment. The baseline monitoring locations were selected based on the latest alignment made available at the time of this EIA.

### 6.9.1 Approach & Methodology

Locations of the baseline monitoring were identified from aerial and site review of likely sensitive receptors that may be affected by the proposed railway alignment.

Measurement locations were typically residential and other sensitive institutional buildings (schools, education, hospitals) and places of worship that were in reasonably proximity (typically less than 100m) of the alignment. Monitoring locations were identified amongst populated areas (townships and semi-urban). There were nevertheless monitoring done in rural areas when the alignment passes through villages (kampungs, etc.).

Within the towns and residential estates, monitoring locations were selected on the basis on the nearest receptors to the railway corridor, and were deemed representative of receptors that may be affected by the train operations at that residential community.

The baseline monitoring was undertaken for 41 locations along the alignment. The monitoring locations with the respective GPS coordinates are tabulated in **Table 6-39 to Table 6-42** below. Locations of the monitoring points are shown in **Figure 6.7-1 to Figure 6.7-2f**.

Standards and Guidelines applicable for environmental noise and vibration measurements were:

- ISO 1996 Part 1, 1982 / BS 7445 Part 1, 1991: *Description and measurement of environmental noise – Part 1: Guide to quantities and procedures*;
- BS 6472: 1992: *Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*;
- *Guidelines for Environmental Noise Limits and Control*, DOE (2007);
- *Guidelines for Environmental Vibration Limits and Control*, DOE (2007).

Instruments used for the noise measurements were:

- 4 units of 01dB DUO smart noise monitors, fitted with a weatherproof outdoor 12mm pre-polarized GRAS type 40CD microphone;
- Bruel & Kjaer Type 4230 sound level calibrator;
- 2 units GeoSIG GMSPlus vibration data logger fitted with seismic transducers; and
- Rion VE-10 vibration level calibrator.

The noise and vibration monitoring devices were field calibrated prior to and

after the monitoring with the respective calibrators.

The 01dB DUO smart noise monitor is a proprietary purpose built permanent noise monitoring device intended for long term automated outdoor all-weather noise monitoring over extended period under all weather conditions. The 01dB DUO smart noise monitor is a Type 1 precision class instrument in accordance to requirements of DOE Noise Guidelines for authority compliance measurements. It is certified to IEC 61672-1 Class 1, specifications including windscreen effects (for both reference directions 0 degrees and 90 degrees); and conforms to IEC 60651 Type 1, IEC 60804 Type 1.

The monitoring unit have self-monitoring capabilities with automated data storage with on-board memory and automatic downloading of data and data transmission. The microphone is waterproof and have a self-checking system. The GeoSIG GMSPlus is a dedicated seismic vibration measurement system for long term vibration monitoring of ground borne vibrations fitted with seismic transducers for on-site data recording. Vibration transducers conformed to IEC Publication 184, and auxiliary equipment (amplifiers, frequency selective equipment and carrier systems) to IEC Publication 222 in accordance to DOE Vibration Guidelines for authority compliance measurements.

These data loggers continuously sampled peak particle velocities in three directions with reporting of vibration time histories as well as peak vibration events frequency response reporting. The vibration measurement set up was calibrated in the laboratory using vibration excitation setup checked against a vibration level calibrator.

Noise monitoring involved continuous 24-hours noise measurements from 0700 hours to 0700 hours of the following day using the permanent smart noise monitoring devices. Noise data were continuously logged in one (1) second increments over 24 hours, with high noise events automatically recorded for audio playback used for identification of high noise events and/or sources. Data were retrieved for off-site data reduction and analysis. The noise monitoring unit was set for statistical measurements to obtain the  $L_{Aeq}$  (equivalent continuous A weighted sound pressure levels), statistical ninety percentile level  $L_{90}$  (sound pressure levels exceeded for ninety percent of the time), and statistical ten percentile level  $L_{10}$  (sound pressure levels exceeded for ten percent of the time), and instantaneous maximum  $L_{max}$  levels. The noise monitoring unit was installed onto a secure fixture (typically lamp post or suitable elevated exposed structure) for outdoor monitoring.

Noise levels were reported for hourly  $L_{eq}$ ,  $L_{90}$  and  $L_{10}$  levels to provide 24 hours' description of the noise climate. Day and night time equivalent continuous levels  $L_{Aeq}$  and  $L_{90}$  and  $L_{10}$  noise are reported. The measured hourly  $L_{eq}$ ,  $L_{90}$  and  $L_{10}$  levels gave a continuous 24 hours' description of the existing noise climate.

$L_{10}$ ,  $L_{90}$  are statistical percentile levels - where the ninety percentile  $L_{90}$  is sound pressure levels that are exceeded for ninety percent of the time and the ten-percentile level  $L_{10}$  are levels that are exceeded for ten percent of the time.

Measured noise levels as plotted over the 24 hours monitoring period are presented in the Field Measurement Report, **Appendix C**. The measured hourly overall noise levels ( $L_{eq \text{ 1hr}}$ ,  $L_{10 \text{ 1hr}}$ ,  $L_{90 \text{ 1hr}}$ ) are tabulated in the Field Measurement Report, **Appendix C**.

Summary results of the measured baseline noise levels are tabulated in **Table 6-36** below. These baseline noise levels were then assessed against recommended DOE Acceptance Limits for railways and urban transits based on the respective receiving land use, Schedule 5 of the DOE Planning Guidelines for Environmental Noise Limits and Control.

Measured day time equivalent noise level,  $L_{eq \text{ Day}}$  in urban areas with relatively high road traffic and/or in close vicinity to busy roads had existing noise levels were typically above recommended limits of 65 dBA  $L_{eq \text{ day}}$ , and 60 dBA  $L_{eq \text{ night}}$ . At low density and rural areas, noise levels were typically in the low 60 dBA day and below 60 dBA night. The recommended limits for low density residential and sensitive areas based on Schedule 5 is 60 dBA  $L_{eq \text{ day}}$ , and 50 dBA  $L_{eq \text{ night}}$ .

Noise levels in the some of the sub-urban and low-density areas at the above-mentioned townships had baseline levels above the Schedule 5 recommended limits for low density residential areas.

## 6.9.2 Monitoring Locations

### 6.9.2.1 Segment 1 : Kelantan

The baseline noise monitoring was carried out at 15 locations in Kelantan (**Table 6-39**, **Figure 6.7-1a-c**).

**Table 6-39 : Noise Monitoring Locations**

Ref.	Location	GPS Location		Measurement Date
NVK 01	Houses at Jalan Salor Pasir Mas	6.06582	102.22514	27 - 28 Aug 2017
NVK 02	Houses at Kg Tendong, Pasir Mas	6.06834	102.21680	27 - 28 Aug 2017
NVK 03	Houses at Kg Pandang Embong, Pasir Mas	6.08580	102.19869	20 - 21 Aug 2017
NVK 04	Houses at Kg. Alor Durian, Wakaf Bharu	6.10007	102.19163	20 - 21 Aug 2017
NVK 05	Houses at Kg. Lati, Wakaf Bharu	6.13063	102.17481	21 - 22 Aug 2017
NVK 06	Houses at Kg Kubang Batang, Wakaf Bharu	6.11221	102.18307	21 - 22 Aug 2017
NVK 07	Houses at Kg Bendang, Wakaf Bharu	6.14282	102.16265	22 - 23 Aug 2017
NVK 08	Houses at Jalan Taliair, Kubang Batang	6.14980	102.15515	22 - 23 Aug 2017
NVK 09	Houses at Jalan Kota Bharu - Pengkalan Kubor	6.15966	102.14782	23 - 24 Aug 2017
NVK 10	Houses at Kg Teluk, Tumpat	6.16874	102.13983	28 - 29 Aug 2017
NVK 11	Terrace houses at Jalan Kg Nechang, Telaga Bata	6.17520	102.13353	23 - 24 Aug 2017
NVK 12	Houses at Taman Sri Neting 2, Kg Pauh Sebanjan	6.19955	102.10376	24 - 25 Aug 2017
NVK12a	Houses at Kg Kok Semru, Pengkalan Kubor	6.203223	102.10545	23 - 24 Aug 2017
NVK 13	Houses at Kg Ketil, Pengkalan Kubor	6.22018	102.09407	24 - 25 Aug 2017
NVK13a	Houses at Kg Seri Serkong, Pengkalan Kubor	6.21586	102.09050	22 - 23 Aug 2017

### 6.9.2.2 Segment 2 : Selangor

#### Segment 2A: Gombak North to Serendah

The baseline noise monitoring in Segment 2A was carried out at 5 locations (**Table 6-40, Figure 6.7-2a to Figure 6.7-2b**).

**Table 6-40 : Noise Monitoring Locations**

Ref.	Location	GPS Location		Measurement Date
NVS 01	Terrace house at Jalan BP 11, Taman Bukit Permata, Batu Caves	3.26447	101.70200	29 - 30 Aug 2017
NVS 02	Terrace houses at Jalan Jasa Utama 14, Taman Jasa Utama, Batu Caves	3.27211	101.68338	29 - 30 Aug 2017
NVS2a	Terrace houses at persiaran Jasa Utama, Gombak	3.27041	101.68170	9 - 10 Oct 2017
NVS2b	Apartment Jalan Jasa Perwira, Gombak	3.27152	101.67949	9 - 10 Oct 2017
NVS 03	Apartment Templer Impian, Jalan Bukit Anak Tukun	3.30268	101.64420	11 - 12 Sept 2017

## Segment 2B: Serendah to Bandar Puncak Alam

The baseline noise monitoring in Segment 2B was carried out at 12 locations (**Table 6-41, Figure 6.7-2c to Figure 6.7-2d**).

**Table 6-41 : Noise Monitoring Locations**

Ref.	Location	GPS Location		Measurement Date
NVS 04	Terrace houses at Taman Desa Kiambang	3.37003	101.60953	19 - 20 Aug 2017
NVS4a	Terrace at Jalan Bunga Simpuh Air 5, Serendah	3.35810	101.60649	9 - 10 Oct 2017
NVS4b	Sri Selva temple, Serendah	3.36636	101.60407	9 - 10 Oct 2017
NVS 05	Terrace houses at Jalan Melati 2b, Taman Melati	3.36775	101.60170	28 - 29 Aug 2017
NVS 06	Houses at Taman Tok Pinang, Serendah	3.36607	101.59573	19 - 20 Aug 2017
NVS 07	Terrace houses at Lorong Dua, Serendah	3.36480	101.59185	28 - 29 Aug 2017
NVS 08	Terrace houses at Jalan Teratai 10, Serendah	3.36682	101.56640	12 - 13 Sept 2017
NVS 09	Houses at Jalan Bunga Raya 3, Serendah	3.36588	101.56011	17 - 18 Aug 2017
NVS 10	Terrace at Taman Saujana Rawang, Rawang	3.34393	101.50824	11 - 12 Sept 2017
NVS10a	M Residence, Jalan Tasik Puteri Rawang	3.31970	101.50256	10 - 11 Sept 2017
NVS 11	Terrace houses at Jalan Batu Arang	3.30721	101.47470	11 - 12 Sept 2017
NVS 12	Terrace houses at Taman Alam Suria	3.23955	101.40534	17 - 18 Aug 2017

## Segment 2C: Bandar Puncak Alam to Port Klang

The baseline noise monitoring in Segment 2B was carried out at 9 locations (**Table 6-42, Figure 6.7-2e to Figure 6.7-2f**).

**Table 6-42 : Noise Monitoring Locations**

Ref.	Location	GPS Location		Measurement Date
NVS 13	Terrace houses at Jalan Kapar Setia 1, Taman Kapar Setia	3.13351	101.39407	9 - 10 Aug 2017
NVS 14	House at Kampung Sementa, Klang	3.08206	101.38766	14 - 15 Aug 2017
NVS 15	Houses at Jalan Sungai Saim, Klang	3.05348	101.38959	15 - 16 Aug 2017
NVS 16	Terrace houses at Lor Haji Taha, Taman Sri Delek, Klang	3.03201	101.39622	9 - 10 Aug 2017
NVS 17	Terrace houses at Lor Haji Ariffin, Klang	3.02673	101.40724	9 - 10 Aug 2017
NVS 18	Terrace houses at Jalan Sireh Pinang	3.02160	101.40907	8 - 9 Aug 2017
NVS 19	Houses at Jalan Sungai Sireh 1, Klang	3.01826	101.40550	9 - 10 Aug 2017
NVS 20	Sri Perantau Apartment, Kawasan 14, Klang	3.01464	101.40199	8 - 9 Aug 2017
NVS 21	Terrace house at Lorong Bunga Siantan, Klang	3.01218	101.39938	7 - 8 August 2017

## 6.9.3 Monitoring Results

### 6.9.3.1 Segment 1 : Kelantan

**Table 6-43 : Summary of Measured Baseline Noise Levels in Kelantan**

Ref.	Location	Time	L <sub>eq</sub>	L <sub>10</sub>	L <sub>90</sub>	L <sub>max</sub>	Range
NVK 01	Houses at Jalan Salor Pasir Mas	24 Hr	57.4	59.1	53.6	72.0	- 80.0
		Day	57.2	59.3	51.7	69.3	- 78.9
		Night	57.8	58.7	55.5	64.8	- 83.3
NVK 02	Houses at Kg Tendong, Pasir Mas	24 Hr	57.2	59.9	43.7	75.7	- 86.2
		Day	58.9	61.7	44.8	78.0	- 90.2
		Night	50.6	51.9	41.0	63.3	- 81.8
NVK 03	Houses at Kg Pandang Embong, Pasir Mas	24 Hr	59.8	62.6	48.1	69.8	- 93.7
		Day	61.0	63.9	45.5	76.4	- 80.6
		Night	56.3	58.9	50.5	66.4	- 89.3
NVK 04	Houses at Kg. Alor Durian, Wakaf Bharu	24 Hr	52.5	54.4	46.8	69.9	- 82.6
		Day	53.6	55.8	46.2	71.5	- 75.0
		Night	49.5	50.5	47.7	57.0	- 83.2
NVK 05	Houses at Kg. Lati, Wakaf Bharu	24 Hr	55.7	57.3	49.0	73.6	- 83.7
		Day	56.2	58.0	43.5	76.1	- 82.2
		Night	54.7	55.7	52.5	63.7	- 78.8
NVK 06	Houses at Kg Kubang Batang, Wakaf Bharu	24 Hr	53.9	55.2	50.2	69.4	- 85.8
		Day	53.0	54.4	47.1	67.5	- 72.5
		Night	55.0	56.3	52.8	59.2	- 69.5
NVK 07	Houses at Kg Bendang, Wakaf Bharu	24 Hr	57.2	59.9	43.7	75.7	- 86.2
		Day	58.9	61.7	44.8	78.0	- 90.2
		Night	50.6	51.9	41.0	63.3	- 81.8
NVK 08	Houses at Jalan Taliair Kubang Batang	24 Hr	63.4	64.6	61.4	65.9	- 78.8
		Day	59.1	60.8	56.5	69.0	- 69.5
		Night	66.5	67.6	64.7	66.0	- 82.9
NVK 09	Houses at Jalan Kota Bharu - Pengkalan Kubor	24 Hr	59.8	62.2	51.7	74.6	- 89.2
		Day	60.9	63.3	51.2	75.6	- 84.5
		Night	57.0	59.1	52.3	71.9	- 79.0
NVK 10	Houses at Kg Teluk, Tumpat	24 Hr	57.5	60.7	48.4	66.0	- 96.2
		Day	58.1	60.8	46.2	74.9	- 79.9
		Night	56.3	60.4	50.6	70.0	- 89.2
NVK 11	Terrace houses at Jalan Kg Nechang, Telaga Bata	24 Hr	59.5	61.2	55.8	63.1	- 92.3
		Day	57.0	59.1	50.9	64.9	- 73.8
		Night	61.9	63.4	59.1	64.0	- 72.6

**Table 6-43 : Summary of Measured Baseline Noise Levels in Kelantan (Cont'd)**

Ref.	Location	Time	L <sub>eq</sub>	L <sub>10</sub>	L <sub>90</sub>	L <sub>max</sub>	Range
NVK 12	Houses at Taman Sri Neting 2, Kg Pauh Sebanjan	24 Hr	66.4	70.4	52.5	71.0	- 87.7
		Day	68.3	72.4	52.1	70.5	- 100.8
		Night	55.8	57.7	53.1	58.2	- 75.9
NVK 13a	Houses at Kg Kok Semru, Pengkalan Kubor	24 Hr	57.5	60.7	48.4	66.0	- 96.2
		Day	58.1	60.8	46.2	74.9	- 79.9
		Night	56.3	60.4	50.6	70.0	- 89.2
NVK 13	Houses at Kg Ketil, Pengkalan Kubor	24 Hr	61.8	63.3	58.6	65.2	- 81.9
		Day	58.2	60.2	50.9	77.4	- 96.1
		Night	64.7	65.9	62.4	64.0	- 74.9
NVK 13b	Houses at Kg Seri Serkong, Pengkalan Kubor	24 Hr	57.5	60.7	48.4	66.0	- 96.2
		Day	58.1	60.8	46.2	74.9	- 79.9
		Night	56.3	60.4	50.6	70.0	- 89.2

### 6.9.3.2 Segment 2 : Selangor

#### Segment 2A: Gombak North to Serendah

**Table 6-44 : Summary of Measured Baseline Noise Levels in Segment 2A**

Ref.	Location	Time	L <sub>eq</sub>	L <sub>10</sub>	L <sub>90</sub>	L <sub>max</sub>	Range
NVS 01	Terrace at Jalan BP 11, Taman Bukit Permata, Batu Caves	24 Hr	51.8	54.0	45.2	66.2	- 83.7
		Day	52.9	55.0	45.5	64.8	- 84.1
		Night	48.9	51.6	44.5	47.7	- 80.4
NVS 02	Jalan Jasa Utama, Taman Jasa Utama Gombak	24 Hr	53.4	56.8	42.3	64.5	- 84.1
		Day	55.2	58.6	42.9	65.1	- 82.0
		Night	44.6	47.3	41.1	48.9	- 77.1
NVS 02a	Terrace houses at persiaran Jasa Utama, Gombak	24 Hr	62.4	65.7	45.9	69.3	- 90.6
		Day	62.9	65.8	46.2	77.5	- 90.6
		Night	60.3	64.7	40.8	69.3	- 85.0
NVS 02b	Apartment Jalan Jasa Perwira, Gombak	24 Hr	54.4	55.5	44.1	52.8	- 84.0
		Day	55.5	56.7	45.4	68.5	- 84.0
		Night	51.8	51.9	40.6	52.8	- 78.0
NVS 03	Apt Templer Impian, Jalan Bukit Anak Tukun	24 Hr	51.2	52.4	46.5	55.8	- 74.5
		Day	51.2	52.4	46.5	66.9	- 74.5
		Night	45.9	47.7	41.9	55.8	- 73.8

## Segment 2B: Serendah to Bandar Puncak Alam

**Table 6-45 : Summary of Measured Baseline Noise Levels in Segment 2B**

Ref.	Location	Time	L <sub>eq</sub>	L <sub>10</sub>	L <sub>90</sub>	L <sub>max</sub>	Range
NVS 04	Terrace houses at Jalan Kiambang 3, Taman Desa Kiambang	24 Hr	54.2	56.7	41.1	69.2	- 80.8
		Day	55.7	58.0	41.8	68.5	- 82.5
		Night	48.4	52.9	39.7	68.2	- 78.7
NVS 04a	Terrace at Jalan Bunga Simpuh Air 5, Serendah	24 Hr	56.0	58.0	45.8	68.6	- 84.4
		Day	56.9	60.0	48.0	71.8	- 84.0
		Night	52.9	55.0	42.0	66.1	- 85.0
NVS 04b	Sri Selva temple, Serendah	24 Hr	62.8	65.1	53.2	73.3	- 98.9
		Day	64.2	66.5	54.8	75.5	- 98.9
		Night	58.4	61.0	46.6	73.3	- 83.3
NVS 05	Terrace at Jalan Melati 2b, Taman Melati	24 Hr	63.9	67.7	50.1	67.7	- 90.5
		Day	65.8	69.6	51.6	76.7	- 83.8
		Night	53.5	56.0	45.1	58.8	- 76.9
NVS 06	Houses at Taman Tok Pinang, Serendah	24 Hr	59.8	62.5	48.5	79.6	- 88.6
		Day	59.9	61.8	46.1	78.9	- 81.8
		Night	59.6	63.4	50.8	71.1	- 86.4
NVS 07	Terrace houses at Lorong Dua, Serendah	24 Hr	67.8	69.7	57.2	83.5	- 90.1
		Day	69.1	71.2	58.8	87.0	- 89.2
		Night	63.9	64.8	51.2	73.3	- 87.9
NVS 08	Terrace houses at Jalan Teratai 10, Serendah	24 Hr	54.4	55.5	43.8	70.6	- 86.2
		Day	56.0	56.7	44.5	77.1	- 92.6
		Night	49.1	52.2	42.3	66.9	- 77.6
NVS 09	Houses at Jalan Bunga Raya 3, Serendah	24 Hr	49.4	53.3	45.0	56.7	- 65.3
		Day	50.9	55.1	45.9	54.2	- 64.2
		Night	44.9	46.1	42.7	46.2	- 54.9
NVS 10	Terrace at Taman Saujana Rawang, Rawang	24 Hr	49.9	51.8	40.1	62.9	- 79.4
		Day	51.3	53.2	40.8	66.6	- 76.7
		Night	45.3	46.9	38.6	54.3	- 76.8
NVS 10a	M Residence, Jalan Tasik Puteri, Rawang	24 Hr	57.1	58.4	53.3	67.2	- 84.3
		Day	56.8	58.0	53.0	76.5	- 85.0
		Night	53.0	58.1	52.3	62.8	- 79.3
NVS 11	Terrace houses at Jalan Batu Arang	24 Hr	48.7	51.8	41.4	63.2	- 79.1
		Day	49.8	51.4	41.9	61.1	- 76.5
		Night	45.7	52.5	40.5	54.9	- 86.1
NVS 12	Terrace houses at Taman Alam Suria, Puncak Alam	24 Hr	49.5	53.3	45.0	56.7	- 65.3
		Day	51.0	55.1	45.9	54.2	- 64.2
		Night	44.9	46.1	42.7	46.2	- 54.9

## Segment 2C: Bandar Puncak Alam to Port Klang

**Table 6-46: Summary of Measured Baseline Noise Levels in Segment 2C**

Ref.	Location	Time	L <sub>eq</sub>	L <sub>10</sub>	L <sub>90</sub>	L <sub>max</sub>	Range
NVS 13	Terrace at Jalan Kapar Setia 1, Taman Kapar Setia	24 Hr	55.8	58.0	45.8	68.6	- 84.4
		Day	56.9	59.2	47.0	71.8	- 83.2
		Night	52.9	54.4	42.0	66.1	- 82.6
NVS 14	House at Kampung Sementa, Klang	24 Hr	59.3	62.4	50.7	78.3	- 87.3
		Day	59.3	62.2	50.0	77.6	- 80.5
		Night	59.4	62.8	51.6	69.8	- 85.1
NVS 15	Houses at Jalan Sungai Saim, Klang	24 Hr	57.1	58.4	53.3	67.2	- 84.3
		Day	57.4	58.5	53.9	76.5	- 84.2
		Night	56.3	58.1	52.3	62.8	- 79.3
NVS 16	Terrace at Lor Haji Taha, Taman Sri Delek, Klang	24 Hr	50.5	52.3	43.6	67.0	- 84.1
		Day	51.5	53.4	42.7	71.4	- 75.7
		Night	47.9	49.3	44.7	48.2	- 70.4
NVS 17	Terrace at Lor Haji Ariffin, Klang	24 Hr	55.4	58.1	45.0	71.0	- 83.2
		Day	57.1	59.8	46.3	70.0	- 82.6
		Night	48.5	50.3	41.0	58.8	- 76.7
NVS 18	Terrace at Jalan Sireh Pinang 2, Klang	24 Hr	59.7	61.5	45.2	75.6	- 89.0
		Day	61.0	62.8	46.3	87.9	- 96.4
		Night	55.7	57.9	42.2	68.9	- 86.3
NVS 19	Houses at Jalan Sungai Sireh 1, Klang	24 Hr	55.8	58.0	45.8	68.6	- 84.4
		Day	56.9	59.2	47.0	71.8	- 83.2
		Night	52.9	54.4	42.0	66.1	- 82.6
NVS 20	Sri Perantau Apartment, Kawasan 14, Klang	24 Hr	59.4	62.1	50.5	75.7	- 89.6
		Day	60.6	63.3	51.6	80.9	- 83.6
		Night	56.0	58.8	47.5	71.7	- 86.8
NVS 21	Terrace at Lorong Bunga Siantan, Klang	24 Hr	56.1	58.4	46.2	73.1	- 86.7
		Day	57.5	58.9	47.4	75.1	- 80.6
		Night	51.2	57.4	42.8	59.5	- 88.3

### 6.9.3.3 Summary

Noise levels in urban areas are typically at or above recommended limits of the DOE Noise Planning Guidelines (Schedule 4) for road traffic noise sources. There are however instances at low density density areas or receptors away from major roads and development that have relative low prevailing ambient noise (L<sub>eq</sub> day time levels typically at or below 55 dBA and night time levels at or below 50 dBA). This include Templer Impian and Batu Arang.

## 6.10 VIBRATION

### 6.10.1 Approach & Methodology

Vibration measurements involved continuous 18 hours' measurements at critical locations, and at other locations for short term measurements during day and evening time periods. Measurements were undertaken at receptors' site boundary for vertical, transverse and longitudinal directions.

Peak vibration events were continuously logged by the analyzer. Peak vibration events were extracted from the vibration monitoring to obtain the peak response levels, with vibration response levels plotted to determine the human vibration response curves for vertical(z-axis), transverse and longitudinal (in direction to construction site). Vibrations were assessed against allowable limits and human response curves.

A summary tabulation of the measured vibration levels in the three orthogonal directions are tabulated in **Table 6-47 to Table 6-50**. The corresponding human response rating curves are tabulated in **Table 6-48**.

### 6.10.2 Monitoring Locations

#### 6.10.2.1 Segment 1 : Kelantan

The vibration monitoring in Kelantan was carried out at 15 locations (**Table 6-47**, **Figure 6.7-1a** to **Figure 6.7-1c**).

**Table 6-47: Vibration Monitoring in Kelantan**

Ref.	Location	GPS Location		Measurement Date
NVK 01	Houses at Jalan Salor Pasir Mas`	6.06582	102.22514	27 - 28 Aug 2017
NVK 02	Houses at Kg Tendong, Pasir Mas	6.06834	102.21680	27 - 28 Aug 2017
NVK 03	Houses at Kg Pandang Embong, Pasir Mas	6.08580	102.19869	20 - 21 Aug 2017
NVK 04	Houses at Kg. Alor Durian, Wakaf Bharu	6.10007	102.19163	20 - 21 Aug 2017
NVK 05	Houses at Kg. Lati, Wakaf Bharu	6.13063	102.17481	21 - 22 Aug 2017

**Table 6-47 : Vibration Monitoring in Kelantan (cont'd)**

Ref.	Location	GPS Location		Measurement Date
NVK 06	Houses at Kg Kubang Batang, Wakaf Bharu	6.11221	102.18307	21 - 22 Aug 2017
NVK 07	Houses at Kg Bendang, Wakaf Bharu	6.14282	102.16265	22 - 23 Aug 2017
NVK 08	Houses at Jalan Taliair, Kubang Batang	6.14980	102.15515	22 - 23 Aug 2017
NVK 09	Houses at Jalan Kota Bharu - Pengkalan Kubor	6.15966	102.14782	23 - 24 Aug 2017
NVK 11	Terrace houses at Jalan Kg Nechang, Telaga Bata	6.17520	102.13353	23 - 24 Aug 2017
NVK 12	Houses at Taman Sri Neting 2, Kg Pauh Sebanjan	6.19955	102.10376	24 - 25 Aug 2017
NVK12a	Houses at Kg Kok Semru, Pengkalan Kubor	6.203223	102.10545	23 - 24 Aug 2017
NVK 13	Houses at Kg Ketil, Pengkalan Kubor	6.22018	102.09407	24 - 25 Aug 2017
NVK13a	Houses at Kg Seri Serkong, Pengkalan Kubor	6.21586	102.09050	22 - 23 Aug 2017

### 6.10.2.2 Segment 2 : Selangor

#### Segment 2A: Gombak North to Serendah

The vibration monitoring in Segment 2A was carried out at 5 locations (Table 6-48, Figure 6.7-2a to Figure 6.7-2b).

**Table 6-48: Vibration Monitoring in Segemnt 2A**

Ref.	Location	GPS Location		Measurement Date
NVS 01	Terrace house at Jalan BP 11, Taman Bukit Permata, Batu Caves	3.26447	101.70200	29 - 30 Aug 2017
NVS 02	Terrace houses at Jalan Jasa Utama 14, Taman Jasa Utama, Batu Caves	3.27211	101.68338	29 - 30 Aug 2017
NVS2a	Terrace houses at persiaran Jasa Utama, Gombak	3.27041	101.68170	9 - 10 Oct 2017
NVS2b	Apartment Jalan Jasa Perwira, Gombak	3.27152	101.67949	9 - 10 Oct 2017
NVS 03	Apartment Templer Impian, Jalan Bukit Anak Tukun	3.30268	101.64420	11 - 12 Sept 2017

#### Segment 2B: Serendah to Bandar Puncak Alam

The vibration monitoring in Segment 2B was carried out at 12 locations (Table 6-49, Figure 6.7-2c to Figure 6.7-2d).

**Table 6-49 : Vibration Monitoring in Segemnt 2B**

Ref.	Location	GPS Location		Measurement Date
NVS 04	Terrace houses atTaman Desa Kiambang	3.37003	101.60953	19 - 20 Aug 2017
NVS4a	Terrace at Jalan Bunga Simpuh Air 5, Serendah	3.35810	101.60649	9 - 10 Oct 2017
NVS4b	Sri Selva temple, Serendah	3.36636	101.60407	9 - 10 Oct 2017
NVS 05	Terrace houses at Jalan Melati 2b, Taman Melati	3.36775	101.60170	28 - 29 Aug 2017
NVS 06	Houses at Taman Tok Pinang, Serendah	3.36607	101.59573	19 - 20 Aug2017
NVS 07	Terrace houses at Lorong Dua, Serendah	3.36480	101.59185	28 - 29 Aug 2017
NVS 08	Terrace houses at Jalan Teratai 10, Serendah	3.36682	101.56640	12 - 13 Sept 2017
NVS 09	Houses at Jalan Bunga Raya 3, Serendah	3.36588	101.56011	17 - 18 Aug 2017
NVS 10	Terrace at Taman Saujana Rawang, Rawang	3.34393	101.50824	11 - 12 Sept2017
NVS10a	M Residence, Jalan Tasik Puteri Rawang	3.31970	101.50256	10 - 11 Sept 2017
NVS 11	Terrace houses at Jalan Batu Arang	3.30721	101.47470	11 - 12 Sept 2017
NVS 12	Terrace houses at Taman Alam Suria	3.23955	101.40534	17 - 18 Aug 2017

### Segment 2C: Bandar Puncak Alam to Port Klang

The vibration monitoring in Segment 2C was carried out at 9 locations (Table 6-50, Figure 6.7-2e to Figure 6.7-2f).

**Table 6-50 : Vibration Monitoring in Segment 2C**

Ref.	Location	GPS Location		Measurement Date
NVS 13	Terrace houses at Jalan Kapar Setia 1, Taman Kapar Setia	3.13351	101.39407	9 - 10 Aug 2017
NVS 14	House at Kampung Sementa, Klang	3.08206	101.38766	14 - 15 Aug 2017
NVS 15	Houses at Jalan Sungai Saim, Klang	3.05348	101.38959	15 - 16 Aug 2017
NVS 16	Terrace houses at Lor Haji Taha, Taman Sri Delek, Klang	3.03201	101.39622	9 - 10 Aug 2017
NVS 17	Terrace houses at Lor Haji Ariffin, Klang	3.02673	101.40724	9 - 10 Aug 2017
NVS 18	Terrace houses at Jalan Sireh Pinang	3.02160	101.40907	8 - 9 Aug 2017
NVS 19	Houses at Jalan Sungai Sireh 1, Klang	3.01826	101.40550	9 - 10 Aug 2017
NVS 20	Sri Perantau Apartment, Kawasan 14, Klang	3.01464	101.40199	8 - 9 Aug 2017
NVS 21	Terrace house at Lorong Bunga Siantan, Klang	3.01218	101.39938	7 - 8 Aug 2017

### 6.10.3 Monitoring Results

#### 6.10.3.1 Segment 1 : Kelantan

**Table 6-51 : Summary of Measured Vibration Levels in Kelantan**

Ref.	Location	Measured Existing (mm/s)	
		Morning	Evening
NVK 01	Houses at Jalan Salor Pasir Mas	0.23	0.15
NVK 02	Houses at Kg Tendong, Pasir Mas	0.34	0.42
NVK 03	Houses at Kg Pandang Embong, Pasir Mas	0.35	0.42
NVK 04	Houses at Kg. Alor Durian, Wakaf Bharu	0.24	0.45
NVK 05	Houses at Kg. Lati, Wakaf Bharu	0.43	0.24
NVK 06	Houses at Kg Kubang Batang, Wakaf Bharu	0.43	1.08
NVK 07	Houses at Kg Bendang, Wakaf Bharu	0.24	0.29
NVK 08	Houses at Jalan Taliair, Kubang Batang	0.25	0.28
NVK 09	Houses at Jalan Kota Bharu - Pengkalan Kubor	0.37	0.38
NVK 10	Houses at Kg Teluk, Tumpat	0.24	0.77
NVK 11	Terrace houses at Jalan Kg Nechang, Telaga Bata	0.33	0.35
NVK 12	Houses at Taman Sri Neting 2, Kg Pauh Sebanjan	0.29	0.98
NVK 13a	Houses at Kg Kok Semru, Pengkalan Kubor	0.36	0.24
NVK 13	Houses at Kg Ketil, Pengkalan Kubor	0.25	0.26
NVK 13b	Houses at Kg Seri Serkong, Pengkalan Kubor	0.42	0.34

#### 6.10.3.2 Segment 2 : Selangor

##### Segment 2A: Gombak North to Serendah

**Table 6-52 : Summary of Measured Vibration Levels in Segment 2A**

Ref.	Location	Measured Existing (mm/s)	
		Morning	Evening
NVS 01	Terrace house at Jalan BP 11, Taman Bukit Permata, Batu Caves	0.29	0.19
NVS 02	Terrace houses at Jalan Jasa Utama 14, Taman Jasa Utama, Batu Caves	0.43	0.53
NVS 02a	Terrace houses at persiaran Jasa Utama, Gombak	0.32	0.26
NVS 02b	Apartment Jalan Jasa Perwira, Gombak	0.38	0.24
NVS 03	Apartment Templer Impian, Jalan Bukit Anak Tukun	0.44	0.53

## Segment 2B: Serendah to Bandar Puncak Alam

**Table 6-53 : Summary of Measured Vibration Levels in Segment 2B**

Ref.	Location	Measured Existing (mm/s)	
		Morning	Evening
NVS 04	Terrace houses at Jalan Kiambang 3, Taman Desa Kiambang	0.30	0.56
NVS 04a	Terrace at Jalan Bunga Simpuh Air 5, Serendah	0.28	0.38
NVS 04b	Sri Selva temple, Serendah	0.48	0.22
NVS 05	Terrace houses at Jalan Melati 2b, Taman Melati	0.54	0.30
NVS 06	Houses at Taman Tok Pinang, Serendah	0.31	0.36
NVS 07	Terrace houses at Lorong Dua, Serendah	0.46	0.42
NVS 08	Terrace houses at Jalan Teratai 10, Serendah	0.31	0.35
NVS 09	Houses at Jalan Bunga Raya 3, Serendah	0.32	0.56
NVS 10	Terrace at Taman Saujana Rawang, Rawang	0.30	0.37
NVS10a	M Residence, Jalan Tasik Puteri Rawang	0.28	0.35
NVS 11	Terrace houses at Jalan Batu Arang	0.41	0.44
NVS 12	Terrace houses at Taman Alam Suria	0.36	0.56

## Segment 2C: Bandar Puncak Alam to Port Klang

**Table 6-54: Summary of Measured Vibration Levels in Segment 2C**

Ref.	Location	Measured Existing (mm/s)	
		Morning	Evening
NVS 13	Terrace houses at Jalan Kapar Setia 1, Taman Kapar Setia	0.31	0.33
NVS 14	House at Kampung Sementa, Klang	0.49	0.54
NVS 15	Houses at Jalan Sungai Saim, Klang	0.93	0.46
NVS 16	Terrace houses at Lor Haji Taha, Taman Sri Delek, Klang	0.23	0.23
NVS 17	Terrace houses at Lor Haji Ariffin, Klang	0.43	0.24
NVS 18	Terrace houses at Jalan Sireh Pinang 2,	0.26	0.67
NVS 19	Houses at Jalan Sungai Sireh 1, Klang	0.23	0.23
NVS 20	Sri Perantau Apartment, Kawasan 14, Klang	0.62	0.23
NVS 21	Terrace house at Lorong Bunga Siantan, Klang	0.23	0.29

### 6.10.4 Summary

Vibrations assessment showed prevailing groundborne vibration levels to be within DOE recommended limits during the period of monitoring. It is to be noted that vibrations are activities dependent and at the time of monitoring most of these sites did not had high vibration extraneous sources i.e. construction etc. that may otherwise result in high vibrations. Relatively higher vibration levels (>0.4mm/s, Curve 4) were noted at some locations with road traffic induced vibrations from heavy vehicles (lorries pass). These were evident in location near to trunk roads and major roads in the vicinity of the measurement locations at the respective receptors areas.

## 6.11 ECOLOGY

### 6.11.1 Flora

The natural vegetation of Peninsular Malaysia is broadly categorized as Tropical Broadleaf Evergreen Rainforest. However, a number of distinct vegetation types (about 14) occur within this broad category; these occur either as a function of altitude (e.g. Lowland Dipterocarp Forest, Hill Dipterocarp Forest, Montane forest) or underlying soil (e.g. Mangrove Forest, Peat Swamp Forest, Heath Forest). Due to its extensive length, the railway alignment will traverse a number of different vegetation types.

#### 6.11.1.1 Approach & Methodology

The main objective of the flora assessments was to document the different forested areas and plant communities that would be affected by the railway alignment. The general floristic composition of affected forested areas was documented to determine if these areas are likely to harbour any species of conservation importance. The assessments will also aid in the identification of the potential impacts that the alignment may have on the affected areas, both in terms of habitat fragmentation or disruption of sites/plant communities of high conservation value.

The main activities undertaken in the assessments are as follows:

1. Review of secondary data from existing literature

Secondary data was collected pertaining to the plant diversity and composition, specifically on the forest reserves the proposed alignment traverses through (**Appendix D**). Information on the existing issues pertaining to the affected areas were also collected in the form of past reports and newspaper articles to give a preliminary indication of the present situation of these areas.

2. Field visits to affected forested areas

Preliminary field visits were carried out in June and September 2017 to verify the existing conditions of the affected forested areas i.e. both forest reserves and state land forests. The field visits also served to identify potential areas to conduct the rapid flora inventory.

3. Rapid flora survey

Rapid flora surveys were carried out on 12<sup>th</sup> – 14<sup>th</sup> September and 18<sup>th</sup> – 20<sup>th</sup> September 2017 to document the plant diversity and composition specifically at the Sg. Puloh mangroves and Rantau Panjang Forest Reserve. The surveys were conducted via 20m X 20m plot and transect method. The objective of surveys

was primarily to establish an inventory of tree species that occur directly with the ROW of the proposed alignment. Line transects allowed a quick qualitative assessment of the habitat and species composition while allowing a broader coverage of the study area. Additionally, the 20m X 20m sampling plot serves to provide a preliminary quantitative indication of the forested areas in terms of species distribution by diameter classes as well as estimates of volume and stems per hectare.

4. Consultation with relevant stakeholders

Discussions were carried out with relevant stakeholders and experts to obtain additional information as well as feedback on issues and concerns pertaining to the affected forested areas. Stakeholders that were engaged comprised of individuals and organisations that are involved in the management and conservation of flora as well as protected areas in the country which includes:

- Forest Research Institute Malaysia (FRIM) (held on 2<sup>nd</sup> August 2017)
- Forestry Department of Peninsular Malaysia (held on 28<sup>th</sup> August 2017)
- Forestry Department of Selangor (held on 8<sup>th</sup> September 2017)

#### 6.11.1.2 Main vegetation types along the alignment

Most of the natural vegetation along the proposed alignment are located within Permanent Reserved Forests (PRF), which have been created under the State forestry enactments. Some of these PRFs are further classified for various purposes (e.g. wildlife protection, water catchment) under the respective enactments. The proposed alignment will pass through a total of four PRFs (**Figure 6.11-2**). Additionally, the proposed alignment will also traverse through several patches of state land forests.

The following provides a brief description of the main vegetation types that occur along the ECRL Phase 2 alignment (**Figure 6.11-4**).

##### Dipterocarp Forests

Dominated by tall trees from the Dipterocarpaceae family, dipterocarp forests are acknowledged to harbour one of the most diverse assemblages of plants and animals in the world. Three types of Dipterocarp Forests may be distinguished based on elevation:

- i. Lowland Dipterocarp Forest - occurs up to elevations of 300 m. This is generally the most species-rich type of dipterocarp forest, and also the most threatened due to the fact that most development occurs in the lowlands.

- ii. Hill Dipterocarp Forest - occurs at elevations between 300 m and 750m asl. The blue-grey crowns of the Seraya (*Shorea curtisii*), which commonly inhabit ridges from 300 m asl, are a general indicator of this vegetation type.
- iii. Upper Dipterocarp Forests – changes in the floristic composition occurs between 750 to 1,200 asl. The canopy height begins to get lower at these elevations, with plants of the lowland increasingly being replaced by those of the highlands, including various species of oaks and laurel.

### Mangrove Forests

Riparian mangrove forests line the lower reaches of a number of rivers in the east coast, especially where saline water conditions prevail and fine sediment is deposited along river banks. This vegetation type typically inhabits the sections downstream of the nipah (*Nypa fruticans*) belt and extends up to the coast.

Mangrove forests contain plants that are highly tolerant to the higher salinity water conditions within the inter-tidal zone. They are highly productive and unique tropical coastal ecosystems that provide important ecosystem services, such as a breeding ground for marine species, as well as in protecting against soil and coastline erosion.

#### **6.11.1.3 Segment 1 : Kelantan**

The proposed alignment will neither traverse through nor is in close proximity to any PRFs in Kelantan (**Figure 6.11-1**). The closest PRF is the Chabang Tongkat FR, which is located approximately 20 km south from the alignment. The proposed alignment will traverse through some scrublands on vacant areas within rural settlements and agricultural land. As such, these patches of area are expected to comprise of fast-growing pioneer species such as *Acacia* and *Macaranga* (mahang) that are of low conservation value.

#### **6.11.1.4 Segment 2 : Selangor**

The alignment will traverse through total of four Permanent Reserved Forests. Each of these forest reserves have been classified by Selangor State Forestry Department according to their respective function based on economic, environment and social importance (**Figure 6.11-5**). Additionally, the alignment will traverse through seven patches of state land forests. According to the Local Plans in Selangor, most of these forests have been zoned to be cleared, mainly for agricultural purpose in the future (**Figure 6.5-3a** and **Figure 6.5-4a**). The details are described in following sections:

## Segment 2A: Gombak North to Serendah

The proposed alignment will traverse through three PRFs between Gombak North and Serendah i.e. Ulu Gombak FR, Templer FR and Serendah FR (**Table 6-55** and **Figure 6.11-2a**) via a tunnel (approximately 8 km). These forest reserves are part of the Selangor Heritage Park (also known as Selangor State Park). The proposed alignment will also traverse large patches of state land forests adjacent to the Ulu Gombak FR and Serendah FR.

**Table 6-55 : Permanent Reserved Forests Near the Alignment from Gombak North to Serendah**

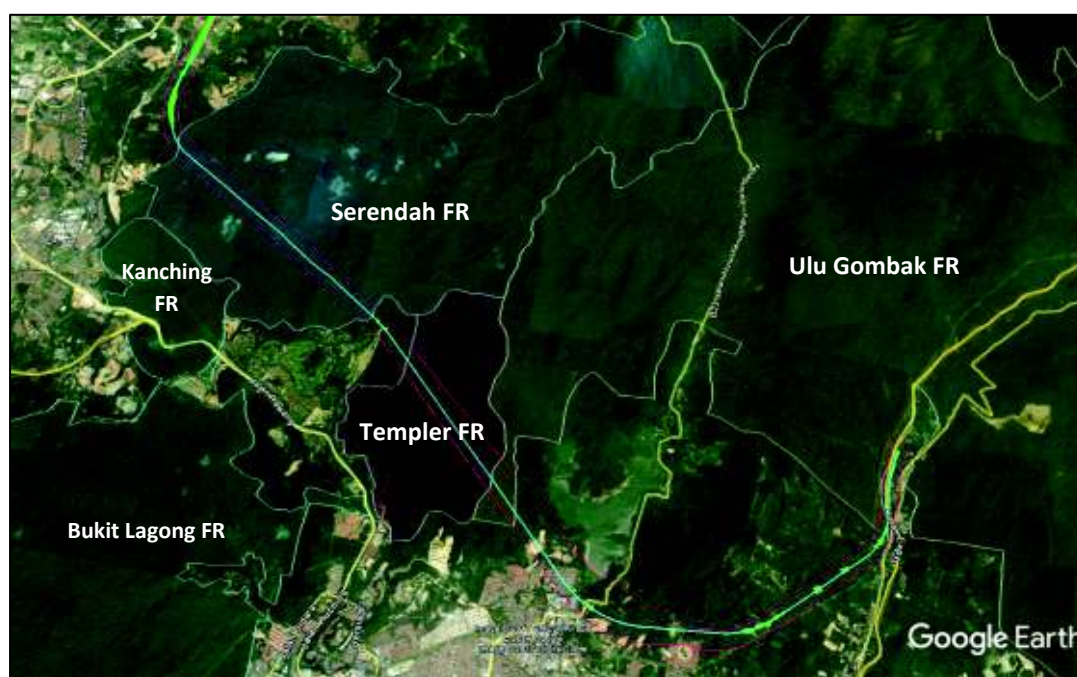
PRF	Area (ha)	Status <sup>1</sup>	Year of Gazettment <sup>1</sup>	Classification <sup>1</sup>	Note
Ulu Gombak FR	16,838	1909	Protection Forest	Water Catchment Forest	<ul style="list-style-type: none"> <li>Alignment tunnel through for approx. 700m southwest tip of the reserve</li> <li>CH 9000 –</li> <li>CH 9700</li> </ul>
Templer FR	850	1995	Protection Forest	Wildlife Protection Forest	<ul style="list-style-type: none"> <li>Alignment tunnel through for approx. 2.3 km middle section of the reserve</li> <li>CH 9700 –</li> <li>CH 12300</li> </ul>
Serendah FR	4,082	1931	Protection Forest	State Park Forest	<ul style="list-style-type: none"> <li>Alignment tunnel through for approx. 5.0 km southwest section of the reserve</li> <li>CH 13400 –</li> <li>CH 18400</li> </ul>

<sup>1</sup>: Rancangan Pengurusan Hutan Negeri Selangor 2011-2020

**Table 6-56 : State Land Forests Adjacent to the Alignment from Gombak North to Serendah**

Area/Approximate Coordinates	Approximate Size	Alignment Type & Length	Note
State land forest south of Ulu Gombak FR  3°16'40.29"N 101°42'37.59"E	1,250 ha	Tunnel for approx. 4.2 km and at-grade for approx. 1.2 km  CH 1800 – CH 7200	<ul style="list-style-type: none"> <li>Alignment crosses from the eastern section and curves to the southwest corner of the forest.</li> <li>Existing and future land use is Agriculture. <sup>1</sup></li> </ul>
State land forest west of Templer FR/north of Setia Eco Templer  3°18'18.51"N 101°38'48.18"E	95 ha	Tunnel for approx. 800 m and at-grade for approx. 250 m  CH 13000 – CH 13250	<ul style="list-style-type: none"> <li>Alignment crosses between Templer FR and Serendah FR</li> <li>Existing and future land use is Forest and Open Space &amp; Recreational<sup>1</sup></li> </ul>
State land forest west of Serendah FR  3°20'1.04"N 101°36'12.43"E	186 ha	Tunnel for approx. 400 m and at-grade for 1.1 km  CH 18900 – CH 20000	<ul style="list-style-type: none"> <li>Alignment tunnels out in the middle section of the forest and curves northwest</li> <li>Existing and future land use is Agriculture<sup>1</sup></li> </ul>

<sup>1</sup>: [iplan.townplan.gov.my](http://iplan.townplan.gov.my), Selayang Local Plan



**Plate 6-20 : Alignment at Ulu Gombak FR, Templer FR and Serendah FR**

### Permanent Reserved Forests

The Ulu Gombak FR, Serendah FR and Templer FR have been classified as Protection Forests by the Selangor Forestry Department under the National Forestry Act 1984. These forests are part of Selangor State Park which was gazetted by the Selangor State Government in 2007. The Park includes most of the forests on the Main Range Forest Complex within the Selangor state boundary, covering an area of 93,002 ha under the management of Selangor State Forestry Department. These forests predominantly comprise of hill dipterocarp forests that phase into oak-laurel forests and subsequently montane ericaceous forests at higher elevations. A typical feature of hill dipterocarp forests is the presence of stands of seraya trees. Seraya (for example *Shorea curtisii*) are large sized dipterocarp trees with silvery hued leaves on the surface.

Flora survey was not conducted in Ulu Gombak FR, Serendah FR and Templer FR as there will be no loss of PRFs. The railway was designed to ensure there will be zero vegetation loss within the Selangor State Park since the preliminary stages. The railway will traverse through the forest reserves entirely via an underground tunnel and the tunnel entrances are located outside the boundary of the State Park and PRFs.

About 3,140 vascular plant species have been recorded in the Selangor State Park (K.M.Wong, 2005). Based on records kept at FRIM on 872 plant specimens from Ulu Gombak FR, Templer FR and Serendah FR, more than 10% have important conservation concerns. They harbour 90 endemic species where 55 were recorded in Ulu Gombak FR, 15 in Serendah FR and 20 in Templer FR. There are also 23 IUCN Red List of Threatened Species recorded in these PRFs. From the 23 species, 11 species are categorised as Endangered (EN) and 12 species as Vulnerable (VU). Species categorised as EN was recorded in Ulu Gombak FR (6 species), Templer FR (2 species) and Serendah FR (3 species). While species categorised as VU was recorded in Ulu Gombak FR (9 species) and Serendah FR (3 species).

Among the species which is categorized as EN include *Johannesteijsmannia magnifica* and the Serendah FR is well known to harbour this rare species. This species of forest palm has gigantic diamond-shaped leaves which can span over 3m in length. This species only grows in humid tropical climates and requires deep shaded areas with high moisture and well-drained rich soil. Coincidentally, this forest reserve was highlighted as one of 20 new localities to have recorded the genus *Johannesteijsmannia* since 1972. Other EN species that have been recorded in Serendah FR as well as Ulu Gombak FR and Templer FR are *Begonia rhoephila*, *Scaphochlamys coccinea*, *Paraboea paniculate*, *Selaginella ridleyi*, *Shorea bentongensis*, *Shorea guiso* and *Shorea uliginosa*.

Besides containing a wealth of floral and faunal communities, the Selangor State Park plays a significant role in safeguarding critical water catchment forests which supply 98% of the water to Selangor and Kuala Lumpur. As such, this whole area has been

categorised as an Environmentally Sensitive Area Rank 1 under the National Physical Plan. There are also eight recreational forests within the State Park. Some of these forests such as Hutan Lipur Sg. Tua and Hutan Lipur Kanching are major attractions to locals and tourists. However, the proposed alignment will not traverse through any recreational forests in Selangor.

#### State Land Forests

Patches of state land forests can be found in the surrounding areas of the Selangor State Park. Notable large patches of forests were noted adjacent to Ulu Gombak FR and Serendah FR. The floral composition in these forests is expected to be similar to the hill dipterocarp forests in the respective forest reserves, albeit with slightly lesser species richness.



**Plate 6-21 : Ulu Gombak FR**



**Plate 6-22 : Aerial view of Ulu Gombak FR nearby the Batu Dam reservoir**



**Plate 6-23 : Templer FR**



**Plate 6-24 : State land forests near Templer FR and Setia Eco Templer**



**Plate 6-25 : Gateway of Selangor State Park at Hutan Lipur Sg. Tua**

### **Segment 2B: Serendah to Bandar Puncak Alam**

Between Serendah and Bandar Puncak Alam, the proposed alignment will traverse through only one PRF, Rantau Panjang FR and will be constructed on embankments (**Table 6-57 & Figure 6.11-2b**). The proposed alignment will also traverse through several patches of state land forest including Hutan Sungai Buaya in Serendah (**Table 6-58**).

**Table 6-57 : Permanent Reserved Forests Near the Alignment from Serendah to Bandar Puncak Alam**

PRF	Area (ha)	Status <sup>1</sup>	Year of Gazettment <sup>1</sup>	Classification <sup>1</sup>	Notes
Rantau Panjang FR	6,817	1910	Production Forest	Plantation Forest	Alignment crosses the southern section at-grade for approx. 3.0 km of the reserve
					CH 35000 – CH 38000

<sup>1</sup>: Rancangan Pengurusan Hutan Negeri Selangor 2011-2020

**Table 6-58 : State Land Forests Near the Alignment from Serendah to Bandar Puncak Alam**

Area/Approximate Coordinates	Approximate Size	Alignment Type & Length	Note
State land forests adjacent to North-South Expressway  3°21'52.71"N 101°33'25.20"E	9.36 ha	At-grade for approx. 450 m Elevated for approx. 250 m  CH 27800 – CH 28500	<ul style="list-style-type: none"> <li>Alignment crosses at the middle of the forest</li> <li>Surrounding areas are oil palm plantation and expressways.</li> <li>Existing and future land use is Institution and Public Amenities<sup>1</sup></li> </ul>
Hutan Sungai Buaya  3°20'54.77"N 101°30'38.01"E	469 ha	Tunnel for approx. 1.8 km and at-grade for 400m  CH 28500 – CH 30700	<ul style="list-style-type: none"> <li>Alignment crosses at the middle of the forest</li> <li>Surrounding areas are oil palm plantation and ex-mining sites.</li> <li>Existing and future land use is Agriculture<sup>1</sup></li> </ul>
State land forest next to Rantau Panjang FR (east)  3°20'21.24"N 101°30'16.22"E	9.81 ha	At-grade for approx. 300 m  CH 34700 – CH 35000	<ul style="list-style-type: none"> <li>Alignment crosses at the south of the forest</li> <li>Surrounding areas are Rantau Panjang FR and aquaculture ponds.</li> <li>Existing and future land use is Forest<sup>1</sup></li> </ul>

<sup>1</sup>: [iplan.townplan.gov.my](http://iplan.townplan.gov.my), Selangor Local Plan

### Permanent Reserved Forest

The Rantau Panjang Forest Reserve is gazetted as a Plantation Forest by the Selangor Forestry Department and managed by Perbadanan Kemajuan Pertanian Selangor (PKPS). Since 1936, large scale planting experiments were carried out in the forest reserve whereby exotic species such as pine (*Pinus caribaea*) were planted. Since then,

the forest reserve has been repeatedly logged over to establish new plantations such as *Acacia* and rubber (*Hevea brasiliensis*).

At present, most of the forest reserve has been leased out to various private companies to be developed as private plantations. The northern section of the forest reserve has been developed as the Selangor Fruit Valley, while the southeastern section still comprises of rubber plantations (**Plate 6-26**). The southern most section of the forest reserve however has not been logged over in the last decade and as such, has regenerated into a relatively good secondary forest.

The rapid flora survey within this forest reserve was carried out in eight locations within the ROW of the proposed alignment. Five sampling locations were within the southern section of the forest reserve, while three sampling locations were at the southeastern section of the forest reserve. A total of 97 tree species were recorded during the survey, along with 27 herbaceous species, 13 species of ferns and three palm species. None of the species listed in the survey are endemic and in any form of conservation threat, although 14 species have been documented to have local medicinal uses (**Appendix D-3**).

Tree species documented in the southern section of the forest reserve include remnants of pine from past plantation projects together with common trees such as sesenduk (*Endospermum diadenum*), mahang (*Macaranga* sp.), and simpoh (*Dillenia* sp.). Commercial species such as kapur (*Dryobalanops aromatica*), bintangor (*Calophyllum* sp.) and kempas (*Koompassia malaccensis*) were also documented, together with fruit tree species (e.g. *Artocarpus* sp., *Durio* sp., *Dacryodes* sp. etc.). The southeastern section of the forest reserve comprises mostly of rubber trees, although shrubs, creepers, ferns were noted in the undergrowth.

From the flora survey, the number of stems in Rantau Panjang FR was relatively good (estimated 380 stems/ha) but it consisted of small sized-trees. About 87% of the trees were between 10 to 30 cm DBH. This resulted in the low total volume of trees estimated to be 58 m<sup>3</sup>/ha. As such, this forest reserve is considered as a poor-quality forest, since the average value of logged-over forest is about 100 m<sup>3</sup>/ha and 200 m<sup>3</sup>/ha for a good production forest.



Plate 6-26 : Alignment at Rantau Panjang Forest Reserve



**Plate 6-27 : Rantau Panjang Forest Reserve**



**Plate 6-28 : M Residence and palm oil plantation adjacent to Rantau Panjang FR**



Plate 6-29 : Forest structure at Rantau Panjang FR



Plate 6-30 : Forest structure in Rantau Panjang FR



Plate 6-31 : Rubber plantation in the southeastern section of Rantau Panjang FR



Plate 6-32 : Fragmentation by transmission line at southeastern section of Rantau Panjang FR

#### State Land Forest

The proposed alignment will traverse through a large patch of state land forest (coordinates N 3°20'54.77"N E 101°30'38.01"), which is locally known as Hutan Sungai Buaya mostly due its close proximity to Kampung Sungai Buaya. Drone imagery indicates the forests here to still be in pristine condition (**Plate 6-14**). However, according to DWNP Selangor, numerous rubber trees (*Hevea brasiliensis*) were directly observed within the forest, as well as other crops such as pineapple

(*Ananas comosus*). It is possible that the land within this forest have been utilised by nearby local communities for crop plantation. According to the Selayang Local Plan, the Hutan Sungai Buaya have been designated to be cleared for agricultural purpose (Figure 6.5-3a and Figure 6.5-4a).



Plate 6-33 : Hutan Sungai Buaya in Serendah (3°20'54.77"N 101°30'38.01"EZ)

### Segment 2C: Bandar Puncak Alam to Port Klang

The proposed alignment will not traverse through any PRFs between Bandar Puncak Alam and Port Klang. However, the proposed alignment will traverse through mangrove forests along Sg. Puloh, Klang (Table 6-59 & Figure 6.11-2c).

**Table 6-59 : State Land Forests near The Alignment from Bandar Puncak Alam to Port Klang**

Area/Approximate Coordinates	Approximate Size	Alignment Type & Length	Note
Sg. Puloh Mangrove Forest  3° 4'17.03"N 101°23'18.99"E	941 ha	Elevated for approx. 900 m (across the river) and at-grade for 600 m  CH 69800 – CH 71300	<ul style="list-style-type: none"> <li>• Alignment crosses the inland section.</li> <li>• Includes riverine forest and contain mangrove.</li> <li>• Important for flood mitigation</li> <li>• Source of livelihood for nearby fishermen.</li> <li>• Existing and future land use is Open Spaces and Recreational (Northern Section) <sup>1</sup></li> <li>Existing and future land use is Industry (Southern Section) <sup>1</sup></li> </ul>

<sup>1</sup>: [ipplan.townplan.gov.my](http://ipplan.townplan.gov.my), Klang Local Plan

### Sg. Puloh Mangroves

The mangroves along Sg. Puloh provide crucial ecosystem services to the surrounding environment, primarily in terms of natural flood mitigation as well as supporting the livelihood of the local fishing communities in the surrounding areas along the river. At present, the mangroves are not gazetted as forest reserves and are considered as state land forests. According to the Klang Local Plan, the eastern section of the mangroves has been zoned as future green spaces, while the mangroves towards the south have been earmarked to be cleared for future industrial development (**Plate 6-34**).

The mangrove survey comprised of eight sampling locations, which were established within the ROW of the proposed alignment. Six sampling plots were in the northern section of Sg. Puloh, while two sampling plots were in the areas that have been earmarked for industrial development. A total of 13 mangrove species were documented during the surveys, which is fairly common in most mangrove habitats (**Table 6-60**). The mangroves are generally dominated by bakau minyak (*Rhizophora apiculata*) and api-api ludat (*Avicennia officinalis*) trees, which are the most common species. Other species which were documented include tengar (*Ceriops tagal*), perepat (*Sonneratia alba*) and nyireh bunga (*Xylocarpus granatum*). Nipah palms (*Nypa fruticans*) were noted mostly in the interior sections of the mangroves in the northern section. Full findings of the mangrove survey are presented in **Appendix D-2**.

Table 6-60 : List of recorded species in Sg. Puloh

Family	Species Name	Local Name
Arecaceae	<i>Nypa fruticans</i>	Nipah
Avicenniaceae	<i>Avicennia alba</i>	Api-api putih
	<i>Avicennia officinalis</i>	Api-api ludat
Celastraceae	<i>Cassine viburnifolia</i>	Barak laut
Meliaceae	<i>Xylocarpus granatum</i>	Nyireh bunga
Pteridaceae	<i>Acrostichu speciosum</i>	Piai laut
Rubiaceae	<i>Scyphiphora hydrophyllacea</i>	Chengam
Rhizophoraceae	<i>Bruguiera cylindrica</i>	Berus / Bosang
	<i>Bruguiera gymnorrhiza</i>	Berus merah
	<i>Ceriops tagal</i>	Tengar
	<i>Rhizophora apiculata</i>	Bakau minyak
	<i>Rhizophora mucronata</i>	Bakau kurap
Sonneratiaceae	<i>Sonneratia alba</i>	Perepat

In terms of habitat quality, the mangroves at the northern section were noted to have been heavily disturbed due to past activities, resulting in large open spaces between the forest canopy. Based on our plot survey, there is an estimated 400 stems/ha (trees >10 cm DBH) in these mangrove areas excluding the two southern plots. However, 85% of the trees belonged to the 10 to 30 cm DBH size classes and only two trees were > 30 cm DBH. This resulted in only 34 m<sup>3</sup>/ha in volume, much lower than in a relatively good mangrove forest.

Based on discussions with the local fishermen, the local communities still enter the mangroves along the river to collect mangrove wood for personal uses. On the other hand, the mangroves in the southern section were noted to have been extensively cleared and heavily fragmented due to land preparation activities for upcoming industrial development.

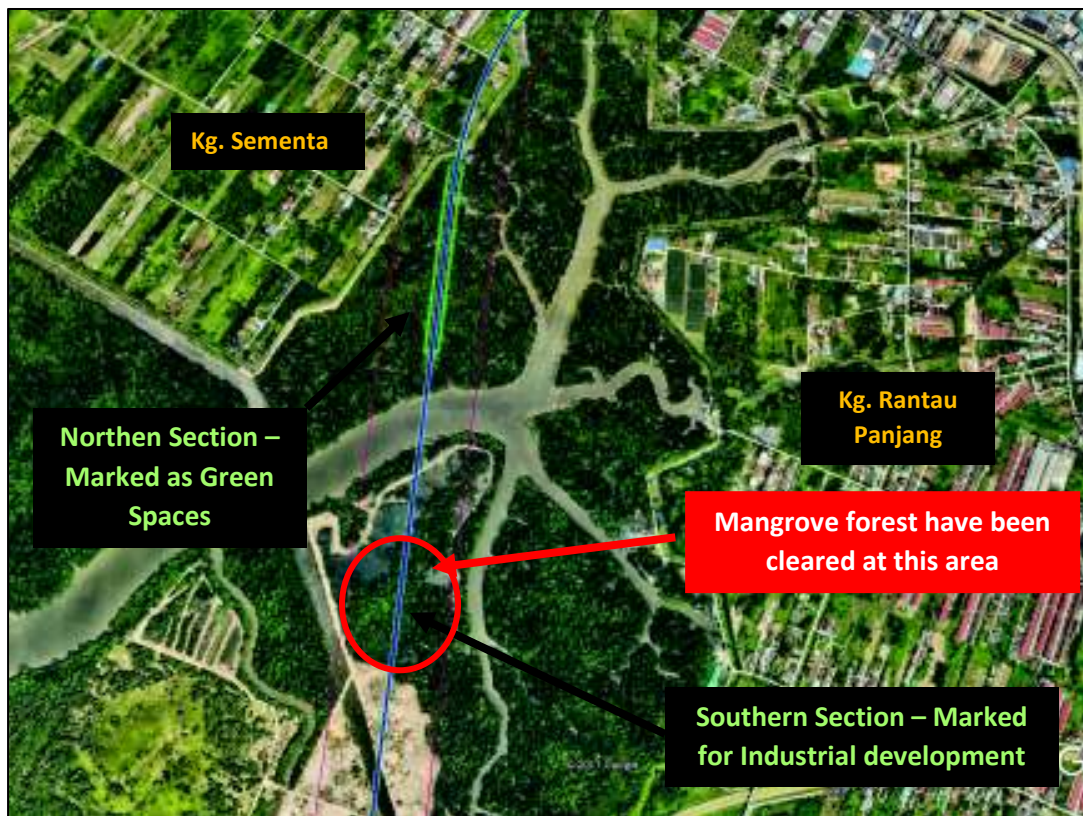


Plate 6-34 : Alignment at Sungai Puloh



Plate 6-35 : Mangroves along Sungai Puloh



Plate 6-36 : Bakau minyak (*Rhizophora apiculata*)



Plate 6-37 : Dense growth of tengar (*Ceriops tagal*) in the interior sections of the mangrove



**Plate 6-38 : Mangrove structure near Kg. Sementa**



**Plate 6-39 : Degraded mangroves in the southern section of Sg. Puloh**

### **6.11.2 Fauna**

Being one of the world's 17 megadiverse countries, Malaysia boasts an exceedingly rich diversity of plants and animals throughout its terrestrial, freshwater and marine biomes. On land, the high diversity of natural vegetation types and the structural complexity that exists within them provides a wide spectrum of ecological niches for the many different animals that occur here; including birds, mammals, reptiles, amphibians and fishes to survive in those specific conditions over the millennia.

Many of these species are considered as Globally Threatened (especially due to hunting or habitat loss) based on conservation assessments made under the International Union for Conservation of Nature (IUCN), whereas some may be endemic to a particular site, state, or region. On the other hand, a few widely-occurring species are well adapted to survive in the vicinity of human settlements. Species such as the common palm civet (*Paradoxurus hermaphroditus*), common treeshrew (*Tupaia glis*) and common myna (*Acridotheres tristis*) are often seen in towns and villages throughout the country.

The greatest extent of wildlife habitats in Peninsular Malaysia are located within forest reserves, some of the most important habitats have been set aside for preservation within protected areas, whereas some pockets of habitats are located on State land or alienated land. Overall, the wild animals of Peninsular Malaysia are afforded protection under the Wildlife Conservation Act 2010 (Act 716) [Box 1], which is enforced throughout the peninsula by the Department of Wildlife and National Parks (DWNP).

**Box 1: Wildlife Conservation Act 2010 (Act 716)**

The Wildlife Conservation Act 2010 provides for the protection and conservation of wildlife in Peninsular Malaysia. Under this act, the wildlife of Peninsular Malaysia is categorized either Protected (under Schedule 1) or Totally Protected (under Schedule 2). Protected species are also known as hunted species whereby license is required to hunt. Examples of Protected species include wild boars, macaques and sambar deers.

Wildlife that are Totally Protected are usually species that are facing conservation threat such as tigers, elephants, tapirs, sun bears and leopards. No hunting or trade is permitted for Totally Protection Species. Under the Act, penalties for hunting or keeping Totally Protected wildlife can reach RM 300,000 and or up to 10 years imprisonment.

### 6.11.2.1 Approach & Methodology

The main objective of the fauna assessments was to document the types of wildlife that may occur within the proposed alignment corridor, as well as potential wildlife hotspots. This will assist in the identification of potential impacts the proposed alignment will have on the faunal communities such as significant habitat disturbances, increased human-wildlife conflicts (HWC) and increased access to poachers. Subsequently, this will aid in identifying and developing the necessary mitigation measures.

The main activities undertaken in the fauna assessments are as follows:

1. Collation of secondary data

Secondary data was collected pertaining to the wildlife communities that are present in the affected forested areas along the proposed alignment. Information such as human-wildlife conflicts were also collated from various literature source to give a preliminary indication of the types of wildlife communities and present issues within these areas. The human-wildlife conflict records by DWNP in 2 km radius of the ECRL Phase 2 alignment from 2012 to 2016 is presented in **Appendix D-5**.

2. Site reconnaissance surveys

Site reconnaissance surveys were carried out between June and September 2017 as ground-truthing excersises verify the existing condition of the affected forested areas. The surveys aided in identifying target areas to conduct the wildlife surveys and focused mainly on the forested areas where the proposed alignment will traverse through i.e. forest reserves and state land forests.

3. Wildlife surveys

Wildlife surveys were conducted by DWNP Selangor via camera trapping method, as well as direct observations during the mangrove survey in September. Five sites were selected to install camera traps (**Table 6-61**), which comprise mostly of areas that are known wildlife habitats or are believed to harbour significant or endangered species. However, the wildlife surveys focused mostly on documenting the presence of large mammals and birds, which are considered as “umbrella species” i.e. species that are expected to provide protection to a large number of naturally co-occurring species through their conservation. The wildlife survey report is presented in **Appendix D-4**.

**Table 6-61: Wildlife survey locations in Selangor**

Site	Reason for Selection Prior to Survey
Selangor State Park (Ulu Gombak FR, Templer FR, Serendah FR) and its surrounding state land forests	<ul style="list-style-type: none"> <li>Consider as biodiversity hotspot</li> <li>Part of Selangor State Park where 114 mammal species and 355 bird species have been recorded in the past.</li> </ul>
Rantau Panjang FR	<ul style="list-style-type: none"> <li>Known to harbour endangered large mammals such as tapir and possibly sun bear</li> </ul>
Hutan Sungai Buaya	<ul style="list-style-type: none"> <li>Large forest patch that may still harbour large mammals.</li> </ul>

4. Consultation with relevant stakeholders

Discussions were carried out with relevant stakeholders and experts to obtain additional information as well as feedback on issues and concerns pertaining to wildlife conflicts and conservation. Stakeholders that were engaged comprised of individuals and organisations that are involved in the management and

conservation of wildlife communities in protected areas of the country which includes:

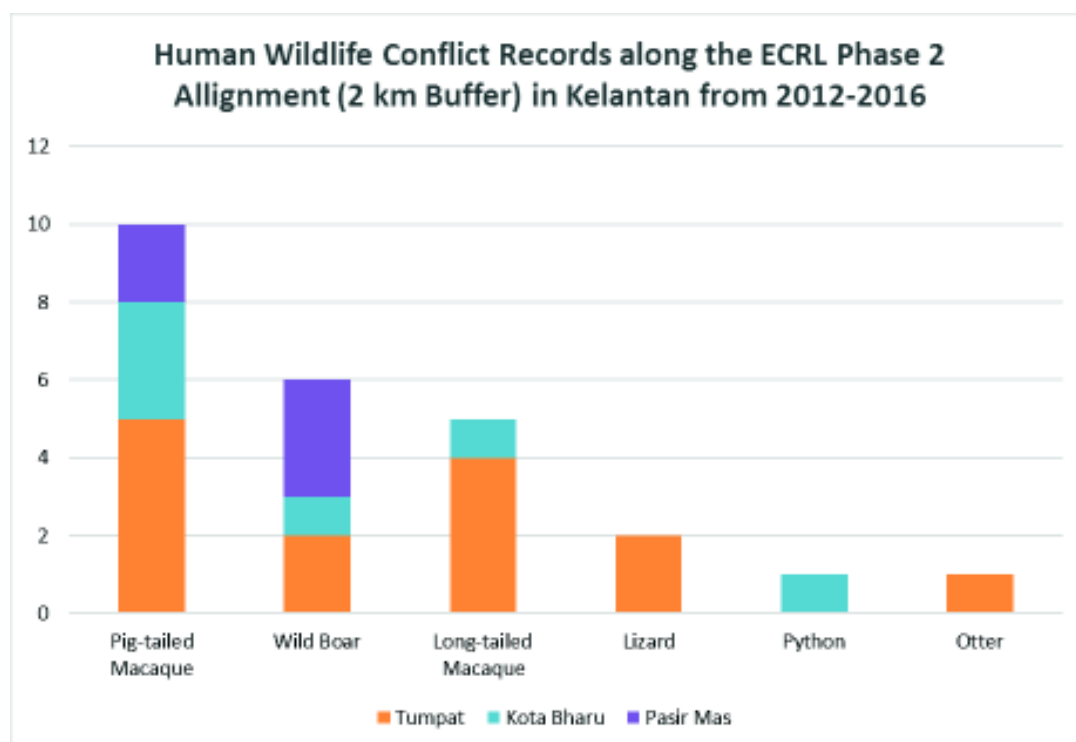
- DWNP Peninsular Malaysia (held on 13<sup>th</sup> July 2017)
- DWNP Selangor (held on 18<sup>th</sup> July 2017)
- Forest Research Institute Malaysia (FRIM) (held on 2<sup>nd</sup> August 2017)
- District Forest Office Hulu Selangor (held on 18<sup>th</sup> of September 2017)

#### 6.11.2.2 Segment 1 : Kelantan

The alignment will not traverse through or come into proximity to any major wildlife habitats in Kelantan. Most of the vegetation areas the alignment will pass through in this segment comprise mainly of agricultural lands, specifically paddy fields. As such, there are no major wildlife populations in these areas.

However, total of 25 human-wildlife conflicts mostly involving small mammals have been reported within the 2km radius of the alignment between 2012 and 2016 (**Chart 6-24**). Most of these conflicts were reported in Tumpat and usually involving long-tailed macaques (*Macaca fascicularis*) [**Box 1**], wild boar (*Sus scrofa*) [**Box 2**] and pig-tailed macaques (*Macaca nemestrina*).

Long-tailed macaques and wild boars are listed as “Least Concern” under the IUCN Red List of Threatened Species. These animals are highly adaptable to wide range of habitats, therefore are commonly involved in human-wildlife conflicts throughout Peninsular Malaysia. In contrast, the pig-tailed macaques (*Macaca nemestrina*) are classified as “Vulnerable” under the IUCN. This diurnal and frugivorous primate inhabits a wide range of habitats, including lowland primary and secondary forest, as well as coastal, swamp and montane forests. Although these macaques prefer dense rainforest, they can also be found in agricultural land.



**Chart 6-24 : Human Wildlife Conflict Records along the Alignment from 2012-2016 (Kelantan)**

Source: Jabatan Perhilitan Semenanjung Malaysia, 2017

#### Box 1: Long-Tailed Macaque

The Long-tailed Macaque (*Macaca fascicularis*) is the most common species involved in human-wildlife conflicts. About 66% of human-wildlife conflicts recorded in Peninsular Malaysia from 2006 to 2015 involve macaques (DWNP, 2016). This species of old-world monkey is extremely tolerant of a range of habitats, which includes mangrove and swamp forests. They can also be found in agricultural areas and urban parks. They feed mainly on fruits, but are known to also feed on insects, stems, young and mature leaves, invertebrates, bird eggs and other material during times of the year when fruit is unavailable. Long-tailed macaques that occur near human settlements are sometimes deemed as pests for their tendency to rummage through rubbish. The long-tailed macaque is listed as a Protected species under the Wildlife Conservation Act 2010.

#### Box 2: Wild Boar

Wild boar (*Sus scrofa*) inhabits a diverse array of habitats, ranging from primary to secondary forests, mangroves as well as disturbed areas such as plantations and forest patches on the fringe of human settlements. They feed mostly on fruits such as figs (*Ficus* spp.) but are also known to feed on soil, earthworms, roots, and other vegetable matter. Near human settlements, wild boars are known to rummage through rubbish and waste material. They can be found in groups of up to 20 individuals, though adult males are often solitary. The wild boar is a Protected species under the Wildlife Conservation Act 2010.

### 6.11.2.3 Segment 2: Selangor

#### Segment 2A: Gombak North to Serendah

Wildlife survey was conducted between September and October in affected forest in the Selangor State Park including Ulu Gombak FR, Templer FR and Serendah FR. The presence of 12 mammal species was recorded. **Table 6-62** presents a list of wildlife recorded from the survey.

The Ulu Gombak FR was found to harbour a significant diversity of fauna. The presence of the endangered Malayan tapir (*Tapirus indicus*) [**Box 4**] were directly captured on camera (**Plate 6-40**) and it is anticipated that at least five individuals are present in Ulu Gombak FR. Other species of IUCN concern such as the white-handed gibbon (*Hylobates lar*) [**Box 5**], siamang (*Symphalangus syndactylus*), sambar Deer (*Rusa unicolor*) and Sumatran Serow (*Capricornis sumatraensis*) was noted to be present in Ulu Gombak FR.

##### **Box 4: Malayan Tapir**

The Malayan tapir (*Tapirus indicus*) is listed as Endangered under the IUCN Red List of Threatened Species, and is a Totally Protected species under the Wildlife Conservation Act 2010. It is a forest-dwelling animal, which has been found in a number of vegetation types (including secondary forests, mature rubber plantations and open fields), but generally prefers undisturbed primary lowland forests. Tapirs may inhabit previously logged forests for browsing, but require nearby primary forests for refuge. They have a home range between 10 km<sup>2</sup> to 25 km<sup>2</sup>, with females having the tendency to have larger home ranges than males (IUCN, 2016).





##### **Box 5: White-Handed Gibbon**

The white-handed gibbon is classified as 'Endangered' under the IUCN Red List of Threatened Species and is a Totally Protected species under the Wildlife Conservation Act 2010. This species is generally found in lowland, hill, and upper dipterocarp forests. They are also known to utilize regenerating secondary forest and selectively logged forest. Like most other species of gibbon, they have a largely frugivorous diet that includes mainly figs, as well as young shoots, leaves, some flowers, and insects. Gibbons, unlike most macaques and leaf monkeys that often share their habitats, swallow nearly all the seeds that they ingest, making them potentially important as seed dispersers (IUCN, 2016).

Presence of clouded leopard (*Felis nebulosa*) was captured in Serendah FR. This rare wild cat is strongly associated with primary tropical forest but there are also records from dry and deciduous forest, as well as secondary and logged forests. They've been listed as Vulnerable under the IUCN Red List of Threatened Species since 1986, largely due to exploitation for pelts in illegal wildlife trade. Secondary signs of

another Vulnerable species under IUCN, the pig-tailed macaques (*Macaca nemestrina*), were also found in all three PRFs.

Eight species of birds were directly observed in the Selangor State Park, of which four – the Greater-Racquet tailed drongo (*Dicrurus paradiseus*), Raffles's Malkoha (*Phaenicophaeus chloropaheus*), Richard's Pipit (*Anthus richardi*) and White-bellied Sea Eagle (*Haliaeetus leucogaster*) - are Totally Protected under the Wildlife Conversation Act 2010.

 <p>ScoutGuard 09/22/2017 02:17:04</p> <p><b>Malayan Tapir</b> Ulu Gombak FR</p>	 <p>Bestok 20C 68F 09/25/2017 14:49 0000</p> <p><b>Sambar Deer</b> Ulu Gombak FR</p>
 <p>Bestok 17C 62F 09/24/2017 08:59 0000</p> <p><b>Sumatran Serow</b> Ulu Gombak FR</p>	 <p>Bestok 22C 71F 09/27/2017 17:23 0000</p> <p><b>Clouded Leopard</b> Serendah FR</p>

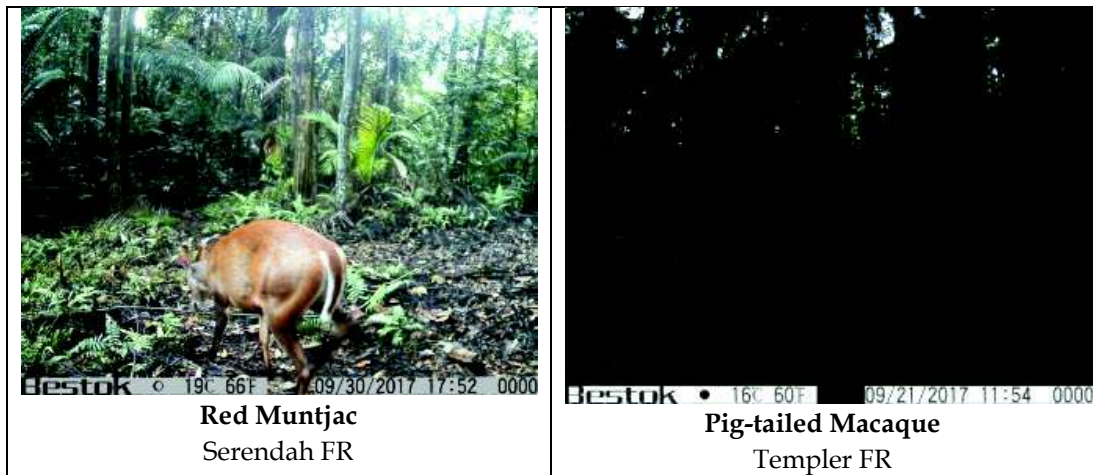
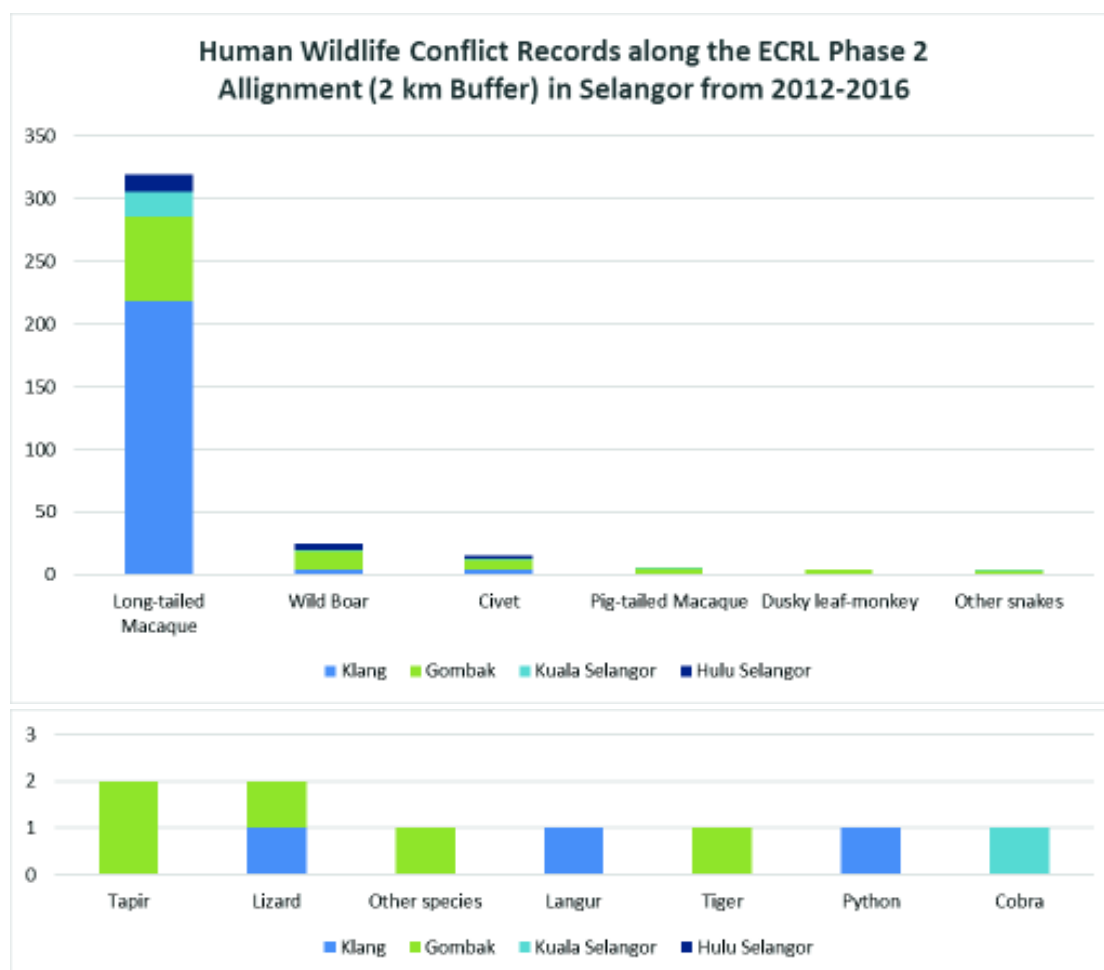


Plate 6-40 : Wildlife spotted in Selangor State Park

Past literature on the faunal communities of the Selangor State Park notes that the area harbours at least 114 species of mammals, some of which are highly threatened or endangered. Besides species identified in the survey, these include the Malayan tiger (*Panthera tigris Jacksoni*) and Malayan pangolin (*Manis javanica*). The State Park also harbours a rich avian diversity, harbouring at least 355 species of birds.

The areas near the alignment corridor between Gombak and Serendah has recorded various type of human-wildlife conflicts between 2012-2016 which includes small mammals, reptiles and large mammals (**Figure 6-2**). However, about 90% of these conflicts involve common small mammals such as macaques, wild boars, and civets that are believed to originate from the Selangor State Park and its nearby state land forests.

One human-tiger-conflict case was reported in 2015 where a Malayan Tiger was spotted nearby Templer FR. The National Tiger Conservation Action Plan (NTCAP) have highlighted that the Selangor State Park is possibly a tiger habitat based on analysis of data from 1999-2003. However, the sighting of tiger at Templer is uncommon since its surroundings have been highly developed. Moreover, according to DWNP Selangor, the forests where the alignment will traverse through is no longer a habitat and home range for tigers. It is likely that this particular tiger had strayed and originated from the Main Range in the north.



**Chart 6-25 : Human Wildlife Conflict Records along the Alignment from 2012-2016 (Selangor)**

Source: Jabatan Perhilitan Semenanjung Malaysia, 2017

**Table 6-62 : List of wildlife recorded during wildlife survey (Gombak North to Serendah)**

Class	Species	Common Name	IUCN Status	Legal Status*	Location
Mammalia	<i>Tapirus indicus</i>	Malayan Tapir	Endangered	Totally Protected	Ulu Gombak FR
	<i>Symphalangus syndactylus</i>	Siamang	Endangered	Totally Protected	Ulu Gombak FR
	<i>Hylobates lar</i>	White-handed Gibbon	Endangered	Totally Protected	Ulu Gombak FR
	<i>Macaca nemestrina</i>	Pig-tailed Macaque	Vulnerable	Protected	Ulu Gombak FR/Temppler FR/Serendah FR
	<i>Felis nebulosa</i>	Clouded Leopard	Vulnerable	Totally Protected	Serendah FR
	<i>Rusa unicolor</i>	Sambar Deer	Vulnerable	Protected	Ulu Gombak FR

Class	Species	Common Name	IUCN Status	Legal Status*	Location
	<i>Capricornis sumatraensis</i>	Sumatran Serow	Vulnerable	Totally Protected	Ulu Gombak FR
	<i>Macaca fascicularis</i>	Long-tailed Macaque	Least Concern	Protected	Ulu Gombak FR/Serendah FR
	<i>Muntiacus muntjack</i>	Red Muntjac	Least Concern	Protected	Ulu Gombak FR/Serendah FR
	<i>Sus sfora</i>	Wild Boar	Least Concern	Protected	Ulu Gombak FR/Serendah FR
	<i>Hystrix brachyura</i>	Malayan Porcupine	Least Concern	Protected	Ulu Gombak FR/Serendah FR
Avia	<i>Chloropsis cochinchinensis</i>	Blue-winged leafbird	Least Concern	Protected	Ulu Gombak FR
	<i>Chalcophaps indica</i>	Emerald Dove	Least Concern	Protected	Serendah FR/Templer FR
	<i>Dicrurus paradiseus</i>	Greater-Racquet tailed drongo	Least Concern	Totally Protected	Serendah FR/Templer FR
	<i>Phaenicophaeus chloropaheus</i>	Raffles's Malkoha	Least Concern	Totally Protected	Serendah FR/Templer FR
	<i>Gallus Gallus</i>	Red Junglefowl	Least Concern	Protected	Serendah FR/Templer FR
	<i>Anthus richardi</i>	Richard's Pipit	Least Concern	Totally Protected	Serendah FR/Templer FR
	<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	Least Concern	Totally Protected	Serendah FR/Templer FR
	<i>Copsychus malabaricus</i>	Common Shama	Least Concern	Protected	Ulu Gombak FR

\*based on Wildlife Conservation Act 2010

## Segment 2B: Serendah to Bandar Puncak Alam

Although the Rantau Panjang FR is gazetted as a plantation forest, it may potentially harbour large mammals due to the large hectareage of the forest reserve as well as it having a good canopy coverage, which provides food and shelter. A total of 16 camera traps were installed between 15<sup>th</sup> – 18<sup>th</sup> August 2017 within Rantau Panjang FR as well as the Hutan Sg. Buaya state land forest. **Table 6-63** presents a list of wildlife recorded from the survey.

The nearby Hutan Sungai Buaya was found to harbour less diversity of wildlife, where presence of only macaques, wild boars and porcupine were captured. In contrast, besides common mammals such as wild boars and macaques, the Rantau Panjang FR was noted to harbour a number of species of IUCN concern, i.e. the Malayan tapir, southern pig-tailed macaque and dusky leaf-monkey. At least 16 pig-tailed macaques are expected to occur within the forest reserve, as well as a pair of tapirs (DWNP, 2017; *pers. comm.*). Most of these mammals are experiencing threats from habitat loss and fragmentation, resulting in encroachments into nearby plantation and residential areas to forage for food.



**Plate 6-41 : Wildlife spotted in Rantau Panjang FR**

During the flora survey (18th – 20th September), shotgun casings were seen within Rantau Panjang FR, indicating that wildlife poaching is still being carried out within the forests. Besides hunting for wild boars, forest birds like the greater racket-tailed drongo and white-rumped shama are sought-after species for the wildlife trade as songbirds. Based on the Wildlife Conservation Act 2010, most of the songbirds are Totally Protected Species i.e. hunting and trade are strictly prohibited.



Plate 6-42 : Wild boar foraging marks



Plate 6-43 : Shotgun casing found in Rantau Panjang FR



**Plate 6-44 : Long-tailed macaques along Jalan Batu Arang in Rantau Panjang FR**

HWC involving small mammals is fairly common between Serendah to Bandar Puncak Alam (**Chart 6-25**). However, the surroundings of Rantau Panjang FR have experienced two reported human-tapir conflicts between 2012-2016. The presence of roads, transmission line and land clearing for agricultural activities in some parcels in northern and eastern section within the reserve have resulted in significant habitat fragmentation. This has led to wildlife such as Malayan tapirs to forage in the surrounding areas. Additionally, it is also very common for groups of long-tailed macaques to be present at the roadside of Jalan Batu Arang scavenging for food (**Plate 6-44**). During the site visits, these macaques displayed “begging” behavior indicating that they have been receiving food from passing cars.

**Table 6-63 : List of wildlife recorded during wildlife survey (Serendah to Bandar Puncak Alam)**

Class	Species	Common Name	IUCN Status	Legal Status*	Location
Mammalia	<i>Tapirus indicus</i>	Malayan Tapir	Endangered	Totally Protected	Rantau Panjang FR
	<i>Macaca nemestrina</i>	Pig-tailed Macaque	Vulnerable	Protected	Rantau Panjang FR
	<i>Presbytis obscura</i>	Dusky Leaf-Monkey	Near Threatened	Protected	Rantau Panjang FR
	<i>Paradoxurus hermaphroditus</i>	Common Palm Civet	Least Concern	Protected	Rantau Panjang FR
	<i>Tragulus napu</i>	Large Mousedeer	Least Concern	Protected	Rantau Panjang FR
	<i>Macaca fascicularis</i>	Long-tailed Macaque	Least Concern	Protected	Rantau Panjang FR/Hutan Sg. Buaya
	<i>Hystrix brachyura</i>	Malayan Porcupine	Least Concern	Protected	Rantau Panjang FR/Hutan Sg. Buaya
	<i>Sus sora</i>	Wild Boar	Least Concern	Protected	Rantau Panjang FR/Hutan Sg. Buaya
	<i>Trimeresurus hageni</i>	Indonesian Pit Viper	Least Concern	Protected	Rantau Panjang FR
	<i>Gekko gecko</i>	Tokay gecko	Not Assessed	Protected	Rantau Panjang FR
Avia	<i>Chalcophaps indica</i>	Emerald Dove	Least Concern	Protected	Rantau Panjang FR
	<i>Copsychus malabaricus</i>	White-rumped Shama	Least Concern	Protected	Rantau Panjang FR
	<i>Dicrurus paradiseus</i>	Greater Racket-tailed Drongo	Least Concern	Totally Protected	Rantau Panjang FR
	<i>Gallus Gallus</i>	Red Junglefowl	Least Concern	Protected	Rantau Panjang FR

\*based on Wildlife Conservation Act 2010

## Segment 2C: Bandar Puncak Alam to Port Klang

Direct wildlife observations were conducted concurrently during the mangrove survey at Sg. Puloh in September 2017. Direct wildlife observations focused mainly on the presence of wildlife, specifically mammals and birds, within the mangrove, as well as documenting all types of visible fauna along Sg. Puloh.

Eight species of birds were directly observed around the Sg. Puloh mangroves. Most of these species are considered to be mangrove-dependant i.e. species which are dependant on mangroves at some stage of their life cycle (though they are not totally dependant on mangroves) (Table 6-64).

**Table 6-64 : List of birds observed at Sg. Puloh mangroves**

Species	Common Name	IUCN Status	Legal Status*
<i>Ardea cinerea</i>	Grey Heron	Least Concern	Totally Protected
<i>Ardea intermedia</i>	Intermediate Egret	Least Concern	Totally Protected
<i>Ardea purpurea</i>	Purple Heron	Least Concern	Totally Protected
<i>Butorides striata</i>	Little Heron	Least Concern	n/a
<i>Haliastur indus</i>	Brahminy Kite	Least Concern	Totally Protected
<i>Leptoptilos javanicus</i>	Lesser Adjutant	Vulnerable	Totally Protected
<i>Spilornis cheela</i>	Crested Serpent-Eagle	Least Concern	Totally Protected
<i>Todiramphus chloris</i>	Collared Kingfisher	Least Concern	Totally Protected

\*based on Wildlife Conservation Act 2010

Most of the birds which were observed in the Sg. Puloh mangroves are common species that are usually found within mangrove habitats and are not IUCN-listed, with the exception of the lesser adjutant. This is the largest species of stork in Malaysia and is currently listed as “Vulnerable” due to continuous population decline. A flock of lesser adjutants consisting of five individuals were observed hovering above the mangrove canopy during the mangrove survey sessions. The presence of lesser adjutants, as well as other mangrove-dependant birds indicate that the mangroves still serve as an important habitat for avian communities, specifically those that rely on mangroves.

The region of Klang have recorded highest HWC cases (60%) in Selangor from 2012-2016. Although 95% of these reported cases involved long-tailed macaques and none were related to large mammals. Based on personal communication with DWNP, the human settlements in Klang is considered as macaque hotspots. 70% of human-macaque conflicts in Selangor within the alignment corridor are reported to occur in Klang (Chart 6-25).

### 6.11.3 Freshwater Ecology

Malaysia’s freshwater ecosystems harbour a diverse range natural habitat, including various types of rivers and lakes, riverine forests and freshwater swamps. A rich diversity of freshwater fauna, notably the fish communities have been recorded within these habitats, though the full extent of these communities has not been fully documented in the country. The proposed alignment is expected to cross numerous major freshwater rivers.

### 6.11.3.1 Approach and Methodology

The main objective of the freshwater ecology assessment was to document the different freshwater ecosystems and faunal communities that may be affected by the proposed alignment. This includes major rivers that are still important in terms of beneficial use and those that may harbour important freshwater fauna.

Due to the extensive length of the alignment, detailed inventories on freshwater biodiversity were not conducted at this stage. The main approach undertaken to document the general freshwater ecosystems was through the collation of secondary information and personal communication with researchers related to freshwater ecology.

For the purpose of reporting, description of the freshwater ecology will firstly entail a general description of the freshwater communities in the respective river systems of Kelantan and Selangor. This will then be followed by beneficial uses and present issues (if any) in a particular area of concern.

### 6.11.3.2 Overview of Freshwater Fauna

#### Fish Communities

The freshwater fish communities in most rivers of Peninsular Malaysia predominantly comprise of species from the Cyprinidae family, i.e. carps and barbs. Fish species from this family represent more than 75 percent of the overall fish diversity in most freshwater rivers in the east coast. An example of a common species from this family is the river barb (*Barbonymus schwanenfeldii*), which is widely distributed in all rivers and lakes in Kelantan and Selangor. Other common species from this family include batang hulu (*Barbichthys laevis*), lampam Jawa (*Barbonymus gonionotus*), temperas (*Cyclocheilichthys apogon*), sebarau (*Hampala macrolepidota*), and krai (*Hypsibarbus wetmorei*). This is followed closely by species from the Bagridae family, which comprise of freshwater catfish such as baung (*Hemibagrus wyckii* and *H. nemurus*) and pisang (*Pseudomystus leiocanthus*).

#### Reptiles

Common reptiles that are usually found in freshwater rivers throughout Peninsular Malaysia include the water monitor lizard (*Varanus salvator*), freshwater terrapins and the estuarine crocodile (*Crocodylus porosus*). While the estuarine crocodile is not considered to be common, it can still be found in certain locations, mostly in lower stretches of rivers, mangroves and estuaries. In the east coast, the estuarine crocodile is known to occur in major rivers of Kelantan.

### 6.11.3.3 Kelantan

More than 35 freshwater fish species have been recorded in the major rivers in Kelantan. Most of these species are cyprinids, i.e. carps and barbs (Rohasliney, 2010). Freshwater fish are generally harvested as food sources, whereby they are consumed fresh and processing focuses on less sophisticated methods like salting and drying. Sg. Kelantan is the main freshwater resource for the State, where edible fish like the river barb and jelawat (*Leptobarbus hoeveni*) are commonly caught, together with freshwater prawns and certain aquatic plants. Although it only contributes a small fraction to the freshwater fisheries in the country, i.e. approximately 5 percent (DOF, 2015), the rivers are still used by local fishermen as a source of income and livelihood.

### 6.11.3.4 Selangor

Information pertaining to the freshwater ecology in Selangor is relatively limited, with very little scientific data on freshwater diversity in the major rivers of Selangor (and the Klang Valley). The freshwater fish communities in Selangor are generally believed to be similar to those found in coastal swamp forests (Ng, 2017; *pers. comm.*). Studies on the freshwater fish diversity in the remaining peat swamp forests in Selangor i.e. Raja Musa Forest Reserve and North Selangor Peat Swamp Forest usually list cyprinids (carps and barbs) as the most common fish, followed by gouramies (family Osphromidae) and catfish (family Bagridae). These species are commonly used for human consumption as well as for ornamental purposes (Norhisyam *et. al.*, 2012; Ismail *et. al.* 2015). These species are thus expected to occur along the major rivers the proposed alignment will cross, i.e. Sg. Puloh, Sg. Klang and Sg. Gombak.

However, it should be noted that the brackish and peat swamp habitats in Selangor also harbour freshwater fish, which are endangered as well as endemic to the state only. Examples include *Betta livida* and *Parasphromenus harveyi*, which are facing threats due to continuous loss of peat swamp and blackwater habitats. The proposed alignment is not expected to traverse through any critical peat swamp areas in Selangor. As such, it is not expected to have significant impacts towards freshwater species that are of conservation concern.

## 6.12 SOCIO-ECONOMY

### 6.12.1 Introduction

The key socio-economic parameters (Table 6-65) show the East Coast Region (ECR) where the proposed ECRL runs through is relatively underdeveloped economically. Selangor is not part of the ECR but plays a key role as a final destination of the ECRL.

Under the ECRL Phase 2, the rail is expected to traverse a considerable length through the state to reach Port Klang, the premier national port. Selangor's dynamic presence is potentially significant for the ECRL as it holds 20% of the nation's population and 22% of its employment while contributing 23% to national GDP.

The East Coast region, on the other hand, has a lower share of national population at 15% and only 13% of national employment. In terms of GDP performance, its combined contribution is 9%, with annual growth of component states falling below the national average of 5% for 2014-2015. Within the East Coast region, there are differences among the component states. Kelantan, which is involved in ECRL Phase 2 is the least developed among the three. Pahang is economically the strongest with high annual GDP growth resulting in high per capita GDP. Kelantan GDP is only RM19,722 million (2015) but it has the largest concentration of population in ECR, giving it a low per capita GDP of RM 12,075 (2015). Its industrial sector is underdeveloped but it has a relatively strong primary and services sectors that may benefit from the ECRL.

**Table 6-65 : Regional Key Socio-Economic Parameters**

	2016		2015				2014		
	Population ('000)	Employment ('000)	Per Capita GDP (RM)	GDP (RM million)	% GDP Annual Growth	Capital Investment - Manufacturing (RM million)	Median Monthly Household Income (RM)	Mean Monthly Household Income (RM)	Incidence of Poverty %
Kelantan	1,797.2	632.9	12,075	19,722	3.5	354	2,716	3,715	0.9
Terengganu	1,183.9	428.5	26,529	27,760	3.3	1,400	3,777	4,816	0.6
Pahang	1,628.1	692.2	30,343	45,882	4.4	1,161	3,389	4,343	0.7
<b>East Coast Region</b>	<b>4,609.2</b>	<b>1,753.6</b>		<b>93,364</b>		<b>2,915</b>			
Share of Nation (%)	14.6	12.4		8.8		3.9			
Selangor	6,298.4	3,217.6	42,611	239,968	5.7	7,964	6,214	8,252	0.2
<b>Malaysia</b>	<b>31,660.7</b>	<b>14,163.7</b>	<b>37,104</b>	<b>1,062,805</b>	<b>5.0</b>	<b>74,693</b>	<b>4,585</b>	<b>6,141</b>	<b>0.6</b>

Sources:

1. DOSM, Current Population Estimates 2016, Tables 4.3, 4.6, 4.2, 4.13; pp59, 62, 68, and p69 (November 2016)
2. DOSM, Labour Force Survey Report 2016, Table B4-1, p 213 (April 2017)
3. DOSM, Household Income Survey 2014, Table 1.6, p 50 (June 2015)
4. DOSM, National Accounts GDP by State, 2010-2015, Table 1,2 and Table 18,21 (September 2016)
5. MIDA, Malaysia Investment Performance Report 2015, Approved Manufacturing Projects by State, Appendix 10, p 126

The lower regional economic performance of ECR is because it is relatively rural with urbanisation concentrated mostly around state capitals. Agriculture remains strong in Kelantan, contributing about a quarter to its GDP while its manufacturing is small and relatively insignificant.

Although the incidence of poverty in East Coast region has been reduced substantially over the past years to below 1% of households, monthly household incomes remain low compared to the national average. It is anticipated that with the implementation of the ECRL, the population and businesses in the ECR could derive more socio-economic benefits from greater connectivity, enhanced attractiveness to investment and the creation of more job opportunities that would improve income levels and the standards of the people staying here.

The ECRL is drawn to avoid densely populated areas in the east coast states in order to reduce negative social impacts from land acquisitions. Yet to be economically and socially effective, the ECRL has also to emphasis on connectivity for the region's population and businesses by providing access and linkages to key urban centres that will not only connect the ECR to the more developed parts of Peninsular Malaysia but it would also serve to facilitate future development growth in the region through enhanced accessibility to most parts of the country. It is expected to encourage the opening up of agricultural lands for urban-based activities such as townships, commercial centres and industrial areas, all of which are commonly associated with higher economic growth. Rural communities nearby to the proposed stations which are not affected by land acquisition are also expected to benefit from these developments through enhanced connectivity and accessibility, the creation of job and business opportunities and possibly an enhancement of property values.

## **6.12.2 Profile of 1 km corridor**

### **6.12.2.1 Population And Household Growth**

Under ECRL Phase 2, the alignment corridor covers two states i.e. Selangor and Kelantan. In Selangor, the administrative units are districts and mukims. In Kelantan, there are three levels, i.e. jajahans, districst and mukims. The analysis covers both district and mukim levels.

**Table 6-66** below shows total population (2016) in the corridor (1 km each side) is estimated at almost 2 million. Around 90% are in the Selangor segment and 10% in the Kelantan segment of the corridor. The estimated households are 473,510; of which 433,000 are in Selangor and 40,480 are in Kelantan.

The average household size is 4.2 persons for household for the entire corridor. It is smaller in Selangor at 4.1 persons per household but in Kelantan, the average household size is relatively large at 4.9 persons per household. Population growth in the respective state is assumed to reflect that of the state during the period 2010-2016.

**Table 6-66 : Population and Household Changes in ECRL Phase 2 Corridor, 2010-2016**

		Population			Household		
District	Mukim	2010	2016	%	2010	2016	Household Size
Gombak	Setapak	76,247	89,840	5.0	15,670	18,470	4.9
	Rawang	199,095	234,590	13.1	48,570	57,230	4.1
	Batu	285,288	336,150	18.8	74,849	88,200	3.8
Hulu Selangor	Serendah	83,099	97,920	5.5	19,760	23,290	4.2
Kuala Selangor	Jeram	45,352	53,440	3.0	9,562	11,270	4.7
Klang	Kapar	262,994	309,880	17.3	61,423	72,380	4.3
Kota Bharu	Klang	568,707	670,100	37.4	137,644	162,190	4.1
<b>Selangor</b>		<b>1,520,782</b>	<b>1,791,920</b>	<b>90.0</b>	<b>367,478</b>	<b>433,030</b>	<b>4.1</b>
		Population			Household		
Jajahan	District	2010	2016	%	2010	2016	Household Size
Tumpat	Jal Besar	13,283	16,240	8.2	2768	3390	4.8
	Pengkalan Kubor	21,701	26,520	13.4	4,317	5,280	5.0
	Tumpat	22,850	27,930	14.1	4,253	5,200	5.4
	Terbok	17,289	21,130	10.7	3,731	4,560	4.6
	Wakaf Bharu	37,495	45,830	23.1	7,708	9,420	4.9
Pasir Mas	Kubang Sepat	15,538	18,990	9.6	3,287	4,020	4.7
	Bunut Susu	16,879	20,630	10.4	3,551	4,340	4.8
Kota Bharu	Pendek	17,254	21,090	10.6	3,493	4,270	4.9
<b>Kelantan</b>		<b>162,289</b>	<b>198,360</b>	<b>10.0</b>	<b>33,108</b>	<b>40,480</b>	<b>4.9</b>
<b>Total</b>		<b>1,683,071</b>	<b>1,990,280</b>		<b>400,586</b>	<b>473,510</b>	<b>4.2</b>

Sources: 1. DOSM, Current Population Estimates 2016, Table 4.12, (November 2016)  
2. DOSM, Population Distribution by Local Authority Areas and Mukims. Population and Housing Census 2010 (April 2013)  
3. Consultant's Estimate

### **Kelantan**

The Kelantan segment covers the districts of Jal Besar, Pengkalan Kubor, Tumpat, Terbok and Wakaf Bharu in Tumpat Jajahan which have a combined population of 137,650 in 2016 or 69.6% of the segment population. This is the highest concentration

of people in this segment, posing a need to be careful in the drawing up the alignment in order to avoid settlements and minimize adverse impacts on them. The other districts in the segment are Kubang Sepat and Bunut Susu in Pasir Mas Jajahan and Pendek in Kota Bharu Jajahan. Population in these districts is estimated at 60,710 in 2016. Among these, a relatively high concentration of people is found in Pendek (10.6%) which is before the proposed Kota Bharu station under ECRL Phase

### **Selangor**

The Selangor segment includes mukims Setapak, Rawang, Batu, Serendah, Jeram, Kapar and Klang. Among them, the largest concentration is in Klang at 37.4%, followed by Batu with 18.8% and Kapar with 17.3% of population in this segment. The fourth largest concentration is in Rawang with 13% share. As these areas hold large number of people and households, the alignment passing through them are likely to encounter constraints from the presence of dense settlements.

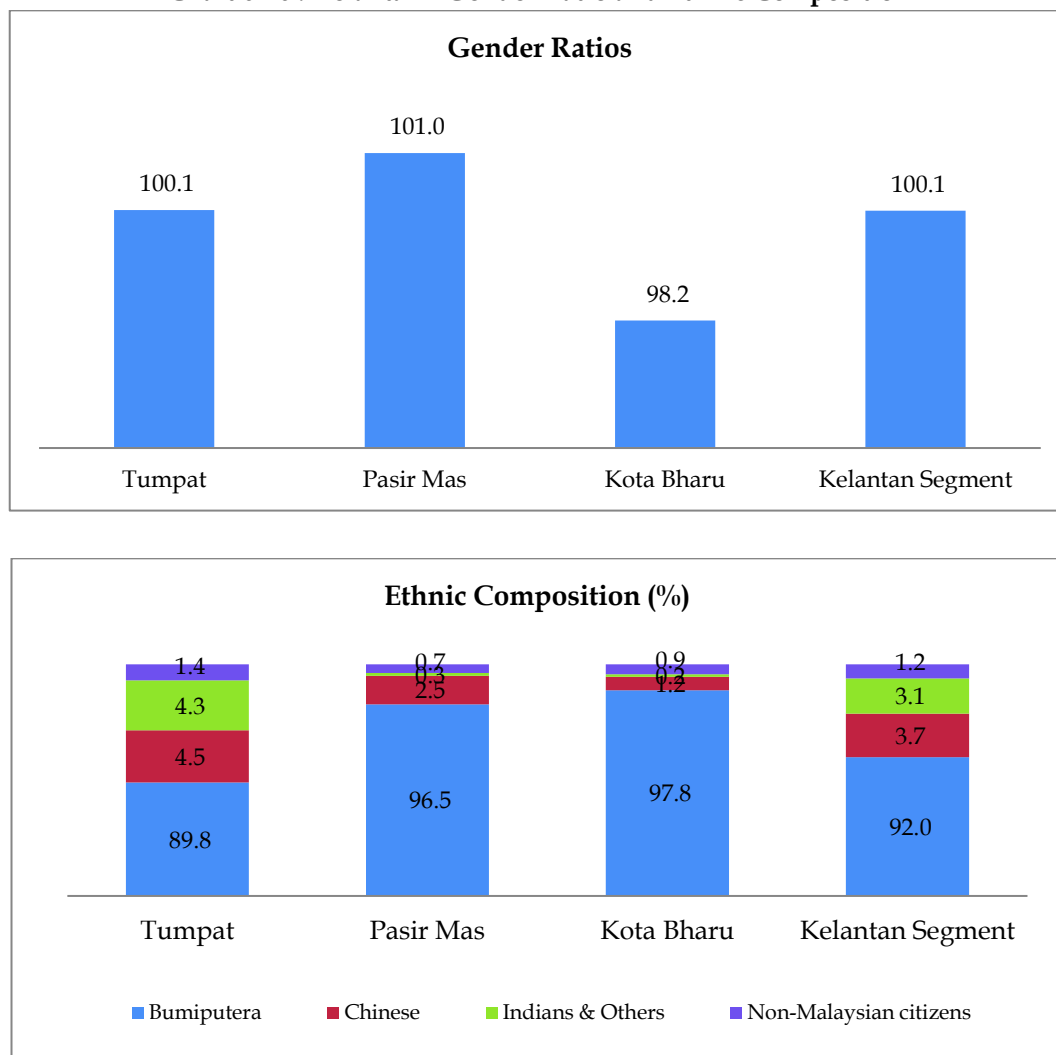
## **6.12.2.2 Gender Ratio and Ethnic Composition**

### **Kelantan**

The gender ratio in Kelantan segment shows a balance of 100 males to 100 females. This pattern is similar among the Jajahans in the segment with the exception of Pendek in Kota Bharu where the ratio falls to below 98, indicating a shortage of males relative to females (**Chart 6-26**). It also indicates possible outmigration of males from this place to elsewhere to find work.

In terms of ethnic composition, this segment is predominately occupied by Bumiputera population whose share is over 90%. This is consistent throughout the component Jajahan. Their dominant presence, combined with the rural environs where they live, tends to influence their perceptions, especially on matters related to cultural and traditional values and social conflicts. The shares of Non-Bumiputera population including Non-Malaysian citizens are extremely small.

Chart 6-26 : Kelantan - Gender Ratio and Ethnic Composition



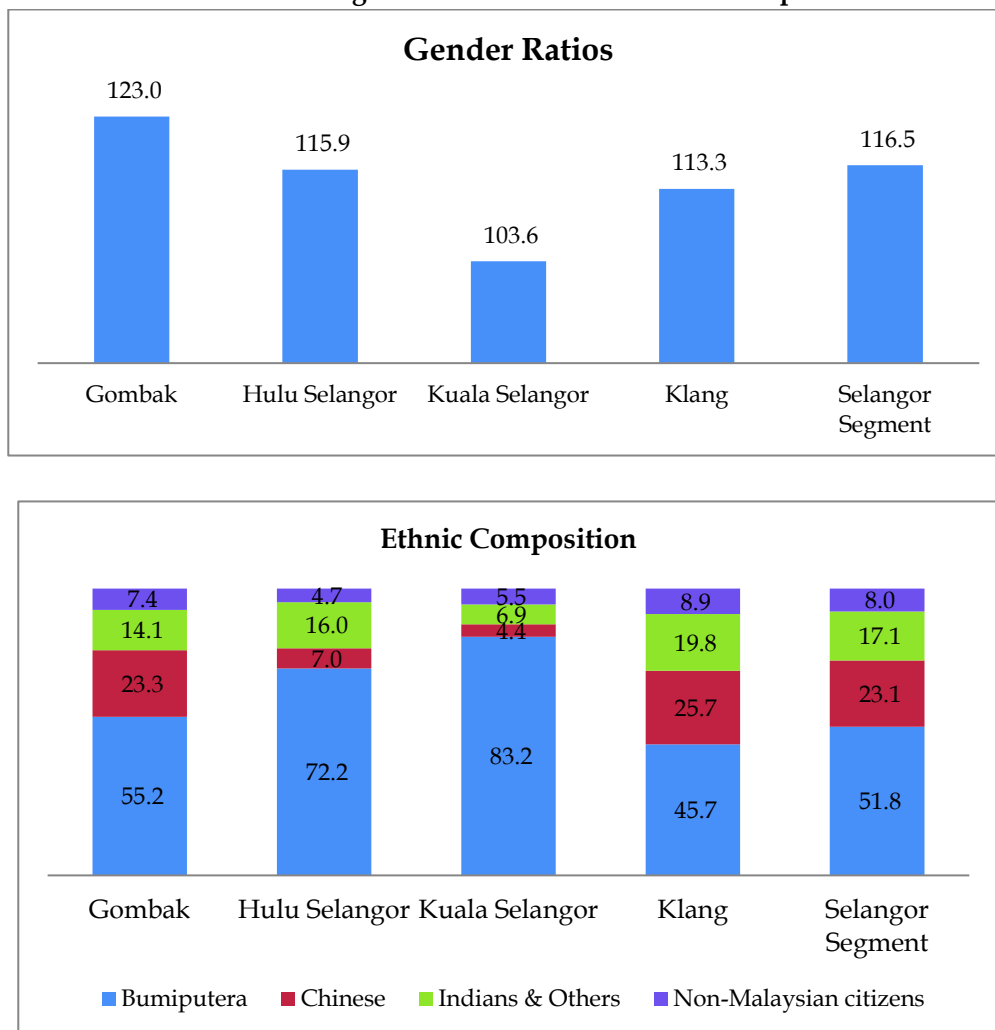
Source: DOSM, Population Distribution by Local Authority Areas and Mukims. Population and Housing Census 2010 (April 2013)

## Selangor

Gender ratios in the Selangor segment and in its component district show a strong presence of male population with ratios much higher than the normal ratio of 106 males to 100 females. Most of them have gender ratios ranging from 113 to 123 per 100 females, indicating that these places are attracting males, likely to be single and working (**Chart 6-27**). The exception is Jeram in Kuala Selangor with a much lower gender ratio.

The ethnic composition in the segment reflects a relatively well-mixed racial mix with Bumiputera holding a 52% share and forming the majority group. The Chinese have 23% share while the share of Indians and Others is 17%. The proportion of Non-Malaysian citizens is quite high at 8% of segment population (**Chart 6-27**).

Chart 6-27 : Selangor - Gender Ratio and Ethnic Composition



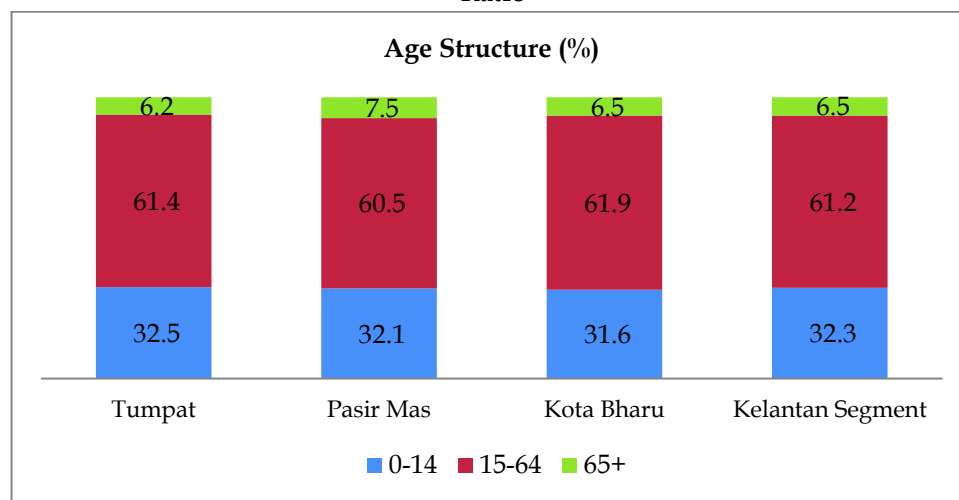
Source: DOSM, Population Distribution by Local Authority Areas and Mukims. Population and Housing Census 2010 (April 2013)

### 6.12.2.3 Age Structure

#### Kelantan

The size of the working-age population in Kelantan averages at 61% while that of the young group is at almost a third of the population and the elderly group has a high share of nearly 7% (**Chart 6-28**). This structure imposes more strain on the working-age population in supporting a larger group of dependents. The dependency ratio in the Kelantan segment is estimated at a high of 63%. Details on the age composition within districts in the Kelantan segment are summarized in **Table 6-67**.

**Chart 6-28 : Kelantan Segment-Age Structure, Mean and Median Age and Dependency Ratio**



	Kelantan	Tumpat	Pasir Mas	Kota Bharu
Mean age (years)	8.5	28.3	29.4	28.6
Median age (years)	28.6	28.4	29.7	28.6
Dependency Ratio (%)	63.3	63.0	65.4	61.4

Source: DOSM, Population Distribution by Local Authority Areas and Mukims. Population and Housing Census 2010 (April 2013)

**Table 6-67 : Kelantan Segment-Age Composition, Mean and Median Age, Dependency Ratio by District**

District	Age (years)		Age Structure (%)			Dependency Ratio (%)
	Mean	Median	0-14	15-64	> 64	
Jal Besar	29.6	29.5	30.6	62.0	7.3	61.3
Pengkalan Kubor	27.3	27.0	34.3	59.9	5.8	66.9
Tumpat	27.1	30.0	35.5	58.9	5.5	69.7
Terbok	30.0	31.3	29.8	62.9	7.3	59.0
Wakaf Bharu	28.4	29.0	31.4	62.8	5.8	59.3
Kubang Sepat	29.9	29.6	31.8	60.7	7.5	64.8
Bunut Susu	28.9	28.8	32.3	60.3	7.4	66.0
Pendek	28.6	28.6	31.6	61.9	6.5	61.4

Note: Pendek District is similar to Jajahan Kota Bharu

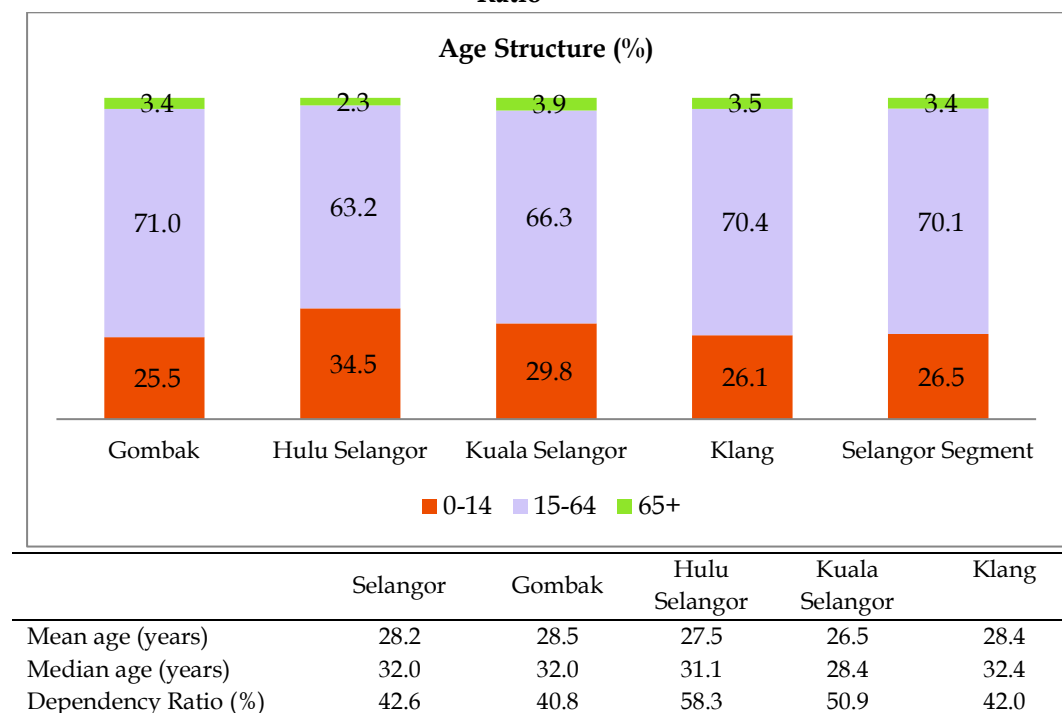
Source: DOSM, Population Distribution by Local Authority Areas and Mukims. Population and Housing Census 2010 (April 2013)

## Selangor

In the Selangor segment, the size of the working-age population is relatively large, averaging 70% (compared to a smaller size of 61% in Kelantan). The shares of the elderly are relatively small, falling below 4% across the segment while those of the young are below 30% (**Chart 6-29**). This pattern affects the dependency ratio in the segment as the combination of a large workforce and a small group of the elderly

tends to lower the dependency ratio. The mean age in the segment is estimated at 28 years with the median at 32 years. This implies that the population here is young, and likely to be working. More details on age composition at mukim level in the Selangor segment are shown in **Table 6-68**.

**Chart 6-29 : Selangor Segment-Age Structure, Mean and Median Age and Dependency Ratio**



	Selangor	Gombak	Hulu Selangor	Kuala Selangor	Klang
Mean age (years)	28.2	28.5	27.5	26.5	28.4
Median age (years)	32.0	32.0	31.1	28.4	32.4
Dependency Ratio (%)	42.6	40.8	58.3	50.9	42.0

Source: DOSM, Population Distribution by Local Authority Areas and Mukims. Population and Housing Census 2010 (April 2013)

**Table 6-68 : Selangor Segment-Age Composition, Mean and Median Age, Dependency Ratio by Mukim**

Mukim	Age (years)		Age Structure (%)			Dependency Ratio (%)
	Mean	Median	0-14	15-64	> 64	
Setapak	27.9	34.0	22.0	74.6	3.4	34.1
Rawang	27.5	31.1	30.0	67.0	3.0	49.4
Batu	29.5	33.5	23.4	72.9	3.7	37.2
Serendah	25.5	27.9	34.5	63.2	2.3	58.3
Jeram	26.5	28.4	29.8	66.3	3.4	50.9
Kapar	28.0	32.0	22.0	74.6	3.9	42.7
Klang	28.5	32.6	25.9	70.6	3.5	41.7

Source: DOSM, Population Distribution by Local Authority Areas and Mukims. Population and Housing Census 2010 (April 2013)

## 6.13 TRAFFIC

The traffic volumes of the roads along the ECRL line are reviewed, recognising that these roads may be affected during the construction phase. The current traffic volumes are sourced from a primary and secondary database and reviewed against the existing road inventory, specifically the road capacity, resulting in the drawing up of a broad based volume over capacity ratio. This is necessary to gauge the performance of these roads during the construction phase of the Project.

**Table 6-69** tabulates the location of the stations, the type of stations and the roads where the stations are to be located.

**Table 6-69 : Roads Adjacent to Proposed Stations**

State/Segment	Station	Type of Station (Type of Platform)	Station's Function	Road Adjacent to Station
<b>Kelantan</b>	Pengkalan Kubor	At- Grade	Passenger	Jalan Pengkalan Kubor
	Wakaf Bharu	At- Grade	Passenger & Freight	Jalan Kota Bharu- Pengkalan Kubor
<b>Selangor</b>				
Segment 2A: Gombak North to Serendah	Serendah	At- Grade	Passenger & Freight	Federal Route 1, Serendah
Segment 2B: Serendah to Bandar Puncak Alam	Puncak Alam	At- Grade	Passenger	Persiaran Puncak Alam 10
Segment 2C: Bandar Puncak Alam to Port Klang	Kapar	At- Grade	Passenger	Jalan Haji Abdul Manan
	Jalan Kastam	At- Grade	Passenger & Freight	Jalan Kastam

### 6.13.1 Segment 1: Kelantan

The proposed ECRL Phase 2 alignment has 2 stations in Kelantan, namely Pengkalan Kubor and Wakaf Bharu. The main road adjacent to Pengkalan Kubor station is Jalan Pengkalan Kubor while the main road adjacent to Wakaf Bharu station is Jalan Kota Bharu – Pengkalan Kubor. The v/c ratio analysis shows that Jalan Pengkalan Kubor and Jalan Kota Bharu – Pengkalan Kubor are performing at a satisfactory level with a level of service A.

## Pengkalan Kubor Station

The Pengkalan Kubor Station will cater for passenger traffic only. This station is located off Jalan Pengkalan Kubor which is a 2-lane single carriageway with capacity of 1,100 veh/hr/lane. It is currently performing at LOS A during both morning and evening peak hours. This shows that the roadway is at a satisfactory level. The local roads accessing the stations are Jalan Pengkalan Kubor (LOS A) and Jalan Besar (LOS A). These roads are performing at satisfactory levels of service.

The amenities in the vicinity of the station are mainly residential areas such as Kampung Kok Semru, Kampung Kok Serai, Kampung Pauh Sebanjan, Kampung Ketil and Kampung Telaga Lanas. **Chart 6-30** shows the location of the station and the road network in the vicinity.

**Chart 6-30 : Existing Road Network Surrounding Pengkalan Kubor Station**



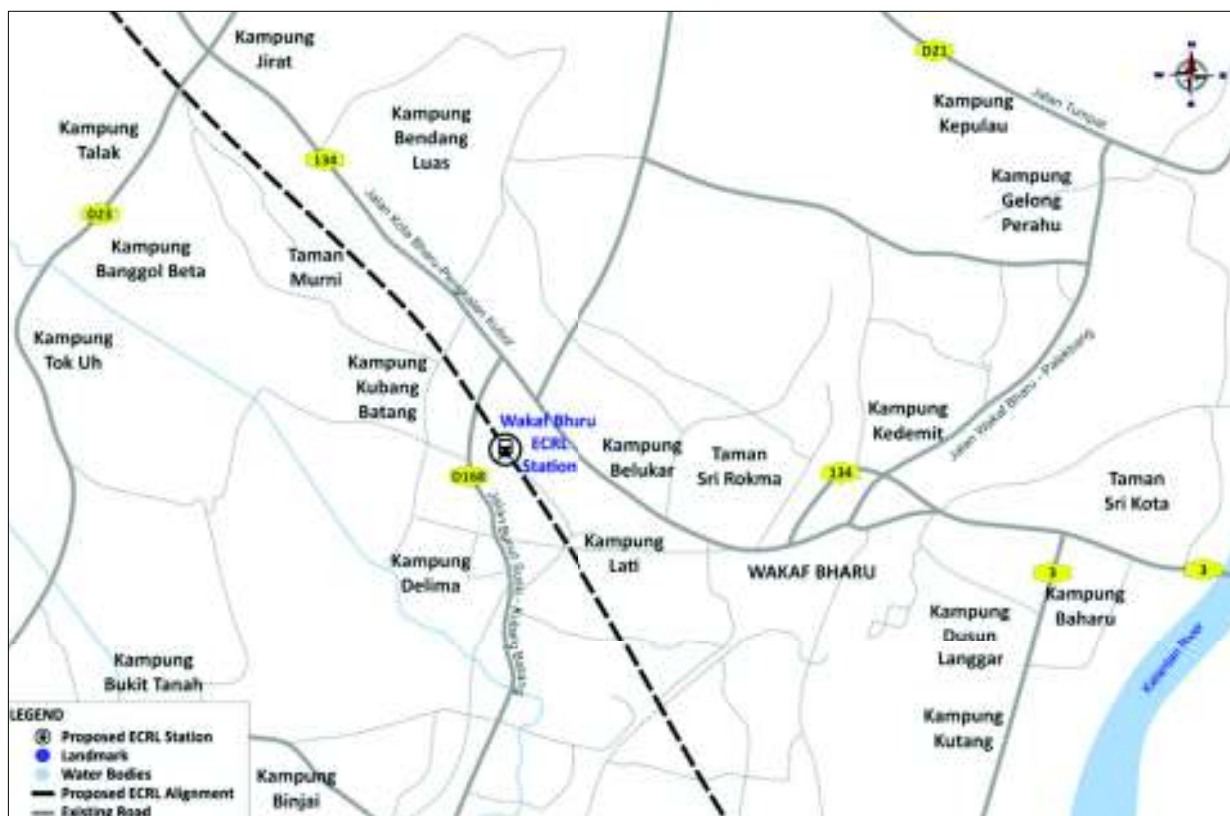
## Wakaf Bharu Station

The Wakaf Bharu Station will cater for both passenger and freight traffic. The station is situated at Wakaf Bharu, Kelantan. It is a 2-lane single carriageway with a capacity of 1,100 veh/hr/lane which is performing at LOS A during both morning and evening peak hours.

The amenities in the vicinity of the station are mainly residential areas such as Kampung Belukar, Taman Sri Rokma, Kampung Lati and Kampung Delima. The

survey carried out at the road indicates that it is performing at a satisfactory level of service A during peak hours. **Chart 6-31** shows the location of the station and the road network in the vicinity.

**Chart 6-31 : Existing Road Network Surrounding Wakaf Bharu Station**



### 6.13.2 Segment 2 : Selangor

There are four stations proposed along the segment of the alignment in Selangor, i.e. Serendah station, Puncak Alam station, Kapar station and Jalan Kastam station. The Serendah station and Jalan Kastam station are planned for passenger traffic or/and freight while Puncak Alam station and Jalan Kastam station are passing loop stations which will be operational in the future. The Serendah station is situated off Federal Route 1 while the Puncak Alam station is situated at Persiaran Puncak Alam 10. The Kapar station is located at Jalan Haji Abdul Manan and the Jalan Kastam station is located at Jalan Kastam.

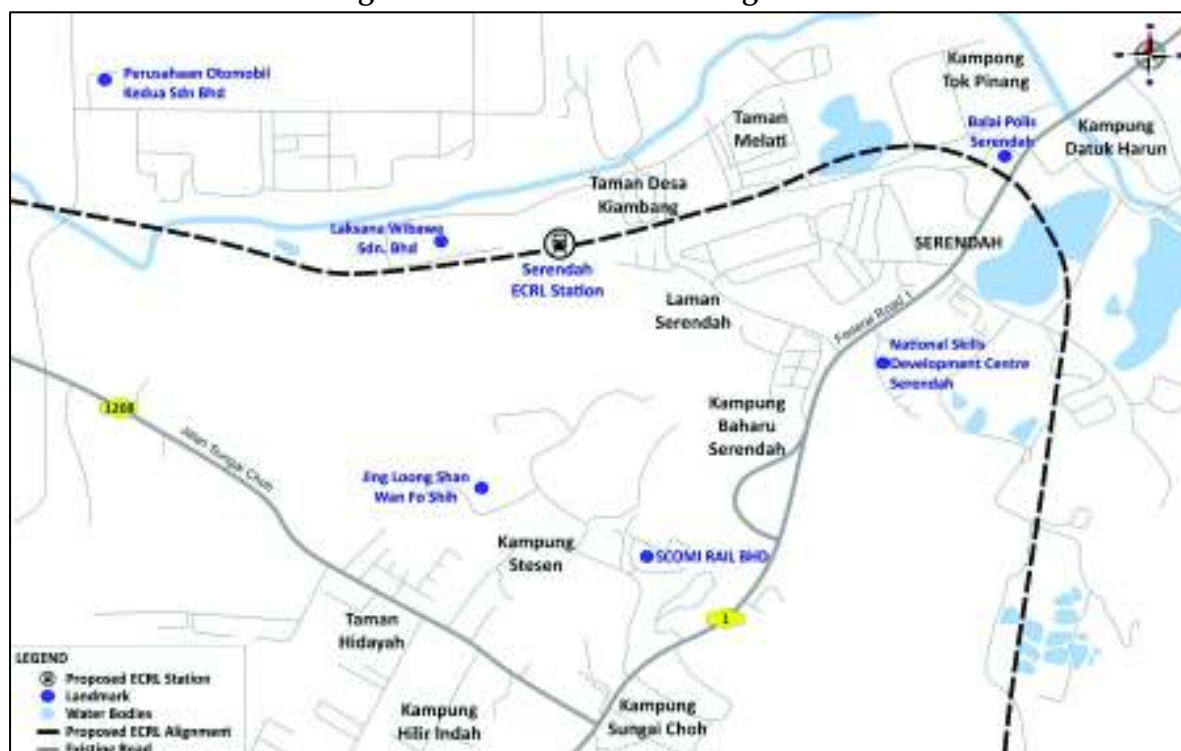
## Segment 2A: Gombak North to Serendah

### Serendah Station

The Serendah Station will cater for both passenger and freight traffic. The station is located off Federal Route, (FR 1) at Serendah, Selangor, which is a 4-lane single carriageway at the capacity of 1,200 veh/hr/lane. It is performing at LOS C during both morning and evening peak hours. It shows that the road is performing at acceptable levels of service during peak hours with sufficient capacity to accommodate future traffic growth.

The station is surrounded by residential areas namely Taman Garing Utama, Taman Bukit Rawang Jaya, Taman Anugerah Suria, and Taman Rawang Jaya. **Chart 6-32** shows the location of the station and the road network in the vicinity.

**Chart 6-32 : Existing Road Network Surrounding Serendah Station**



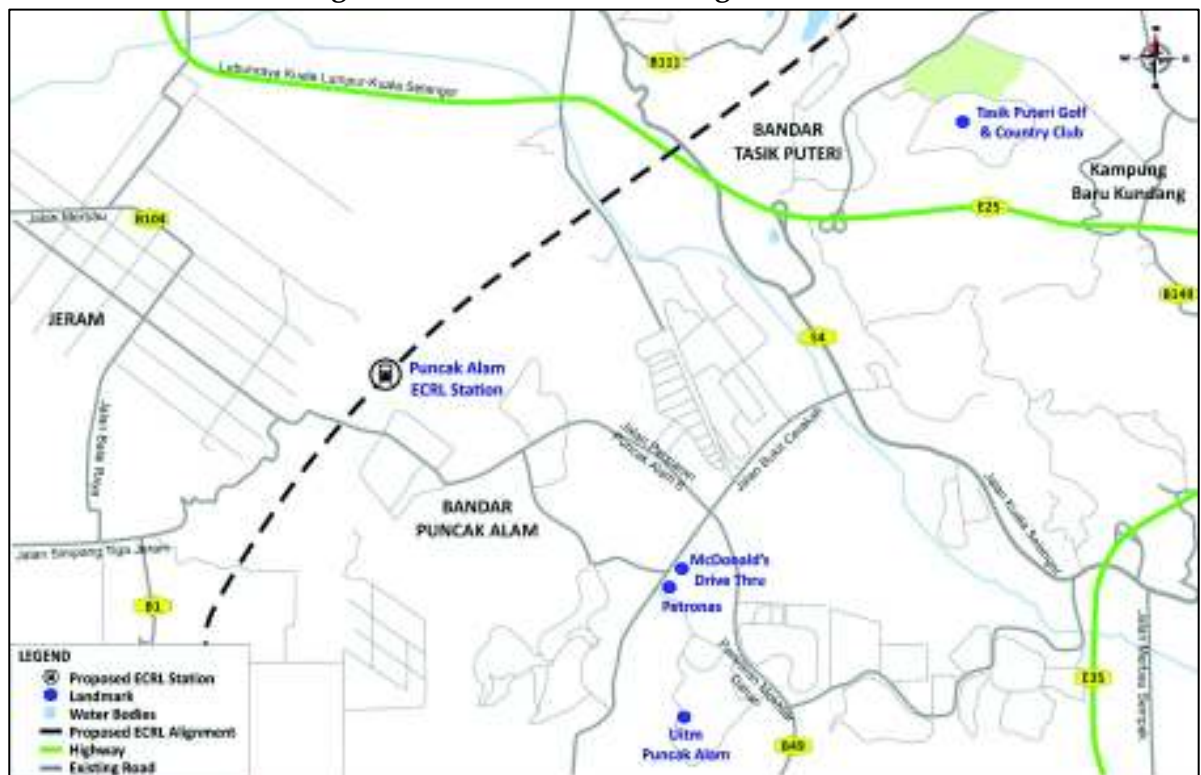
## Segment 2B: Serendah to Bandar Puncak Alam

### Puncak Alam Station

The Puncak Alam Station is a passing loop station being planned as a proposed station for the future. The station is located at Persiaran Puncak Alam 10 at Bandar Puncak Alam, which is a dual two (2) lane carriageway with a capacity of 1,800

veh/hr/lane. It is performing at LOS B during the morning peak hour and LOS A during the evening peak hour. The analysis shows that the road is performing at acceptable levels during peak hours with sufficient capacity to accommodate future traffic growth. **Chart 6-33** shows the location of the station and the road network in the vicinity.

**Chart 6-33 : Existing Road Network Surrounding Puncak Alam Station**



## Segment 2C: Bandar Puncak Alam to Port Klang

### Kapar Station

The Kapar Station is a passing loop station being planned for the future. The station is located at Jalan Haji Abdul Manan at Kapar, Klang, which is a 2-lane single carriageway with a capacity of 1,100 veh/hr/lane. It is performing at LOS E during the morning peak hour and LOS F during the evening peak hour, which confirms that this road has insufficient capacity to accommodate current traffic conditions. The Jalan Meru/Jalan Haji Abdul Manan junction is busy and congested during peak hours. Significant queue is observed at this junction during peak hours. Other roads in the vicinity of the station are Jalan Meru Tambahan and Persiaran Hamzah Alang. **Chart 6-34** shows the location of the station and the road network in the vicinity.

Chart 6-34 : Existing Road Network Surrounding Kapar Station

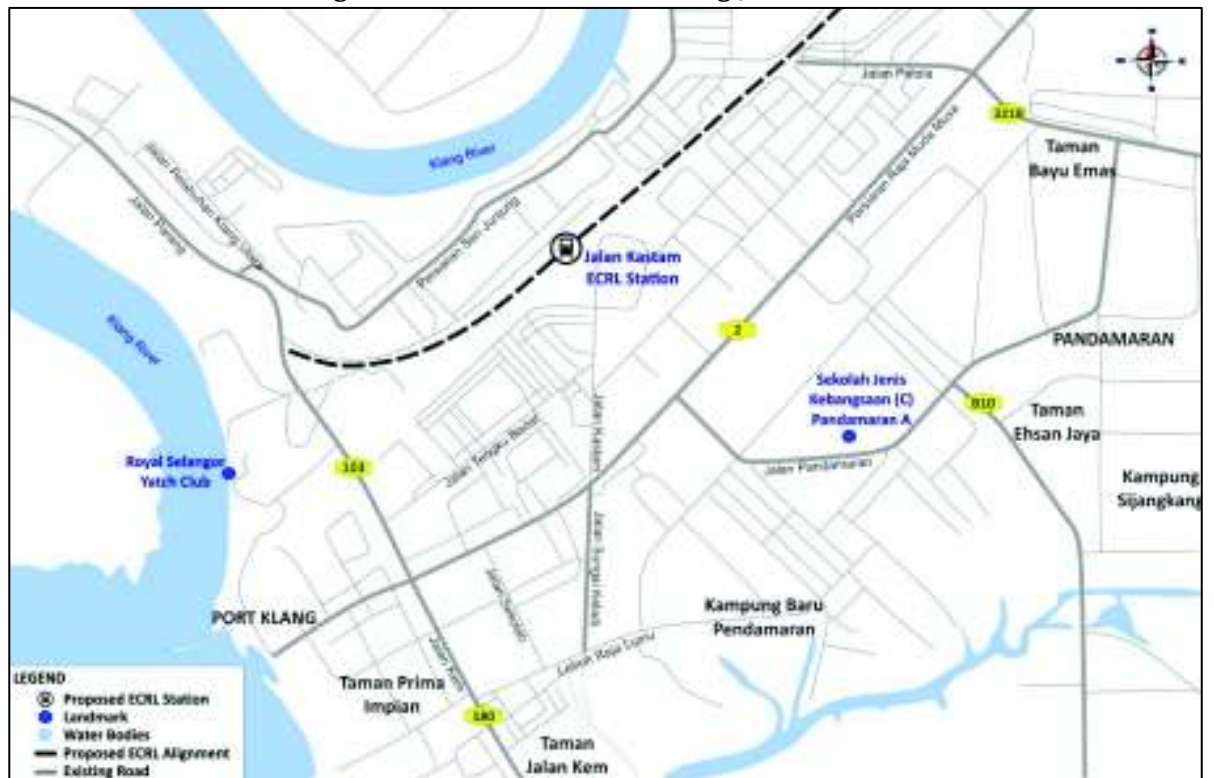


### Jalan Kastam Station

The Jalan Kastam Station will cater for passenger and freight traffic. The station is accessible via Jalan Kastam which is a 2-lane single carriageway road with a capacity of 1,200 veh/hr. It is performing at LOS C during the morning peak hour and LOS D during the evening peak hour, which are acceptable levels of service.

The station is about 3 km away from Port Klang. Other roads in the vicinity of the station are Persiaran Raja Muda Musa, Jalan Batu Unjur and Persiaran Pegaga. The residential area in the vicinity of the station are Kampung Telok Gadung Besar, Kampung Raja Uda and Kampung Kastam. **Chart 6-35** shows the location of the station and the road network in the vicinity.

**Chart 6-35 : Existing Road Network Surrounding Jalan Kastam Station**



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**Table 6-70 : Road Performance in the Vicinity of Stations**

Station	Road Section	Direction	Number of lanes	Capacity (pcu/hr)	AM Peak		PM Peak		Highest v/c ratio (LOS)
					Volume (v/c ratio)	LOS	Volume (v/c ratio)	LOS	
Kelantan									
Pengkalan Kubor	Jalan Pengkalan Kubor (2-lane single carriageway)	2-way flow	2	2200	337 (0.15)	A	309 (0.14)	A	0.15 (A)
Wakaf Bharu	Jalan Kota Bharu-Pengkalan Kubor (2-lane single carriageway)	2-way flow	2	2200	499 (0.23)	A	372 (0.17)	A	0.23 (A)
Selangor									
Serendah	Federal Route 1 (4-lane single carriageway)	2-way flow	4	4800	2708 (0.56)	C	2772 (0.58)	C	0.58 (C)
Puncak Alam	Persiaran Puncak Alam 10 (Dual-2 carriageway)	Eastbound	2	3600	1017 (0.28)	B	728 (0.20)	A	0.28 (B)
		Westbound	2	3600	459 (0.13)	A	723 (0.20)	A	0.20 (A)
Jalan Kapar	Jalan Haji Abdul Manan (2-lane single carriageway)	2-way	2	2200	1923 (0.89)	E	2495 (1.13)	F	1.13 (F)
Jalan Kastam	Jalan Kastam (2-lane single carriageway)	2-way flow	2	2200	990 (0.45)	C	820 (0.37)	B	0.45 (C)

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## 6.14 WASTE

This section describes the existing solid waste management by the local authorities in Kelantan and Selangor which are involved with the proposed Project alignment. The information such as waste generation, waste management and available landfills described in this section will form the baseline for impact assessment in **Section 7**. All the information was collated from literature review and confirmed via consultation with the relevant local authorities and landfill operators.

### 6.14.1 Segment 1: Kelantan

Solid waste management in Kelantan is currently managed by the local authorities under the Local Government Act 1976 (Act 171). The Project alignment will pass through three local authorities' areas which are Majlis Daerah Ketereh (MDK), Majlis Daerah Pasir Mas (MDPM) and Majlis Daerah Tumpat (MDT). Solid waste generation within these local authorities is tabulated in **Table 6-72**. The information of the existing landfills is listed in **Table 6-74** and shown in **Figure 6.14-1**.

**Table 6-71 : Solid Waste Generation in Kelantan (Current)**

District	Waste generation (tonnes / day)
Ketereh	120
Tumpat	125
Pasir Mas	120

Source: MDK, MDT and MDPM (2017)

#### Majlis Daerah Ketereh (MDK)

Solid waste generation within the MDK areas which includes domestic and bulk wastes is currently estimated about 120 tonnes per day. The collection, transportation and disposal of solid waste is carried out by MDK on a daily basis (7.30 a.m. to 2.30 p.m.) from Sunday to Saturday. The existing disposal site at Bukit Ajil Landfill is an open dumping site which is managed by MDK. At present, this landfill had already reached its full capacity. Based on information obtained from MDK, new adjacent areas (~16ha) have been acquired from the State for the expansion of the existing landfill.

### **Majlis Daerah Tumpat (MDT)**

At present, generation of solid waste is estimated about 125 tonnes per day within areas under the jurisdiction of MDT. The collection, transportation and disposal of solid waste are fully carried out by MDT. Domestic and bulk wastes from residential and commercial areas are collected on a daily basis (7.30 a.m. to 2.30 p.m.) from Sunday to Saturday. Upon collection, wastes will be transported and disposed at the Kg Kok Bedollah Landfill (open dumping) which is managed by MDT. This landfill had reached about 40% of its full capacity with a projected life span until year 2045. The type of wastes that can be received by this landfill includes domestic, inert and construction wastes.

### **Majlis Daerah Pasir Mas (MDPM)**

Generation of solid waste within areas under Majlis Daerah Pasir Mas is estimated about 120 tonnes per day. The solid waste management is carried out solely by MDPM. Domestic and bulk wastes are picked up on a daily basis (Sunday to Saturday) from 7.30 a.m. to 2.30 p.m. All wastes will be transported and disposed at an open dumping of Kg Pusu 40 Landfill. The type of wastes that can be received by this landfill includes domestic and construction wastes.

## **6.14.2 Segment 2 : Selangor**

Solid waste management in Selangor is currently managed by the local authorities under the Local Government Act 1976 (Act 171). At present, Selangor has yet to adopt the solid waste management policy introduced through Solid Waste and Public Cleansing Management Act 2007 (Act 672) by the Federal Government. Therefore, the responsibility of managing the solid waste in each area will be under local authorities and monitored by the State Government.

The alignment passes through four local authorities which are Majlis Perbandaran Selayang (MPS), Majlis Daerah Hulu Selangor (MDHS), Majlis Daerah Kuala Selangor (MDKS) and Majlis Perbandaran Klang (MPK). The current amount of solid waste generation within these local authorities' areas is tabulated in **Table 6-73**. The information of the respective landfills for each local authority is listed in **Table 6-54** and shown in **Figure 6.14-2**.

**Table 6-73 : Solid Waste Generation in Selangor (Current)**

<b>District</b>	<b>Waste generation (tonnes / day)</b>
Selayang	600
Hulu Selangor	130
Kuala Selangor	215
Klang	500

Source: MPS, MDHS, MDKS and MPK (2017)

### **Majlis Perbandaran Selayang (MPS)**

The amount of solid waste generated within MPS areas is currently estimated about 600 tonnes/day. KDEB Waste Management Sdn Bhd has been appointed as the contractor for the collection, transportation and disposal of solid waste. The frequency for waste collection is three times a week for residential and daily for commercial. After collection, domestic waste is transported to two sanitary landfills which are Bukit Tagar Landfill and Jeram Landfill. Construction waste (e.g. concrete debris, disused formwork) and bulk waste (e.g. furniture, electrical appliances, tree trunks) are disposed at Sg. Kertas Landfill and Kuang Landfill.

### **Majlis Daerah Hulu Selangor (MDHS)**

Solid waste in Hulu Selangor areas is solely under the management of MDHS. The solid waste generation within MDHS areas is estimated about 130 tonnes/day with a frequency of waste collection three days a week for both domestic and commercial. For construction waste, collection and disposal is carried out by contractors registered with MDHS.

The main disposal site for Hulu Selangor areas is located at Sg. Sabai Landfill in Kalumpang which is an open dumping site. At present, this dumping ground can only receive construction and bulk wastes while domestic wastes are being disposed at Bukit Tagar Sanitary Landfill. The instruction to terminate Sg. Sabai Landfill from receiving domestic wastes was made by Lembaga Urus Air Selangor (LUAS) due to possible river pollution from untreated leachate discharge into Sg. Sabai.

### **Majlis Daerah Kuala Selangor (MDKS)**

The current solid waste generation within MDKS areas is estimated about 215 tonnes/day. The collection, transportation and disposal of solid wastes (domestic, construction and bulk) is carried out by the appointed contractors three times a week for residential and on a daily basis for commercial and market. After collection, solid wastes are transported and disposed at the Jeram Landfill.

### **Majlis Perbandaran Klang (MPK)**

Solid waste management in MPK areas is currently contracted to KDEB Waste Management Sdn Bhd. The solid waste generation (domestic, bulk and garden wastes) is estimated about 500 tonnes/day. For domestic wastes, the frequency of collection is three times a week while for garden and bulk wastes, the frequency is twelve or 36 times per month. Industrial and construction wastes are managed by the contractors that are registered with MPK. All wastes from MPK areas are disposed at Jeram Landfill.

**Table 6-74 : List of Active Landfills near the Alignment in Kelantan and Selangor**

Landfill Name	Local Authority	Landfill Area (ha)	Landfill Current Capacity	Distance from Alignment	Type of Landfill	Type of waste accepted	Landfill Operator	Lifespan (Year)
<b>Kelantan</b>								
Bukit Ajil Landfill (N5.89367°, E102.26009°)	Majlis Daerah Ketereh (MDK)	2.9	100% (in process for expansion of new 16ha areas)	20 km	Open dumping	<ul style="list-style-type: none"> <li>Domestic waste</li> <li>Construction waste in small quantity</li> </ul>	Majlis Daerah Ketereh	2017
Pusu 40 Landfill (N5.98818°, E102.09245°)	Majlis Daerah Pasir Mas (MDPM)	4.45	NA	16 km	Open dumping	<ul style="list-style-type: none"> <li>Domestic waste</li> <li>Construction waste</li> </ul>	Majlis Daerah Pasir Mas	2027
Kg. Kok Bedollah Landfill (N6.19458°, E102.13444°)	Majlis Daerah Tumpat (MDT)	20.23	40%	2 km	Open dumping	<ul style="list-style-type: none"> <li>Domestic waste</li> <li>Construction waste</li> </ul>	Majlis Daerah Tumpat	2045
<b>Selangor</b>								
Jeram Landfill (N 3.19174°, E101.36778°)	Majlis Perbandaran Klang (MPK)	64.7	NA	2.3 km	Sanitary	Accept domestic waste (95%) and others (5%)	Worldwide Landfills Environmental	2032
	Majlis Daerah Kuala Selangor (MDKS)							
	Majlis Perbandaran Selayang (MPS)							

NA = Not Available

**Table 6-74 : List of Active Landfills near the Alignment in Kelantan and Selangor (cont'd)**

Landfill Name	Local Authority	Landfill Area (ha)	Landfill Current Capacity	Distance from Alignment	Type of Landfill	Type of waste accepted	Landfill Operator	Lifespan (Year)
<b>Selangor</b>								
Kuang Landfill (N 3.2566°, E101.5635°)	Majlis Perbandaran Selayang (MPS)	10.9	NA	12 km	Open dumping	Accept construction waste	Worldwide Landfills Environmental	2032
Sungai Kertas Landfill (N 3.264304°, E101.687813°)		5.74	NA	100 m	Inert waste landfill	Accept construction waste	Worldwide Landfills Environmental	Pending info
Sg Sabai Kalumpang Landfill (N 3.6078°, E 101.5412°)	Majlis Daerah Hulu Selangor (MDHS)	25.9	11 %	27 km	Open dumping	Accept inert waste (Garden waste, soil, construction waste, tyre and any non-leachable waste)	YWT Enterprise	No information on the lifespan
Bukit Tagar Landfill (N 3.5000°, E 101.4700°)	Majlis Daerah Hulu Selangor (MDHS)	283.3	NA	18 km	Sanitary	Accept domestic waste only	KUB Berjaya Enviro Sdn Bhd	2079

NA = Not Available