04 PROJECT OPTIONS

Section 4

PROJECT OPTIONS

4.1 INTRODUCTION

Various alignment options were identified and evaluated in the process of selecting the preferred, optimum alignment for the Project. The options varied according to the physical characteristic, socio-economic constraints and transport network design requirements of each alignment options. In addition to the alignment options, two options for railway gauge were also considered, namely standard gauge and meter gauge.

4.2 PLANNING & DESIGN BASIS

During the Feasibility Study for the ECRL Phase 2, a set of planning guidelines were used to develop the design concept for the ECRL Phase 2 corridor and the alignment (**Table 4-1**).

Table 4-1 : Planning Guidelines for ECRL Phase 2

Aspect	Description
Strategic position	• Enhancing existing railway stations close to town centers to provide connectivity for freight transport
Future development	• To avoid encroaching on areas committed for future development
Connectivity	• Provide connectivity to: ▪ Major urban centers ▪ Industrial clusters ▪ Sea ports and internal container depot ▪ Tourism zones ▪ Integrated transport terminals
Environment	• Minimize encroaching to Environmentally Sensitive Areas (ESAs) such as swamp forest, river corridors, forest reserves, ecological linkages and wildlife habitats wherever possible

Additionally, a set of criteria will also be used to evaluate alignment options and to determine the preferred alignment (**Table 4-2**).

Table 4-2 : Alignment Criteria for ECRL Phase 2

Aspect	Objective	Criteria
Policy Considerations	• Compliance to, National Physical Plan and State Structure Plans • Compliance with the statutory local plans • Promote regional development	• Connect Key Development Areas identified in the structure and local plans • Integration with other transport system (e.g freight accessibility to railway line, intercity bus routes) • Conform with local plan alignment wherever possible • Good accessibility to state capital and town centres (5-8km from town centre)
Economic & Financial	• Maximize economic and financial returns	• Achieve acceptable Financial Internal Rates of Return • Achieve acceptable Economic Internal Rates of Return
Engineering	• Minimize construction cost of the proposed alignment • Optimize the use of existing infrastructure • Minimize operation & maintenance cost	• Avoid coastal zone (5km from coastline) and flood prone areas • Compliance with speed & geometrical requirements • Prefer flat land with less than 1% gradient wherever possible • Suitable geology & bedrock
Environment	• Minimize intrusion into environmentally sensitive areas (ESA)	Avoid: • ESA Rank 1 • Storm surge areas (Area affected by climate change) • Wildlife habitat and Ecological linkages • Coastal River corridors • Coastal Swamp forests
Social	• Minimize land acquisition cost • Mitigate objections from local stakeholders • Promote sustainable public transport • Optimize end to end journey time • Provide increased connectivity between East Coast states and the West Coast	Avoid: • High density built up areas • Committed development areas • National security installations • Small holding agricultural land • Avoid local community severance • Avoid culturally sensitive land and historical sites such as cemetery, places of worship etc Prefer: • Route alignment to traverse state land and large land holdings wherever possible • Connect all existing railway lines / stations • Scenic route (promote experiential tourism)

4.2.1 Station Planning Criteria

ECRL stations can serve as passenger, mixed passenger and freight stations, or as freight-only stations. The design planning criteria principles considered when determining the station locations in the Feasibility Study are as follows:

- Connecting all state capitals as well as major urban centers that have sufficient population catchment for intercity transit or commuter stations
- Easy accessibility to a wide segment of the population by a central location within urban limits
- Availability of land for development of station and its ancillary uses
- Adjacent to bus routes and KTMB transit routes for interchanges
- Avoidance or minimized severance of communities

The stations in Kelantan will be located as close to the coast as possible, without intruding on the coastline and its potential for tourism and other industries (at least 5 km away from the coastline). These considerations will allow easy access from the stations to towns, tourism hotspots and industrial zones yet still avoid the coastal zone.

4.3 NO PROJECT OPTION

The No Project would have resulted in foregoing the benefits of the east-west railway link between the East Coast and the West Coasts of Peninsular Malaysia as envisaged and planned in the various National Physical Plans, State Structure Plans, ECER Master Plan, Land Transport Master Plan and the Feasibility Study.

4.4 ALIGNMENT OPTIONS

4.4.1 Kelantan Options

Alignment option study was carried out to assess route options. For the Kelantan extension, four proposed routes were studied for to determine the best alignment (**Chart 4-1**). The options were:

- **Option A & D**: Generally in the same northwest direction from Kota Bharu Station to Pengkalan Kubor Station with some differences in curvature of the alignments.
- **Option B**: Also starts from Kota Bharu but will turn northeast at Wakaf Bharu to join the existing KTM line before heading northwest again and ending at Pengkalan Kubor.

- **Option C**: Commences from Jelawat station and travels closer to the coast, passing Kota Bharu and Pengkalan Chepa and then continuing northwest before ending at Pengkalan Kubor.

Chart 4-1 : Kelantan Route Options

Source: Presentation to EXCO Kelantan, 2017

The criteria used in deriving these options are construction costs, alignment geometry, social impact, constructability, station location and land costs. The evaluation of options is shown in **Table 4-3**.

Table 4-3: Kelantan Alignment Options Evaluation

Evaluation Criteria / Alignment Description	Weightage %	Option A	Option B	Option C	Option D
Construction Costs	15	10.5	10.5	12	15
Alignment Geometry	15	15	15	15	15
Social and Environmental Impact	20	9	1.5	9	9.5
Constructability	20	14	6	10	12
Station Location	25	17	18	17	16
Land Costs	5	3.5	3.5	4	5
Total Score	**100**	**69**	**54.5**	**67**	**72.5**

From this study, **Option D** was preferable as it had the lowest construction and land costs (shorter and more straightforward alignment) and the least social impacts (shorter alignment passing through less communities).

4.4.2 Selangor Options

Three proposed routes were studied for freight relief and connectivity (**Chart 4-2**). The options were:

- **Option 1**: Gombak – Batu Caves – Sg Buloh – SkyPark – Subang Jaya – Port Klang
- **Option 2**: Gombak – Bandar Malaysia – Subang Jaya – Port Klang
- **Option 3**: Gombak – Serendah – Port Klang

The criteria used in deriving these three options are:

- To further enhance connectivity of the ECRL Phase 1 by providing a link to Port Klang
- To provide freight relief to the existing KTMB North-South Line by providing an alternative route for freight trains.
- Should utilize road and other government reserves so as to minimize private land take

Chart 4-2 : Selangor Route Options

Source: Feasibility Study of The East Coast Rail Link Project Extension Line (Gombak To Port Klang), May 2017

An appraisal of the three main options indicates that **Option 3** is likely to have the most significant benefits while at the same time satisfying the project requirements. Comparison of the alignment options are summarized in **Table 4-4**.

- Although Option 2 has the highest ridership catchment, it is not recommended due to its poor alignment geometry, social impact, potential construction issues from sharing KTMB corridor as well as risks of having a long tunnel in Kuala Lumpur. The long stretch of tunnel under the city centre other than being expensive is unsuitable for the transfer of freight and poses safety issues / concerns in an event of a disaster such as tunnel fire or train fire.
- Option 3 has the better alignment geometry, allowing for higher operating speed and lower maintenance costs.
- Option 3 also has the least social impact as it passes through more agriculture areas.
- Constructability is not a major issue with Option 3, compared with the other options which require construction adjacent a live railway line and also construction of a tunnel under the Kuala Lumpur city.
- Option 3 with moderate land acquisition is much preferred compared to Option 2 for less social issues and shorter acquisition time.
- The new rail corridor along Option 3 will open up new opportunities for further development & growth along the corridor. Option 3 also does not duplicate existing railway corridors as it does for Option 1 (28km) and Option 2 (33km).
- In terms of construction cost, Options 1 and 3 have been determined to be the cheapest. As Option 3 best meets the requirements for freight relief, the investment can be easily paid up as it will provide a competitive option for the transport of goods.

Table 4-4: Selangor Alignment Options

Evaluation Criteria	Option 1	Option 2	Option 3
Journey time	• Length = 64 km (Shortest route)	• Length = 67 km	• Length = 83 km (Longest route)
Alignment Geometry	• Alignment passes through built-up areas with many substandard curves	• Alignment passes through built-up areas with many substandard curves	• Alignment with best geometry
Freight connectivity	• Links Port Klang with East Coast Ports • 11.6 MTPA per annum (year 2030)	• Long stretch of tunnel under city center – unsuitable for freight transfer	• Links Port Klang with East Coast Ports • 11.6 MTPA per annum (year 2030)

Table 4-4: Selangor Alignment Options (Cont'd)

Evaluation Criteria	Option 1	Option 2	Option 3
Social and environmental impact	• High social and environmental impact – passes through built up areas	• Moderate social and environmental impact	• Moderate social and environmental impact
Constructability	• Proposed corridor may not be able to accommodate ECRL	• 19 km tunnel	• Mostly through green area
ROW and land issues	• Moderate land acquisition	• Significant land acquisition	• Moderate land acquisition
Duplication of rail corridor	• Shared KTMB corridor for 28 km	• Shared KTMB corridor for 33 km	• New corridor – opportunity for local growth
Construction cost	• Lowest construction cost	• Highest construction cost	• Second lowest construction cost
Freight relief for KTMB line	• Partially meets TOR requirements of KTMB freight relief	• Does not meet TOR requirements of KTMB freight relief	• Meets TOR requirements of KTMB freight relief
Ridership	• Moderate population catchemnt • 555k pax per annum (year 2030)	• High population catchment • 692k pax per annum 9year 2030)	• Moderate population catchemnt • 432k pax per annum (year 2030)

Source: Feasibility Study of The East Coast Rail Link Project Extension Line (Gombak To Port Klang), May 2017

Note: Good Average Bad

4.5 RAILWAY GAUGE OPTIONS

The Feasibility Study examined options for railway gauge, namely standard gauge and the meter gauge. The main advantage of the meter gauge was the compatibility with the existing KTM railway system, which would enable interoperability of the

rolling stock between the ECRL and KTMB railway systems. The standard gauge would enable higher operating speeds, more stability and wider options of rolling stock from international suppliers as the standard gauge is more widely used globally. For Phase 2, the standard gauge was eventually adopted from Gombak North – Serendah while a combination of standard gauge and meter gauge is proposed from Serendah to Port Klang to integrate with the existing KTMB lines from Serendah.

4.6 Structural Options

In addition to the alignment options, a number of options for structural design of the ECRL railway were evaluated, namely the options for the alignment structure in hilly terrain and in low-lying areas. For construction of the railway through hilly terrain, the option of tunneling was preferred for areas hilly areas, in order to avoid massive hill cutting and minimize risks of erosion and slope instability. Another benefit of tunneling was that it avoided fragmentation of forests in areas where the alignment passed through forest reserves, which tended to be on hilly terrain. For construction of the alignment in low-lying areas, the two options were embankment (filling) and elevated viaducts, which were designed for the railway formation level to be above flood levels as well as to avoid flooding impacts to the surrounding areas.

05 PROJECT DESCRIPTION

Section 5

PROJECT DESRIPTION

5.1 INTRODUCTION

The ECRL Phase 2 consists of two extension lines, namely:

- Northern Extension at Kelantan (Kota Bharu – Pengkalan Kubor) – 26.7 km
- Southern Extension at Selangor (Gombak – Serendah – Port Klang) – 79.5 km

The total mainline length for Phase 2 will be of 102.7 km with 3.5 km of spur lines hence totaling 106.2 km. Phase 2 will follow the theme of Phase 1 by connecting all major towns and industrial zones with stations (passenger or combination of passenger and freight station) to ensure connectivity.

5.2 PROJECT ALIGNMENT

For ease of description in this EIA, the alignment is divided into the following segments (**Figure 5.2-1a-c and Figure 5.2-2a-f**).

- **Segment 1: Kelantan (**MD Ketereh – MD Pasir Mas – MD Tumpat**) –** 26.7 km

- **Segment 2: Selangor –** 79.5 km

  - **Segment 2A: Gombak North to Serendah** (MP Selayang- MD Hulu Selangor) – 24.4 km
  - **Segment 2B: Serendah to Bandar Puncak Alam** (MD Hulu Selangor – MD Kuala Selangor) - 25.4 km
  - **Segment 2C: Bandar Puncak Alam to Port Klang** (MD Kuala Selangor – MP Klang) – 29.7 km

The main line of the Project alignment is mostly at-grade (55.9%) but will also include 26.6 km of elevated sections and 18.7 km of tunnels as described in **Table 5-1**. In addition to the main line, the Project alignment will include one spur line at Wakaf Bharu with a length of 3.5 km.

Segment 1 in Kelantan will be a single track standard gauge line on a double track formation similar to Phase 1. For Selangor, Segment 2A will still follow this single line and standard gauge arrangement. Starting from Segment 2B until the end of Segment 2C, the alignment will be travelling on double tracks. One track will be standard gauge as a continuation from Segment 2A while the second track will be meter gauge to accommodate the KTMB line starting from the Serendah Station. Both tracks will travel parallel to each other.

Table 5-1(a): Description of Project Alignment in Kelantan

Alignment / Station	Description	Length / Quantity
Mainline	Elevated	8.3 km
	At-grade	14.9 km
	Tunnel	-
	Total	**23.2 km**
Spur Line	Wakaf Baru	3.5 km
	Total	**3.5 km**
Mainline & Spur Line	**Total Length**	**26.7 km**
Stations	Passenger	1 no
	Passenger & Freight	1 no
Gauge & Track	Single track with standard gauge	

Table 5-1(b): Description of Project Alignment in Selangor

Alignment / Station	Description	Length / Quantity
Mainline	Elevated	18.3 km
	At-grade	42.5 km
	Tunnel	18.7 km
	Total Length	**79.5 km**
Stations	Passenger	2 nos**
	Passenger & Freight	2 nos
Gauge & Track	• Segment 2A : Single track with standard gauge • Segment 2B & 2C : Double track with Standard gauge and Meter gauge	

Note:
1. ** means future passenger station at Bandar Puncak Alam and Kapar

Table 5-2(a): Alignment Lengths According to District in Kelantan

State	Local Authorities	Station	Length
Kelantan	Majlis Daerah Ketereh	-	1.1
	Majlis Daerah Pasir Mas	-	6.1
	Majlis Daerah Tumpat	Wakaf Bharu Pengkalan Kubor	19.5
		Total	**26.7 km**

Table 5-2(b): Alignment Lengths According to District in Selangor

State	Local Authorities	Station	Length
Selangor	Majlis Perbandaran Selayang	-	26.1
	Majlis Daerah Hulu Selangor	Serendah	16.3
	Majlis Daerah Kuala Selangor	*Puncak Alam	15.2
	Majlis Perbandaran Klang	*Kapar Jalan Kastam	21.9
	Total		**79.5 km**

Note:
1. * means future passenger station which will serve as passing loops

5.2.1 Segment 1: Kelantan – 26.7 km

The northern extension line will be an electrified single-track standard gauge railway line built on a double track formation at 23.2 km in length for mainline. A new meter gauge spur line of 3.5 km will be provided at the Wakaf Bharu Station for easier integration of passengers to/from the existing KTMB line. Segment 1 in total will be 26.7 km. Segment 1 will be mostly at-grade with elevated sections at waterway and road crossings.

The alignment starts off with an elevated section right after Kota Bharu Station of Phase 1 (Phase 2 assessment does not include this station) and travels west before crossing Sg. Kelantan. After the river crossing, the alignment will descend to at-grade and slightly curve towards northwest near Kg. Tendong. Next the at-grade section will travel by some paddy fields (Kemubu Agricultural Development Authority – KADA), and mostly village areas until the proposed at-grade Wakaf Bharu Station.

From the alignment will continue northwest parallel to Jalan Kota Bharu – Pengkalan Kubor (Route 134). Along this route, the alignment will pass by mainly village areas such as Kg. Lati, Kg. Kubang Batang, Taman Murni, Kg. Telok, Kg. Jirat, Kg. Kubang Panjang before crossing Sg. Peng Nangka. After crossing the river, the alignment continues northwest and crosses a vast expanse of paddy fields and also Sg. Mentua before arriving at the at-grade Pengkalan Kubor Station. After the station, the alignment crosses more paddy fields before before terminating near the proposed

Customs, Immigration & Quarantine (CIQ) Complex at Pengkalan Kubor and the proposed future Tak Bhai - Pengkalan Kubor cross-border bridge crossing.

5.2.2 Segment 2: Selangor – 79.5 km

The ECRL Phase 2 in Selangor of 79.5 km comprises combination of both single and double track and also a mixture of Standard Gauge Railway (SGR) and Meter Gauge Railway (MGR) as below:

- **Segment 2A : Gombak North – Serendah – 24.4 km**
  Standard Gauge Railway on single track formation

- **Segment 2B & 2C :Serendah – Port Klang – 55.1 km**
  Meter and Standard Gauge Railway lines laid on double track formation

The Selangor alignment will start at Gombak North (branching off from Phase 1) and will run northwest to Serendah and then southwards where it shall terminate adjacent to the existing KTMB Jalan Kastam Station at Port Klang. The alignment in Selangor consists a mixture of tunnels across hilly areas, elevated sections at for sections crossing water bodies, existing developments and infrastructure and at-grade sections . The detailed description of the alignment crossing will be discussed in the following segments.

Segment 2A: Gombak North to Serendah – 24.4 km

Branching off from ECRL Phase 1, Segment 2A starts off at-grade at Gombak North before crossing Karak Expressway and skirting the edges of Kg. Batu Dua Belas and Kg. Batu Sebelas Gombak. The alignment will then tunnel southwest through hilly terrain before it swings west at Taman Bukit Permata and emerges as elevated near Batu Dam while crossing Taman Jasa Utama.

After Taman Jasa Utama, the alignment tunnels back into the hilly terrain and continues northwest, crossing under the Ulu Gombak Permanent Reserved Forest, Templer Permanent Reserved Forest and Serendah Permanent Reserved Forest (part of Selangor Heritage Park) in its path. The alignment emerges as at-grade near Rawang after exiting the Serendah Permanent Reserved Forest and turns north towards Serendah, traversing a series of ponds and turning northwest while crossing the Masjid Serendah lake (ex-mining) and Jalan Ipoh-Kuala Lumpur (Route 1). The alignment will then cross the existing KTM line and turns west Kg. Tok Pinang, Taman Desa Kiambang and Taman Melati before it meets with the existing KTMB Serendah Freight Terminal, where a new integrated passenger and freight station called the Serendah Station will be constructed to enable transfer services between the ECRL and KTMB.

Segment 2B: Serendah to Bandar Puncak Alam – 25.4 km

This segment starts from the proposed Serendah Station and continues to the west while passing by Taman Ehsan Ibu and crossing Jalan Bukit Beruntung (Federal Route 3208). This new westward line will then cross the North South Expressway and tunnels through the hills south of Bandar Baru Sungai Buaya.

The alignment will emerge as at-grade and turn southwest near Saujana Rawang and crosses the Rantau Panjang Permanent Reserved Forest before passing by Batu Arang and Bandar Tasik Puteri. The alignment continues to fly over Jalan Kuala Selangor and LATAR Expressway, passing through mainly oil palm estates and turning south near Bandar Puncak Alam. There will be a future passenger station at Bandar Puncak Alam which will serve as a passing loop.

Segment 2C: Bandar Puncak Alam to Port Klang – 29.7 km

From Bandar Puncak Alam, the alignment will continue southwest across oil palm plantations and then crosses the West Coast Expressway (WCE) which is under construction. Then, it will continue south through more oil palm plantations while passing by Kapar. A future passenger station is proposed at Kapar which will serve as a passing loop.

After that, the alignment will travel across the Sg. Kapar Industrial Area and runs alongside Kg. Sementa before crossing Sg. Puloh and the surrounding mangrove area. The alignment will then cross the New North Klang Straits Bypass (NNKSB) and heads towards southeast direction crossing Sg. Klang, Kg. Delek and Kg. Sireh. While following Sg. Klang's curvature, the alignment continues south-westerly while crossing Sg. Telok Gadong Besar and Kg. Sg. Sireh Tambahan till it reaches the existing KTMB Jalan Kastam Station which will be expanded into a passenger and freight station for Phase 2. From the station, the alignment will continue south-west and terminates near the Klang Port Authority.

5.2.3 Alignment Design

The design parameters applied to the engineering of the ECRL alignment are given in **Table 5-3**.

Table 5-3 : ECRL Design Parameters

No	Description	Standard Gauge Railway (SGR)	Meter Gauge Railway (MGR)
1	Segment	• Gombak North – Port Klang • Kota Bharu – Pengkalan Kubor	• Serendah to Port Klang • Spurline – Wakaf Bharu
2	Number of tracks	Single Track	Single track
3	Distance between centers of tracks (track spacing)	• 4.2 m- 5.3 m • Track spacing will be widened in curved section	
4	Gauge	1435 mm	1000 mm
5	Rail Section	CHN 60Kg/m	60E1
6	Maximum Train Speed	Passenger -160 km/h Freight – 80 km/h	Freight – 80 km/h
7	Maximum cant	150 mm	100 mm
8	Maximum cant deficiency	90 mm	70 mm
9	Maximum surplus cant	50 mm	Not applicable
10	Maximum track gradient (mainline)	0.9%	1.0%
11	Minimum radius of vertical curves	15,000 m (parabolic shape)	10,000 m (parabolic shape)
12	Horizontal radius	Desirable minimum: 1600 m Absolute minimum: 600 m Exceptional minimum: 300 m	Desirable minimum: 1600 m Absolute minimum: 500 m Exceptional minimum: 300 m
13	Algebraic difference between grades where vertical curves shall be provided	0.1% (minimum)	0.25% (minimum)
14	Maximum track gradient in station yard limits including crossovers, loop lines and sidings	0.1% (1:1000) 0.6% (6:1000) for passing loop under difficult conditions	0.1% (1:1000) 0.2% (2:1000) in exceptional cases
15	Headroom control		
	Bridges over Rail (ROB)-ECRL under existing tracks/roads	6.55 m from finished rail level to soffit of over bridge	6.1 m from finished rail level to soffit of over bridge
	Road Under Bridges (RUB)-ECRL over existing estate tracks /roads	4.5 1~ 5.4 m from finished level of road to soffit of railway bridge	
16	Traction type	Electric	Electric / Diesel
17	Traction tonnage	3,500t	2,500t

Source: Railway Scheme Report for ECRL Phase 2

5.3 ALIGNMENT TYPE

As described in **Section 5.2**, the alignment structure in both the states will include a combination of at-grade, elevated and tunnel structures depending on many factors including the terrain, geomorphic features, geological and geotechnical conditions.

5.3.1 At-Grade Sections

The main line of the Project alignment is mostly at-grade with 57.4 km in length and another 3.5 km of spurline giving a total of 60.9 km.

Segment 1 : Kelantan will involve mainly at-grade sections measuring up to 18.4 km (69%) along villages and agriculture land. Only a small portion elevated sections (8.3 km) are provided for crossings.

Selangor will comprise 42.5 km (53%) of at-grade sections. In Selangor, at-grade sections are concentrated in Segment 2B and 2C where the terrain is flatter such as in Rawang, Batu Arang, Bandar Puncak Alam, Kapar and Klang. **Chart 5-1a-b** shows the typical cross section at embankment sections.

Plate 5-1 : Visualization of at-grade Section at Kg. Sementa

5.3.2 Elevated Sections

About 26.6 km of the alignment will be elevated at urbanized locations, flood prone areas and at area with swampy /poor ground. In addition, bridges and culverts are needed to carry the rail line over existing roads and rivers or streams. **Chart 5-2**

shows the typical cross section of bridges. Special spans will be provided where necessary for longer crossings (to be determined during the detailed design stage).

In Kelantan, elevated sections (8.3 km, 31%) can be found along main river crossings such as Sg. Kelantan, Sg. Peng Nangka, Sg. Mentua and other waterways such as irrigation canals and smaller drains and streams. Road crossings will also be elevated.

Similar to Kelantan, elevated sections in Selangor (18.3 km, 23%) will occur along main river crossings such as Sg. Puloh, Sg. Klang, waterbodies and also other smaller waterway crossings. Road crossings are also elevated. Additionally, elevated sections in Selangor have also been proposed at populated/developed areas such as Taman Jasa Utama, Serendah, Sg. Kapar Industrial Area and near Perdana Industrial Park.

Plate 5-2 : Visualization of elevated section at Kelantan

Plate 5-3 : Visualization of elevated section along Jalan Sg. Puloh, Klang

5.3.3 Tunnel Sections

As the alignment traverses through hilly and undulating terrain, tunneling will be required at locations where the alignment passes though steep terrain and forest reserves. After technical comparison of numerous alternatives, it has been determined that 10 short tunnels with a total length of 18.7 km will be required. Tunnels are only proposed in Selangor as Kelantan has relatively flat terrain.

In Selangor, the main tunnels are proposed under the Ulu Gombak Permanent Reserved Forest, Templer Permanent Reserved Forest and Serendah Permanent Reserved Forest (part of Selangor Heritage Park). Other tunnels are proposed under hilly areas in Gombak, near Bandar Sg. Buaya and near Bandar Puncak Alam.

The standard cross section for the tunnels have been determined based on the comprehensive considerations of many factors including construction limitations, number of tracks and line spacing, the aerodynamic effects of trains, disaster prevention and rescue and ventilation requirements.

From Gombak to Serendah, the track will be of standard gauge single track and as such will utilize only a single-track tunnel. From Serendah to Jalan Kastam, the track comprises of standard gauge track and a meter gauge track running parallel. Double track tunnel will be constructed to accommodate the twin tracks. Rescue walkways will be provided along the tunnel. The typical section of the tunnel as shown in **Chart 5-3a-b**.

Measures to prevent and limit fire damage at tunnels are as follows:

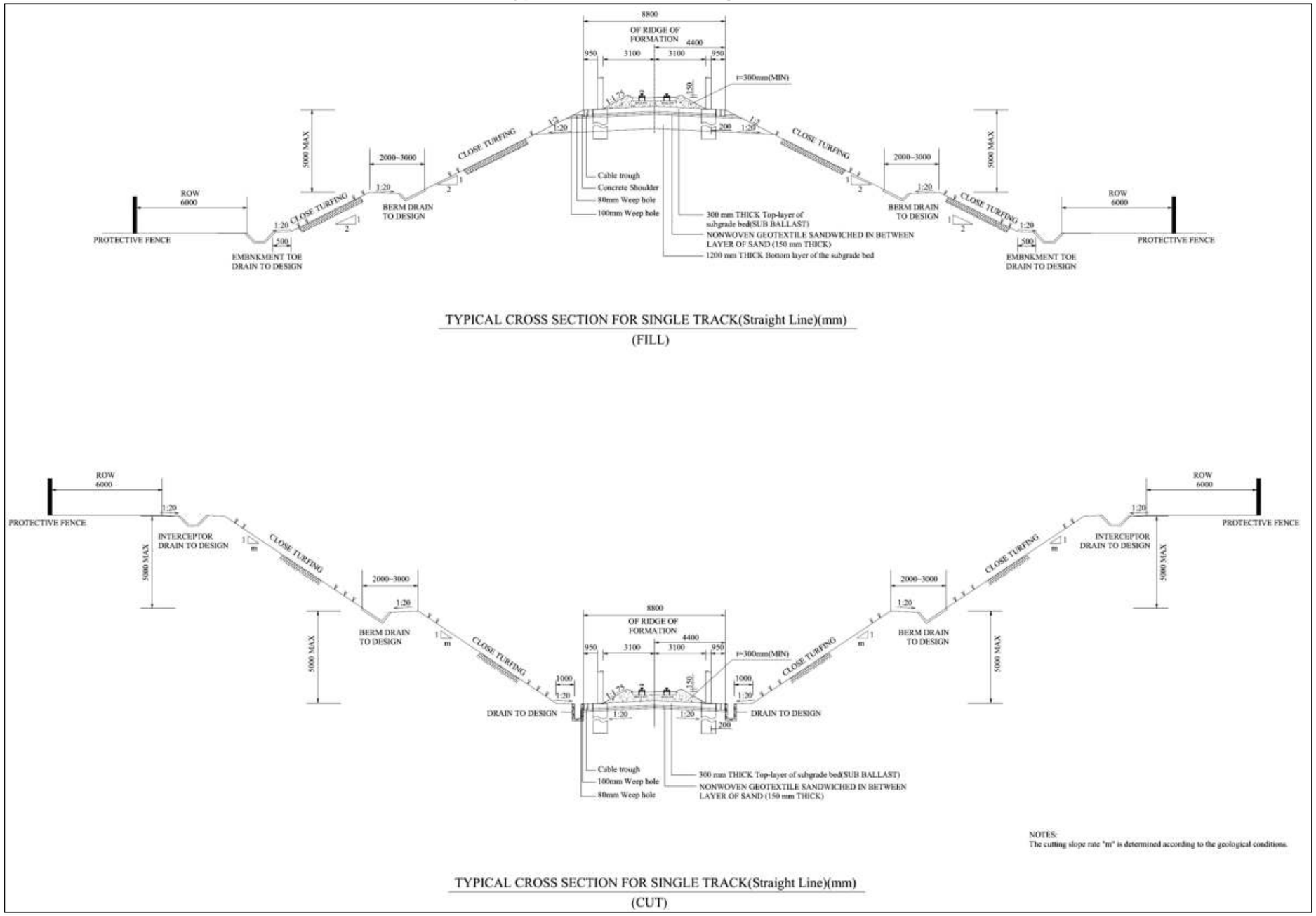
- Emergency measures for tunnel facility fires
- Emergency measures for freight train fires
- Emergency measures for passenger train fires
- Emergency escape exits
- Emergency lighting
- Firefighting

All tunnels will have escape walkways and in any emergency conditions, it will be used for evacuation of passengers and for rescue personnel to enter the accident scene. The requirement of Emergency Escape Exits will be based on the length of tunnel, the environment conditions which will be determined based on the simulation analysis during the detailed design stage.

The emergency exits will be equipped with emergency ventilation, emergency lighting system and fire-fighting, signal and communication system. Escape signs, which will indicate the direction and distance to emergency exits and secure areas will be positioned on the tunnel walls adjacent to the escape walkways.

Plate 5-4 : Visualization of tunnel Portals at Templer Park

Chart 5-1a : Typical Cross Section for Single Track Embankment



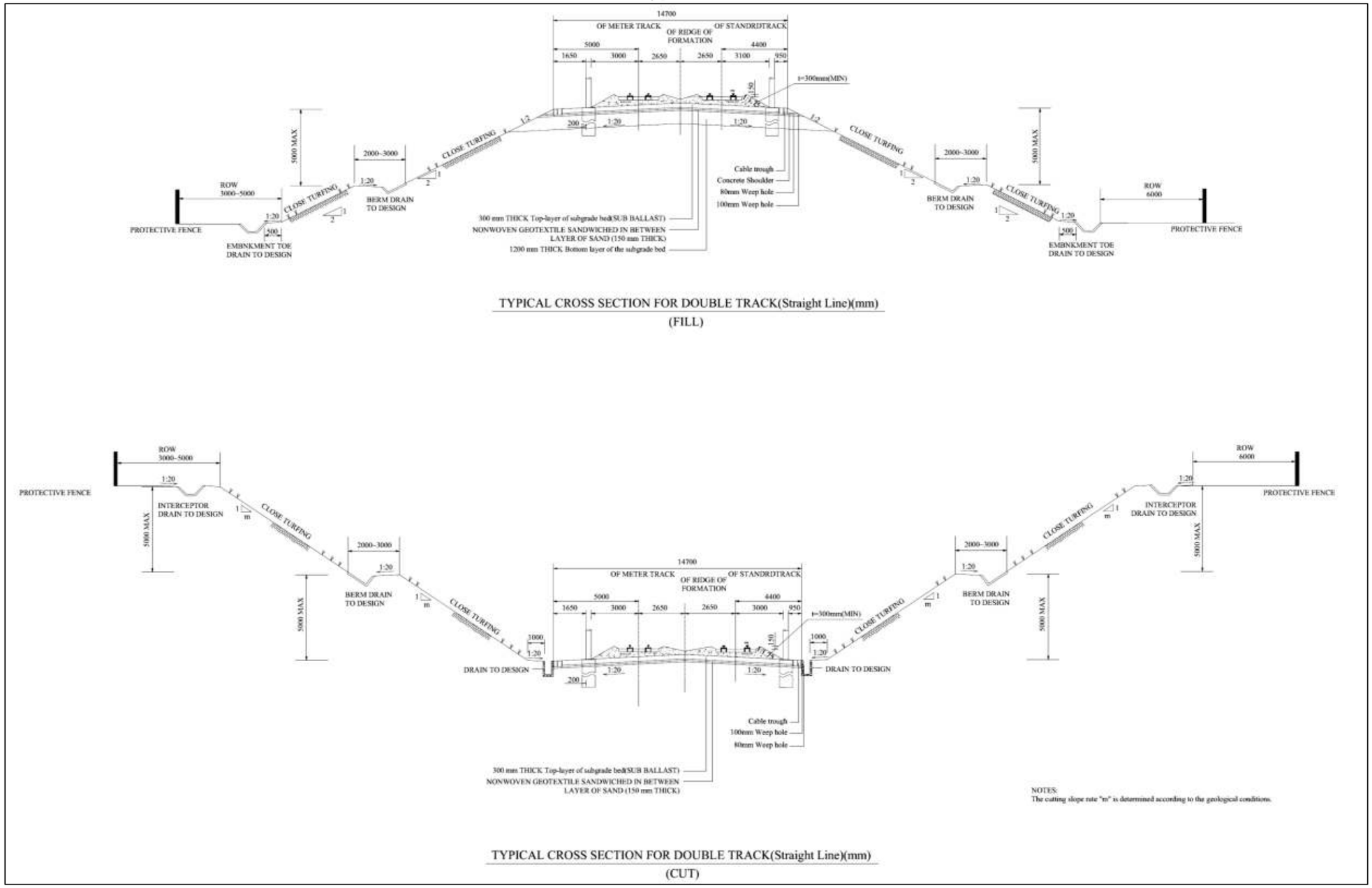
TYPICAL CROSS SECTION FOR SINGLE TRACK(Straight Line)(mm)
(FILL)

NOTES:
The cutting slope rate "m" is determined according to the geological conditions.

TYPICAL CROSS SECTION FOR SINGLE TRACK(Straight Line)(mm)
(CUT)

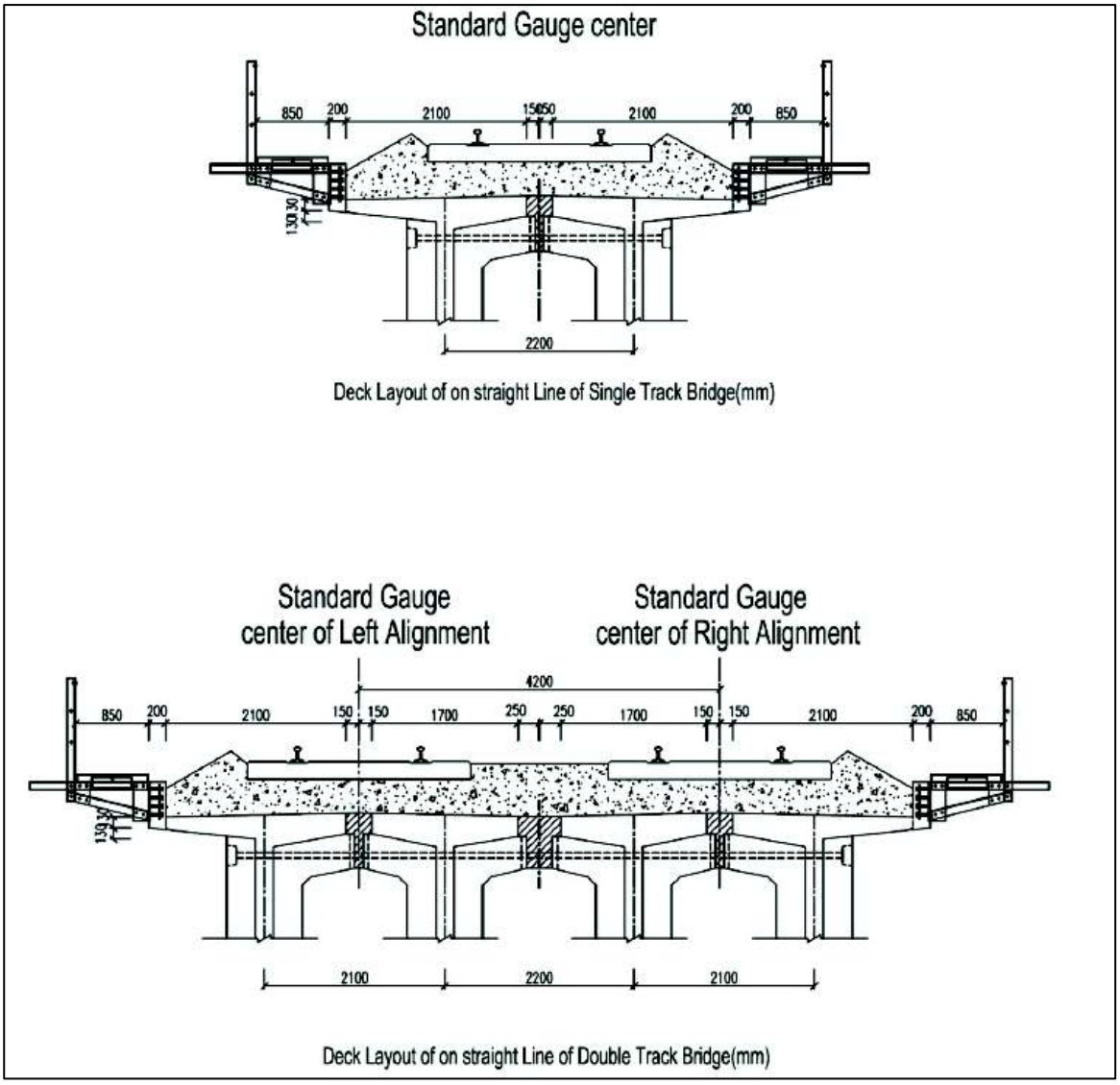
Source: HSS Integrated Sdn Bhd, 2017

Chart 5-1b : Typical Cross Section of Double Track Embankment



Source: HSS Integrated Sdn Bhd, 2017

Chart 5-2 : Typical Cross Section of Bridges



Source: HSS Integrated Sdn Bhd, 2017

Chart 5-3a: Cross Section of Single-Track Tunnel

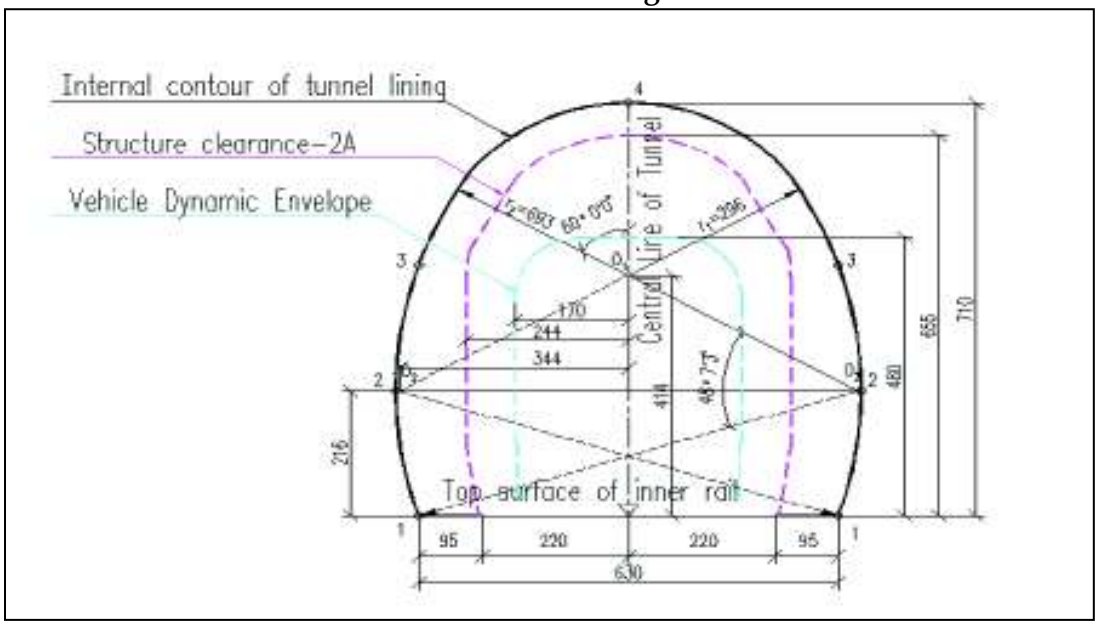
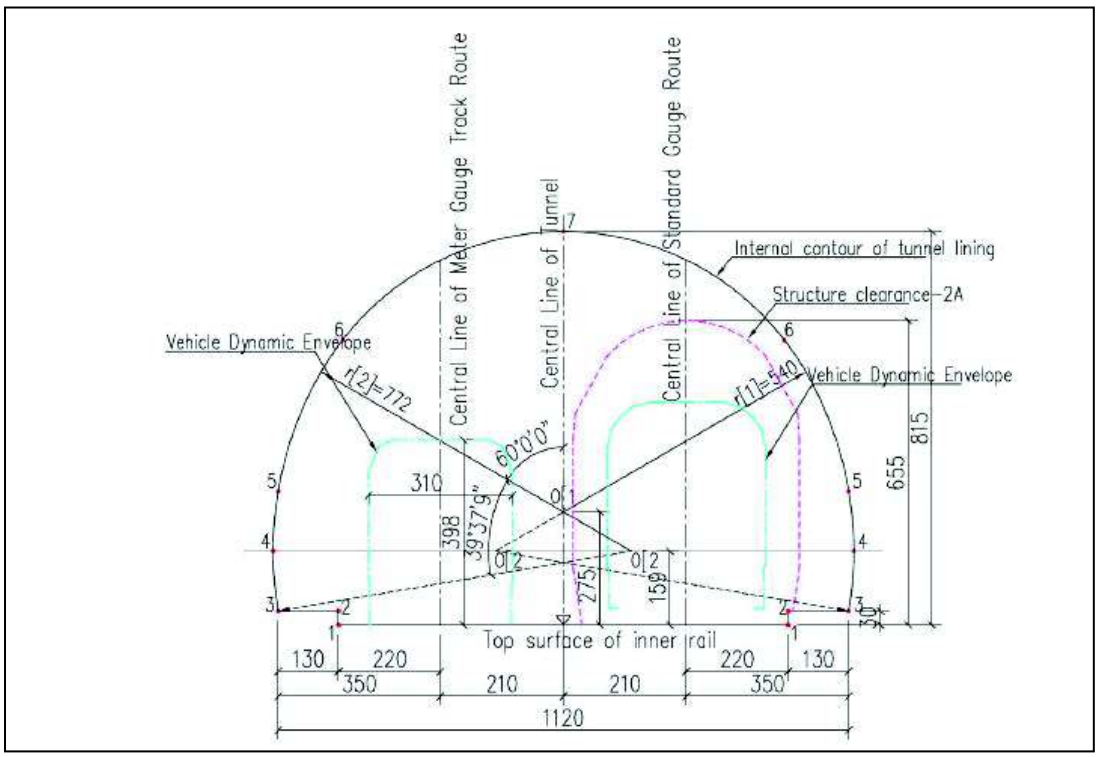


Chart 5-3b: Cross Section of Double-Track Tunnel



Source: HSS Integrated Sdn Bhd, 2017

5.4 STATIONS

There will be 6 stations along the ECRL Phase 2 (**Table 5-4** and **Chart 5-4**). The types of stations are based on their function, i.e. passenger station and mixed passenger and freight stations, and passing loops. The ECRL Phase 2 has also taken into consideration of interchanges with existing KTMB lines to enable the transfer of passengers and goods from one line to another.

Table 5-4 : ECRL Stations and Configuration

No.	State	Station Name	Coordinates		Type of Station	Interchanges
			Latitude	Longitude		
1	Kelantan	Pengkalan Kubor	6°12'45.89"N	102° 5'46.40"E	Passenger	-
2		Wakaf Bharu	6° 7'28.68"N	102°10'39.51"E	Passenger & Freight	KTMB
3	Selangor	Serendah	3°21'51.93"N	101°35'19.36"E	Passenger & Freight	KTMB
4		Puncak Alam (P)	3°14'55.31"N	101°24'42.42"E	Passenger	-
5		Kapar (P)	3° 7'30.00"N	101°23'39.86"E	Passenger	-
6		Jalan Kastam	3° 0'55.16"N	101°24'11.85"E	Passenger & Freight	KTMB

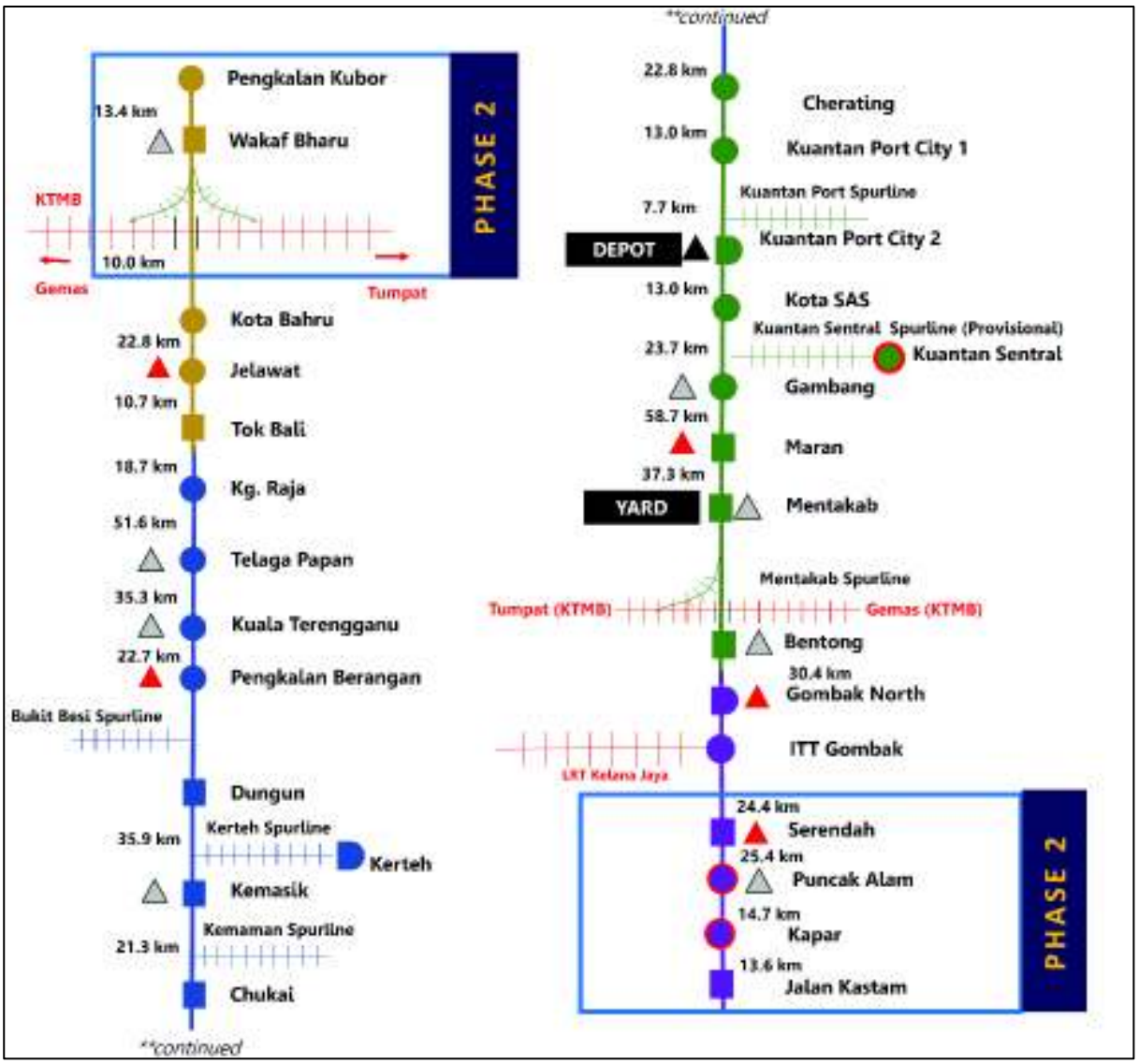
Note: (P) denotes passing loops and future station

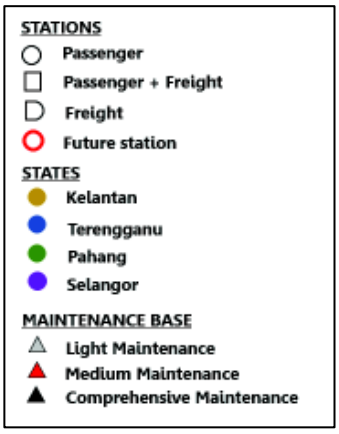
5.4.1 Station Facilities & Layout

The stations will be equipped with two platforms connected by an overpass. All passenger platforms and overpass will be covered by canopies. Similarly to ECRL Phase 1 stations, every station in Phase 2 will consist of station buildings that includes necessary operating offices. A retail store, public telephones, public restrooms, seating areas, surau, lifts, escalators and barrier-free facilities will be provided for passengers too. All stations will be at-grade (or on raised embankment) which is shown in **Figure 5.3-1**. A typical section track schematic showing the integration of standard gauge (ECRL) and meter gauge lines (KTMB) is shown in **Chart 5-5**.

Plate 5-5 : Visualization of station at Jalan Kastam

Chart 5-4: Diagrammatic Layout of Stations





Source: Railway Scheme Report for ECRL Phase 2

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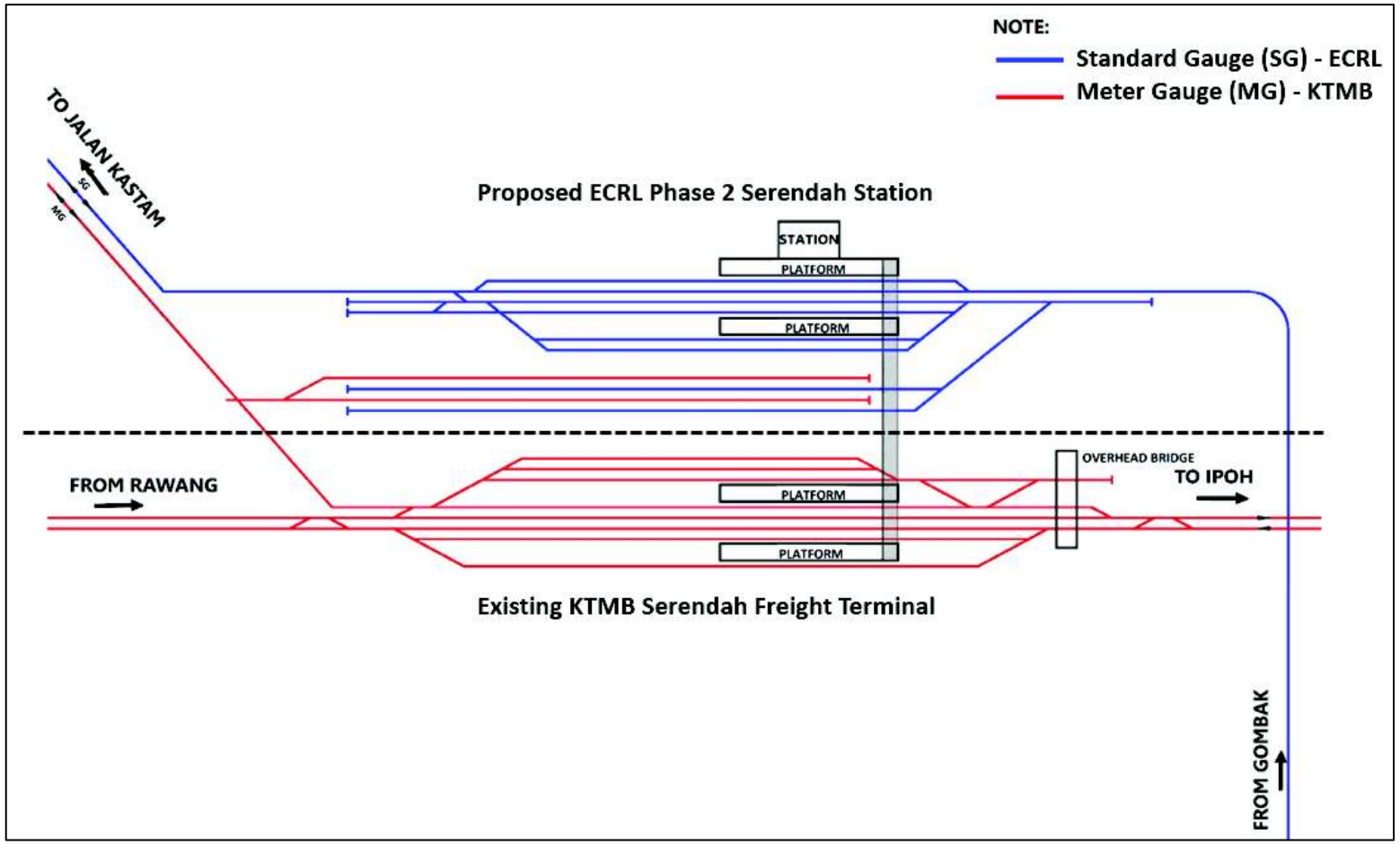
Chart 5-5: Typical Section Track Schematic (Serendah)



Source: Railway Scheme Report for ECRL Phase 2, September 2017

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5.5 DEPOT AND MAINTENANCE BASES

5.5.1 General

The maintenance workload for ECRL Phase 2 locomotives, wagons and EMUs are not expected to be significant. Maintenance bases, EMU stabling line and locomotive stabling lines will be established to stable and maintain the infrastructure and systems.

5.5.2 Depot and Stabling Lines

Standard Gauge (Gombak North – Port Klang)

For Standard Gauge lines, inspection and maintenance of locomotives, wagons and EMUs will be at Kuantan Port City Depot under ECRL Phase 1.

One EMU stabling line will be established at Jalan Kastam Station for Phase 2. There will also be locomotive stabling lines at the Serendah and Jalan Kastam stations.

Meter Gauge (Serendah– Port Klang / Wakaf Bharu Spurline)

For the Meter Gauge lines (KTMB), infrastructure maintenance and light maintenance of rolling stock will be provided by staff familiar with KTMB's maintenance practices for both on-track maintenance as well as rolling stock maintenance. Light and heavy maintenance will utilize the existing KTMB's maintenance facilities in the Batu Gajah Depot. Locomotive stabling lines for meter gauge railway will be set both at the Serendah and Jalan Kastam stations for Phase 2.

5.5.3 Light and Medium Maintenance Bases

Standard Gauge (Gombak North – Port Klang / Kota Bharu – Pengkalan Kubor)

For Phase 2, only light and medium maintenance bases are provided within some stations. In order to provide distributed maintenance service along the line, Light Maintenance bases will be established at Wakaf Bharu and Bandar Puncak Alam. One more capable, Medium Maintenance base will be located at Serendah. The locations of the maintenance facilities are shown in **Chart 5-4**.

Light Maintenance are provided from bases spaced at around 50km along the main line – which are generally co-located with stations or yards. Larger bases will be better equipped to serve or provide Medium Maintenance. Heavy Maintenance will

make use of the facilities of Kuantan Port City Depot (ECRL Phase 1) for comprehensive maintenance facility.

The Light and Medium Maintenance will be responsible for:

- daily inspection and detection and repair of infrastructure and minor systems issues
- providing facilities for parking, servicing and maintenance of large maintenance machinery such as rail mounted maintenance vehicles

5.6 SYSTEMS

5.6.1 Trackwork

Standard Gauge

The track works will be designed for a speed of 160 km/hr for passenger and 80 km/hr for freight trains. The maximum axle load will be 25 tonnes and the rails will generally be continuously welded. Bolted rail will be used for spur lines and low speed areas, such as sidings and stabling lines, etc.

Ballasted track will be adopted for both the mainline and spur lines.

Meter Gauge

The track works will be designed for a speed of 80 km/hr for freight trains. The maximum axle load will be 20 tonnes and the rails will generally be continuously welded inclusive of sidings and stabling lines, etc.

Ballasted track will be adopted for both the mainline and spur lines.

5.6.2 Ballasted Track

Standard Gauge

The rail standard for mainline track will be CHN60 and for spur lines, sidings and yards rails will be CHN50. The gauge will be 1435 mm.

Meter Gauge

The rail standard for mainline track will be 60E1, and for spur lines, sidings, yards rails will be 54E1. The gauge will be 1000 mm.

5.6.3 Electric Power Supply System for Railway Facilities

The electric power supply system will provide power for all railway facilities which will be sourced from the nearest 132kV consumer bulk supply system. A dedicated 11//0.4 kV substation will be installed at each station to provide supplies for communications, signals loads and its facilities. For crucial systems such as communications, signals equipment, fire equipment and emergency lighting a second totally independent source of power supply will be provided. Other less crucial systems will be served by just one source.

Intermediate communication bases and fibre -optic repeaters will be provided with a reliable power supply taken directly from the 11kV cable running along the line and transformed locally down to 400V. A power remote control system will be installed which will incorporate PSCADA at the dispatch end. The system will consist of a power dispatching point in the railway's dispatching centre, a reliable communication channel and remote terminals.

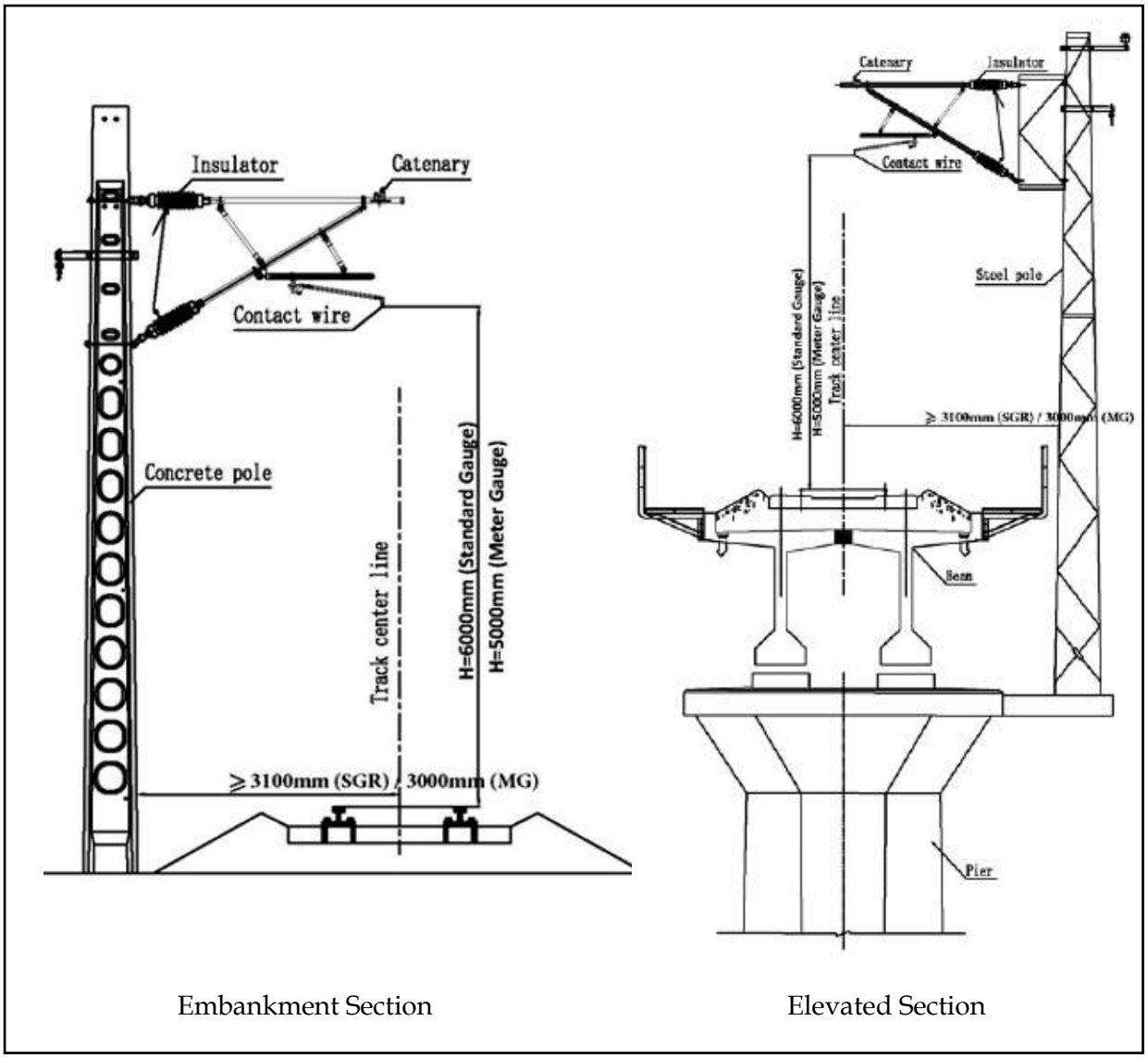
5.6.4 Traction Power Supply System

The traction power requirement of overall ECRL (Standard Gauge Rail and the Meter Gauge Rail) system shall be taken at traction power substation (TPSS) of 132kV from TNB. Based on the voltage and current required for train traction, the traction power substations will transform 132kV electricity to 25kV supply needed for the Overhead Catenary System (OCS) that will feed the trains. The typical Overhead Catenary System (OCS) is shown in **Chart 5-6**.

For ECRL Phase 2, one additional traction power substation will be required for the Selangor alignment. The Kota Bharu traction substation in the northern end of the ECRL Phase 1 will be expanded to supply power for the Phase 2 Kelantan alignment.

The Selangor meter gauge alignment (Serendah – Port Klang) will be using diesel for traction power. However, provision for electrified traction power will be made available too since KTMB is currently testing electric freight locomotives.

Chart 5-6 : Typical Overhead Catenary System (OCS)



Embankment Section Elevated Section

Source: Railway Scheme Report for ECRL Phase 2

5.6.5 Signalling System

A fail-safe signalling system must be seen as crucial infrastructure for the ECRL project. It is the key system to effect train command and dispatch, to guarantee the safety of train operation and to improve the efficiency of operation. The signalling system for ECRL Phase 2 will include the following four subsystems:

- Dispatching Subsystem
- Train Operation Control Subsystem
- Computer Based Interlocking Subsystem
- Centralized Supervision & Monitoring Subsystem

5.7 ROLLING STOCK

Passenger trains will be power centralized Electric Multiple Units (EMU) and will be comprised of one motor car and seven trailer cars, have 600 seating capacity and design speed of 160 km/h. Freight trains on the meter gauge, which will have up to 30-40 wagons will be powered by current KTMB's rolling stock, having 2500t traction power and design speed of 80 km/h. Freight trains operating on standard meter gauge will have up to 45 wagons, powered by electric locomotives, having 3500t traction power. The design speed will be 80 km/h for freight trains.

For the initial stage of the Project, all EMUs, locomotives and wagons running on the standard gauge should share with Phase 1. In addition to this, three locomotives and 242 wagons will be supplied for Phase 2 (**Table 5-5**).

Table 5-5 : ECRL Stations and Configuration

No.	Rolling stock	In service	Maintenance spare	Operation spare	Total
1	EMU	2 sets (Phase 1)	Share with Phase 1		-
2	Locomotives	2 sets	1 set		3 sets
3	Wagons	208 sets	6 sets	28 sets	242 sets

As for the meter gauge operation, the existing locomotives and wagons of KTMB will be utilized.

5.7.1 Electric Multiple Units

Passenger trains for the ECRL will be EMU with the following specifications:

- Model: Power centralised model
- Train formation:1M +7T
- Train total length: 206 m

- Width: 3300 mm
- Seating capacity: 600

Plate 5-6: Electric Multiple Unit Passenger Train
(Source: Railway Scheme Report for ECRL Phase 2)

5.7.2 Locomotives

The specifications of the freight locomotives are as follows:

Standard Gauge
- Axle model: C0-C0
- Length: 22.5 m
- Width: 3.1 m
- Axle Load: 25 T
- Traction tonnage: 3500 T

Meter Gauge
- Axle model: C0-C0
- Length: 20.668 m
- Width: 2.8 m
- Axle Load: 20 T
- Traction tonnage: 2500 T

Plate 5-7: Electric Freight Locomotive
(Source: Railway Scheme Report for ECRL Phase 2)

Plate 5-8 : KTMB Diesel Locomotive
(Source: http://www.toshiba.co.jp)

Plate 5-9 : KTMB Electric Locomotive (under testing)
(Source: https://www.flickr.com)

5.7.3 Wagon

The main wagons to be considered for the ECRL freight services area open top box cars, closed box cars and flatbed wagons. It is likely that some regular users of the railway might have particular requirement to suit the products they will ship.

Plate 5-10 : Freight Wagons
(Source: Google Images)

5.8 PRINCIPAL PROJECT ACTIVITIES

This section describes the key project activities related to construction and operations of the ECRL Phase 2 that may cause environmental impacts. The key activities of the ECRL include, but are not limited to, the following activities (**Table 5-6**).

Table 5-6 : Principal Project Activities

Stage	Activities
Pre-Construction	• Land acquisition • Utilities relocation • Site surveys and investigations
Construction	• Site clearing • Earthworks and embankment construction • Railway bridge and viaduct construction • Tunnel construction • Station construction • Surface works – roads, drainage • Access roads • Installation of railway tracks and systems • Other Advanced works: establishment of site office, workers' quarters, kitchen cum dining hall, recreational facilities, batching plant, pre-casting yard, raw material storage yards (if required)
Operation	• Train operations • Station operations • Light and medium maintenance works at stations

5.8.1 Pre-Construction Stage

5.8.1.1 Land Acquisition

In areas where the proposed ECRL Phase 2 alignment passes through private land and property, land acquisition will be required in order to secure the right-of-way for the ECRL railway tracks and railway reserve. Land acquisition will also likely be required for the construction of stations and maintenance facilities, which generally take up large plots of land.

It is estimated that a total of 5,852 lots of land will be acquired for this project. On average, 37% of this land will be state land while 63% will be private land (**Table 5-7**).

Table 5-7 : Land Acquisition in Kelantan And Selangor

No.	Type of Land	No. of Lots/ Locations	Area Affected	
			Acres	Hectares
Kelantan				
1	Private Land	2,852	1,326.3	536.8
2	State Land/ Road/ JPS/ Utility/ Reserve	-	435.4	176.2
	SUBTOTAL		**1,761.7**	**713.0**
Selangor				
1	Private Land	3,000	3,809.1	1,541.5
2	State Land/ Road/ JPS/ Utility/ Reserve	-	537.1	1,026.7
	SUBTOTAL		**6,346.2**	**2,568.2**
Overall Land Acquisition				
1	Private Land	5,852	5,135.4	2,078.3
2	State Land/ Road/ JPS/ Utility/ Reserve	-	2,972.5	1,202.9
	GRAND TOTAL		**8,107.9**	**3,281.2**

Source: Railway Scheme for ECRL Phase 2, 2017

5.8.1.2 Utilities Relocation

Advanced works such as relocation of utilities will be carried out before the commencement of the construction works. Utilities located along the alignment will be detected and piloted. This exercise is conducted in order to facilitate and further determine the utilities that need to be relocated along the alignment.

The types of utilities include TNB transmission line, water and sewer mains, electrical cables, telecommunication cables, gas pipes and other surface and underground utility lines. Certain roads and junctions may also need to be realigned and reconfigured to accommodate the railway alignment. **Table 5-8** shows some major utilities identified during the EIA stage. Underground utilities can only identified during the detailed design stage.

Table 5-8 : Major Utilities within ECRL Phase 2 Corridor

No.	Utilities	Coordinates	Alignment Type	Locality
Selangor				
TM1	Transmission Line	3°16'53.15"N 101°43'37.44"E	Tunnel	Gombak north
TM2	Transmission Line	3°16'4.13"N 101°41'4.39"E	Elevated	Taman Jasa Utama / Batu Dam
TM3	Transmission Line	3°21'56.88"N 101°33'44.85"E	Elevated	Serendah, Jalan Bkt. Beruntung
TM4	Transmission Line	3°19'45.82"N 101°30'21.28"E	At-grade	Rantau Panjang PRF
TM5	Transmission Line	3°14'41.09"N 101°24'27.91"E	At-grade	Bandar Puncak Alam

Table 5-8 : Major Utilities within ECRL Phase 2 Corridor (cont'd)

No.	Utilities	Coordinates	Alignment Type	Locality
TM6	Transmission Line	3°10'41.07"N 101°23'30.58"E	At-grade	Kapar, Near Kg. Bkt Kerayong
G1	Gas Pipeline	3° 9'53.10"N 101°23'38.46"E	At-grade	Kapar, Near Kg. Bkt Kapar
TM7	Transmission Line	3° 8'42.09"N 101°23'48.23"E	At-grade	Kapar, Near Tmn. Perindustrian Meru
TM8	Transmission Line	3° 7'2.72"N 101°23'39.50"E	At-grade	Kapar, Near Sg. Kapar Industrial Park
TM9	Transmission Line	3° 3'41.40"N 101°23'19.70"E	Elevated	Perdana Industrial Park

5.8.2 Construction Stage

5.8.2.1 Site Clearing and Earthworks

Site clearing and earthworks will be carried out for the alignment, stations and access road construction. The intensity of the site clearing and earthworks to be carried out will depend on the types of railway track (embankment or viaduct structure) and also land uses where the alignment traverses through.

The site clearing will involve the removal of vegetation from agricultural areas (oil palms and paddy field), forested areas and scrubland/secondary forests. Structures such as residential units, workshops etc. that are acquired and located within the ROW will also be demolished. Site clearing will be carried out by means of bulldozers or equivalent machinery within the railway ROW, stations and access roads.

Earthworks will be carried out by either cutting or filling to achieve the design platform levels. Unsuitable material will be removed and disposed of at disposal sites approved by the respective local authority. The top soil may be kept and used for landscaping works at a later time. At areas where imported fill material is required, dump trucks will bring in the fill material, which will be spread by bulldozers on site. Rollers will then compact the earth in layers to the required density and level. Station construction will also involve the construction of support infrastructure such as access roads, drainage system and utilities. Major earthworks are expected at at-grade areas, portals of tunnels at hilly areas and also stations (**Section 5.3.1, 5.3.3 & 5.4**) and will be more extensive in Selangor (Segment 2B and 2C) such as in Rawang, Batu Arang, Rantau Panjang PRF, Bandar Puncak Alam, Kapar and Klang.

Demolition works will be carried out using excavators to knock down the large structures, and manually using hand tools. Piloting works will be carried out to determine if there are any existing utilities running in the area, and shall be relocated if any are found. Demolition of acquired structures is expected in Kelantan (village

houses), Taman Jasa Utama (residential houses), Taman Desa Kiambang, Kg. Delek, Kg. Sireh and Kg. Sireh Tambahan.

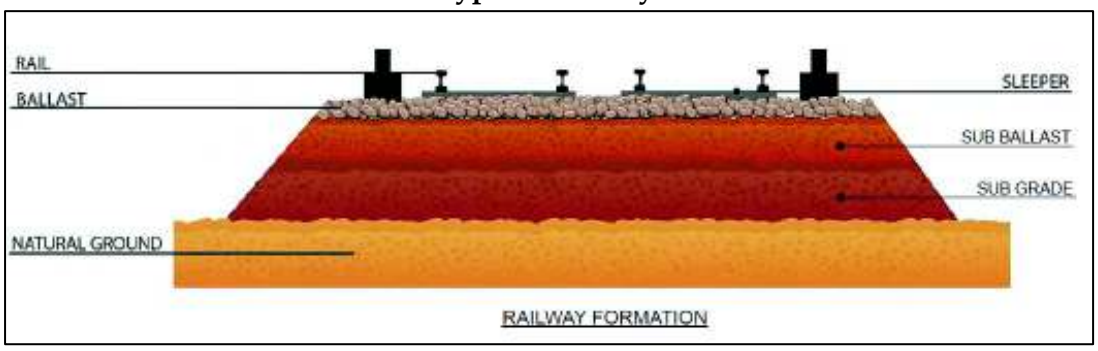
5.8.2.2 Access Roads

Access roads are important to connect the construction site with the existing road network especially at rural areas, plantations and forests where there is limited accessibility. The access roads for ECRL Phase 2 will be identified in the Environmental Management Plan. Nevertheless, access roads will avoid passing through or near sensitive receptors such as residential areas, schools, worship areas and also ecologically sensitive habitats. The construction of the access roads will also be accompanied with adequate Best Management Practices (BMPs) to minimize soil erosion and sedimentation.

5.8.2.3 Embankment Construction

Most of ECRL alignment will be built on earth embankment which will form the rail foundation (**Chart 5-7**). The excavation will be carried out when the subsoil which form part of the embankment foundation is not suitable. The soft compressible cohesive soils are excavated out and replaced with compacted suitable fill that will provide a stronger and less compressible foundation for the railway track. Embankment or retaining walls are built either side of the track, using earth material. The ballast will then be laid on the track foundation (**Chart 5-1a-b**). The typical Right of Way (ROW) for embankments range from 50 m to 70 m.

Chart 5-7 : Typical Railway Formation



In certain, areas cutting of slopes will be necessary for reducing the level of the rail formation to maintain the required gradient (**Chart 5-1a-b**). Major earthworks (cut and fill) will be carried out at certain locations (**Section 5.8.2.1**) in order to achieve the required railway formation level and platform level. Cut and fill works will be balanced within the Project site as much as possible. Where imported fill material is required, such fill material will be transported from designated approved borrow pit areas and unsuitable material will be disposed of at disposal sites approved by respective local authorities.

Areas where loose or soft cohesive deposits are found usually give rise to problems such as excessive settlements, deformations and stability problems. Several measures will be implemented to avoid or reduce those problems such as replacement of soft soil, constructing piles or stone columns.

For high embankments, stone columns will be utilised as ground treatment once the combination of temporary surcharge and geotextile basal reinforcement are found not viable. The presence of stone columns creates a composite material of lower compressibility and higher shear strength than the in-situ very soft to soft clay. Therefore, stone columns can be adopted to support high embankments.

5.8.2.4 Railway Bridge and Viaduct Construction

Plate 5-11 : Example of Railway Bridge (Light Rail Transit)

About 27 km of the alignment will be elevated (viaduct) at urbanized locations, flood prone areas and at areas with swampy /poor ground. In addition, bridges and culverts are needed to carry the rail line over existing roads and rivers or streams. Special spans will be provided where necessary such as Sg. Kelantan, Sg. Puloh and Sg. Klang for large crossings.

The viaduct superstructures are typically formed from beam and slab (**Chart 5-2)**. Post-tensioned or pre-tensioned precast beam depending on the length of the beam will be adopted. Precast beam and in-situ slab has the advantage that it is a technology that is well understood, it is generally a cost-effective solution, and as the beams are precast it should be a high quality finished form.

The viaduct substructures generally comprise reinforced concrete piers, with flared pier heads to support the deck, and reinforced concrete abutments. All piers and abutments are founded on large diameter in-situ bored piles with diameters between 1.0 m and 1.5 m or precast spun piles.

Plate 5-12 : Example of Beam Launching Using Mobile Crane

The typical span decks (~30 m) are all erected on a span-by-span basis, using crane. There are two types of deck, one for the double track and one for the single track arrangement, with both being erected in a similar manner. The beams are transported to the construction site, which later will be lifted into position using crane. After the beam has been positioned onto the bearing, cast in-place deck slab will be done using formwork.

Plate 5-13 : Example of Bridge Construction Machine

Span decks can also be installed using bridge construction machines whereby precast spans can be self-launched to the next span leading to a greater rate of span erection. Typical ROW for elevated sections range from 6 m to 10 m.

5.8.2.5 Tunnel Construction

The alignment will traverse through undulating to mountainous terrain which requires the construction of a total of 18.7 km of tunnels to maintain a constant, gentle gradient of the alignment (**Section 5.3.3**).

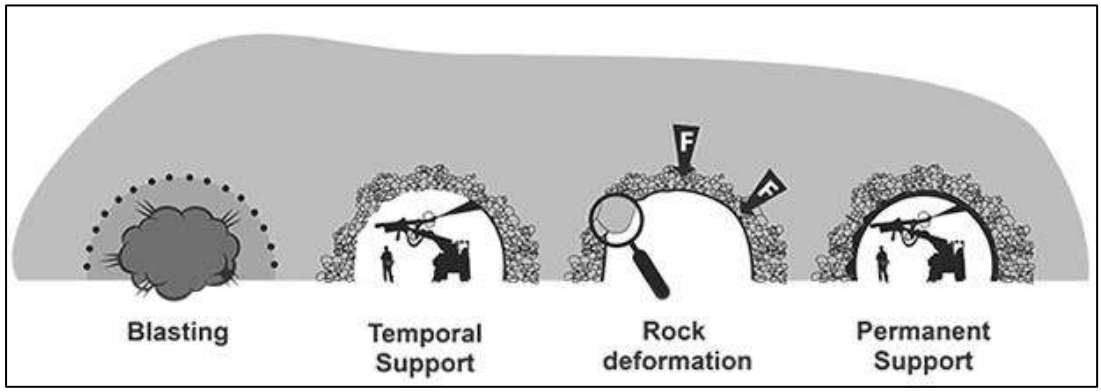
The method of tunneling will depend on the geological conditions of the tunnel alignment and will be determined during the detailed design stage. In addition to

the geology, project specific conditions such as tunnel length and cross section acutely influence the choice of the tunneling method.

Tunnels will be constructed to severely limit water ingress using appropriate measures to be determined as the investigation and the design proceeds once the environmental and geotechnical circumstances become clear. A waterproof layer will be applied to the primary lining before the secondary lining is cast using high quality impermeable concrete. Multiple waterproofing measures will be taken at construction joints and expansion joints. Where permissible along lengths of the tunnel, water seepage from the surrounding rock will be collected and drained through French drains will be positioned outside the waterproof layer. Nevertheless, comprehensive drainage measures will be installed to remove any water that does enter the tunnels.

The New Austrian Tunnelling Method (NATM) will be used for tunnel construction. It is essentially a sequential excavation method with composite lining of the tunnel (a reinforced shotcrete primary lining with an in-situ reinforced concrete secondary lining).

The NATM, which includes methods traditionally known as the "drill and blast" method, involves a sequence of activities such as drilling of blast holes, charging, blasting, ventilating, mucking out, scaling, shotcreting, rockbolting and surveying as shown in the **Plate 5-7**.



Source: http://bestsupportunderground.com/natm-shotcrete

Plate 5-14 : New Austrian Tunnelling Method Cycle

The cycle begins with surveying of the rock face to determine the appropriate drilling and charging pattern. The drilling process takes about 1.5 to 4 hours and typical charging is about 0.5 – 2 hours. The blasting will be conducted sequentially whereby a single blasting round only ranges from 0.8 m to a maximum of 4 m. Following the detonation of the blast charge, the tunnel will be ventilated to remove airborne dust. The blast material will be transported out via mucking trucks, and suitable blast spoil material will be used for railway ballast and/or road construction.

After removal of blast material, the scaling process will be commenced. Scaling is necessary in order to bring down potentially unstable blocks of rock around the tunnel surface. It is also an important process for cleaning and preparing the rock surface for spraying of shotcrete.

Rockbolts will then be installed to further reinforce the tunnel lining. The tunneling work advances forward with a new cycle beginning with surveying and drilling.

5.8.2.6 Station Construction

The construction of station will involve the following major civil works:

- Demolition of existing structures and relocation of existing utilities (if any)
- Preparatory earthworks
- Foundation and substructure works
- Superstructure works
- Infrastructure and utility works

The typical land area for stations ranges from 5 ha to 25 ha as described in **Table 5.9.**

Table 5-9 : Station Footprint

No	Station	Area (ha)
Kelantan		
1	Wakaf Bharu	24.57
2	Pengkalan Kubor	8.57
Selangor		
3	Serendah	5.7
4	Jalan Kastam	4.55
5	Puncak Alam	4.42
6	Kapar	4.76

Ground treatment works will be carried out at areas where required and the foundation works will include piling. The main structure will be constructed using steel beams and the building frame. Steel beams and columns will be delivered to site from the casting factory and installed at the site. The floor shall be concrete slab and will be cast with concrete delivered to the site. The canopy roof is prefabricated in a factory and delivered onto site for assembly before being erected onto the station superstructure.

Plate 5-15 : Example of Railway Station (Electrified Double Track)

5.8.2.7 Installation of Railway Tracks and Systems

After the earthworks and civil and structural works for the alignment have been completed, the railway tracks and systems for control and signalling will be installed. The trackworks system covers the track network that provides support and guidance to the rolling stock, including the major elements such as rails, rail fastenings, sleepers and ballast.

The signaling and control system is important for controlling train movements, enforcing train safety and controlling operations. The system will ensure safe train separation functionality and allows the trains to travel at maximum consistent speed safely. Following the installation of these components, testing and commissioning will be carried out.

5.8.3 Operation Stage

During the operation of the ECRL Phase 2, trains will be running on the railway tracks at regular intervals (**Table 5-10**). The train operations will consist of passenger trains operating at 160 km/h and freight trains operating at 80 km/h. At passenger stations, the typical activities will occur, such as pick-up and drop-off of passengers, with the associated road traffic connecting to the stations. At freight stations, cargo in various forms will be transported and transferred. At stations with maintenance facilities, maintenance work will be carried out on a scheduled basis. For the initial stage of the ECRL Phase 1, 11 EMUs, 18 locomotives and 1003 wagons will be

supplied. Phase 2 will share these facilities at the initial stage. In addition to that, three locomotives and 242 wagons will be supplied for Phase 2.

Table 5-10 : Operation Schedule

Normal Operations	Passenger service: between 5am – 1am next morning Freight service: 22.5hrs daily (outside of maintenance period)
Maintenance window	Between 1.00am – 2.30am daily
Carrying Capacity	Passenger train: Seating for 600
Design Operating Speed	Passenger train: 160 km/h Freight trains: 80 km/h
Stations	Passenger and freight stations – 3 Passenger only stations – 3 (2 future)
Interchange Opportunities	3 interchange opportunities at Wakaf Bharu, Serendah and Jalan Kastam

5.8.4 Passenger Train Operations

Passenger trains will be power centralized EMUs and will comprise of one motor car and seven trailer cars, have 600 seating capacity and a design speed of 160km/h.

The operating time for passenger train services will be from 05:00am each day until 01:00am the next morning. The timing of the first train and the last train of this schedule could be adjusted according to day to day traffic demand.

In determination of annual ridership, EMU utilisation rate, passenger fluctuations and other factors that affects the passenger flow are taken into consideration. The Serendah Station manages the passenger transfer between KTMB Mainline Meter Gauge Railway and ECRL Phase 2 while the Jalan Kastam Station manages the passenger transfer between ECRL Phase 2 and the KTMB Port Klang Line. **Table 5-11 & Table 5-12** show the ridership forecast for Kelantan and Selangor from 2025 to 2045.

Table 5-11 : ECRL Phase 2 Kelantan Passenger Journey Forecast

Year	Passenger Journeys (Thousand)	Year	Passenger Journeys (Thousand)
2025	73.3	2036	87.9
2026	74.6	2037	89.4
2027	75.9	2038	90.9
2028	77.3	2039	92.4
2029	78.6	2040	93.9
2030	79.9	2041	95.4
2031	81.2	2042	97.0
2032	82.5	2043	98.5
2033	83.8	2044	100.0
2034	85.1	2045	101.5
2035	86.4	-	

Table 5-12 : ECRL Phase 2 Selangor Passenger Journey Forecast

Year	Passenger Journeys (Thousand)	Year	Passenger Journeys (Thousand)
2025	196.6	2036	237.1
2026	200.2	2037	241.2
2027	203.9	2038	245.3
2028	207.5	2039	249.4
2029	211.2	2040	253.5
2030	214.8	2041	257.5
2031	218.4	2042	261.6
2032	222.1	2043	265.7
2033	225.7	2044	269.8
2034	229.4	2045	273.9
2035	233.0	-	-

Source : ECRL Phase 2 Railway Scheme (MRL)

5.8.5 Freight Train Operations

Standard Gauge

- Freight trains, which will have up to 45 wagons, will be powered by electric locomotives, having 3500t traction power and design speed of 80km/h.

- Outside the period between 01:00 and 02:30 each day, which will be reserved for general inspection and repair, freight trains will operate 22.5hours per day, seven days per week.
- In order to determine the number of freight trains, the annual freight volume per direction between two stations as obtained from the freight study is converted into the actual number of wagons required per day. Then, considering the freight train traction power of 3500t and coupling limit of 45 wagons, the number of trains per day can be determined.

Table 5-13 : Standard Gauge Railway Freight Train Operation Plan (Train/day/direction)

Section	2025	2030	2035	2040	2045
Jalan Kastam - Serendah	7	10.5	14	19.5	24.5
Serendah - Gombak	8.5	13	17	22	26.5

Source : ECRL Phase 2 Railway Scheme (MRL)

Meter Gauge

- Freight trains, which will have up to 30-40 wagons, will be powered by current KTMB's rolling stock, having 2500t traction power and design speed of 80km/h. KTMB is currently testing and commissioning electric locomotives.
- Freight trains will operate based upon demand or schedule as per service providers.
- In order to determine the number of freight trains, the annual freight volume per direction between two stations as obtained from the freight study is converted into the actual number of wagons required per day. Then, considering the freight train traction power of 2500t and coupling limit of 30-40 wagons, the number of trains per day can be determined.
- KTMB may use either electric or diesel locomotives for freight services.

Table 5-14 : Meter Gauge Railway Freight Train Operation Plan (Train/day/direction)

Section	2025	2030	2035	2040	2045
Jalan Kastam - Serendah	4	5	6	7.5	9

Source : ECRL Phase 2 Railway Scheme (MRL)

Similar to Phase 1, the type of goods to be carried by the freight trains include containers, coal, cement, steel, rubber, polyethylene and palm biomass, which may be transported in various forms such as containers, packages, dry bulk and liquid bulk. The annual freight traffic forecast of containers for the different routes of ECRL Phase 1 and 2 is shown in **Table 5-15**.

Table 5-15 : Freight Traffic Forecast

Commodity	Description	Freight Traffic		
		2025 (mtpa)	2035 (mtpa)	2040 (mtpa)
Containers	ECRL Corridor	1.45	3.00	4.70
	ECRL Land-bridge	2.30	4.60	7.30
	KTMB Transhipment	0.85	1.70	2.70
	Meter Gauge	1.37	2.37	3.74
	Total	5.97	11.67	18.44

Source : Railway Scheme (MRL), Note: mtpa = metric tonnes per annum

5.9 LABOUR QUARTERS AND CONSTRUCTION WORKERS

Maximum of 30,000 workers are expected to be involved during peak period of the construction stage for Phase 1 and Phase 2. All foreign workers will be housed at centralized camps. The labour quarters will be established at the depot and yards area in Phase 1.

5.10 PROJECT IMPLEMENTATION SCHEDULE

Construction works of the ECRL Phase 2 is planned to begin in January 2019. The construction will take six years. The railway operational is expected by end June 2024 (**Table 5-16**).

Table 5-16 : Project Implementation Schedule

Work Activity	Start Date	Completion Date
Construction Works (Infrastructure)	January 2019	December 2022
Track, Communication, signaling, Power, Electrification & Superstructure Works (Procurement, Manufacturing & Installation)	June 2021	February 2024
Testing & Commissioning	February 2024	May 2024
Trial Operation	April 2024	June 2024
Revenue Service Date	-	30 June 2024

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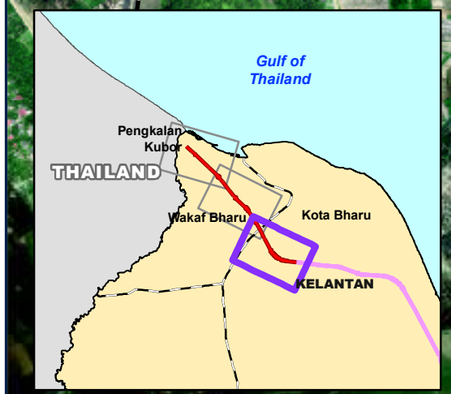
675,000

675,000

Kampung Bechah Temalang
Kampung Kulim
Kg Perupok
Kampung Teliar
Masjid Mukim Alor Durian
Kampung Lama
Kampung Pauh Kumbang
Jalan Pintu Geng
Wakaf Che Yeh
209
Kg Kubang Mas
Kampung Sekil
Sg. Seribong
Jalan Kota Bharu–Gua Musang
Lebuh Raya Tunjong - Salor
Jalan Salor
SK Bechah Durian
Kg Padang Embon
KOTA BHARU STATION (PHASE 1)
D180
Jalan Bunut Susu
Kampung Pak Selamah
Kampung Kayu Tinggi
Kampung Padang Terang
Kampung Perangkap
Kg Tendong
8
Gemas - Tumpat Railway Line
Kampung Manan
Pusat Kesihatan Tendong
Kg Tok Buak
SMK Tendong
Masjid Hajjah Fatimah
Kampung Hutan Cengal
Masjid Mukim Tendong
3
Sg. Kelantan
Sg. Mulong



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

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0 0.375 0.75

km

Coordinate System:Kertau RSO Malaya Meters
Projection: Rectified Skew Orthomorphic Natural Origin
Units: Meter

LEGEND

- Proposed Alignment (At-grade)
- Proposed Alignment (Elevated)
- Proposed Stations
- ECRL Phase 1
- Existing Railway Line
- Major Road
- Waterbodies
- State Boundary

Segment 1: Kelantan (Kota Bharu - Pengkalan Kubor)

Date	20-11-2017
Project No	EJ 616
Produced by	ZAB
Revision	A

FIGURE 5.2-1a

Source: ERE Consulting Group (2015). E:\Project\EJ 616 ECRL Phase 2\Maps\MXD\EJ 616 Segment 1 (Kelantan).mxd

N

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km

Coordinate System:Kertau RSO Malaya Meters
Projection: Rectified Skew Orthomorphic Natural Origin
Units: Meter

LEGEND

- Proposed Alignment (At-grade)
- Proposed Alignment (Elevated)
- Proposed Stations
- Existing Railway Line
- Major Road
- Waterbodies
- State Boundary

ere consulting group

Segment 1: Kelantan (Kota Bharu - Pengkalan Kubor)

Date	20-11-2017
Project No	EJ 616
Produced by	ZAB
Revision	A

FIGURE 5.2-1b

Source: ERE Consulting Group (2015). E:\Project\EJ 616 ECRL Phase 2\Maps\MXD\EJ 616 Segment 1 (Kelantan).mxd

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0 0.375 0.75

km

Coordinate System:Kertau RSO Malaya Meters
Projection: Rectified Skew Orthomorphic Natural Origin
Units: Meter

LEGEND

- Proposed Alignment (At-grade)
- Proposed Alignment (Elevated)
- Proposed Stations
- Major Road
- Waterbodies
- State Boundary

Segment 1: Kelantan (Kota Bharu - Pengkalan Kubor)

Date	20-11-2017
Project No	EJ 616
Produced by	ZAB
Revision	A

FIGURE 5.2-1c

Source: ERE Consulting Group (2015). E:\Project\EJ 616 ECRL Phase 2\Maps\MXD\EJ 616 Segment 1 (Kelantan).mxd

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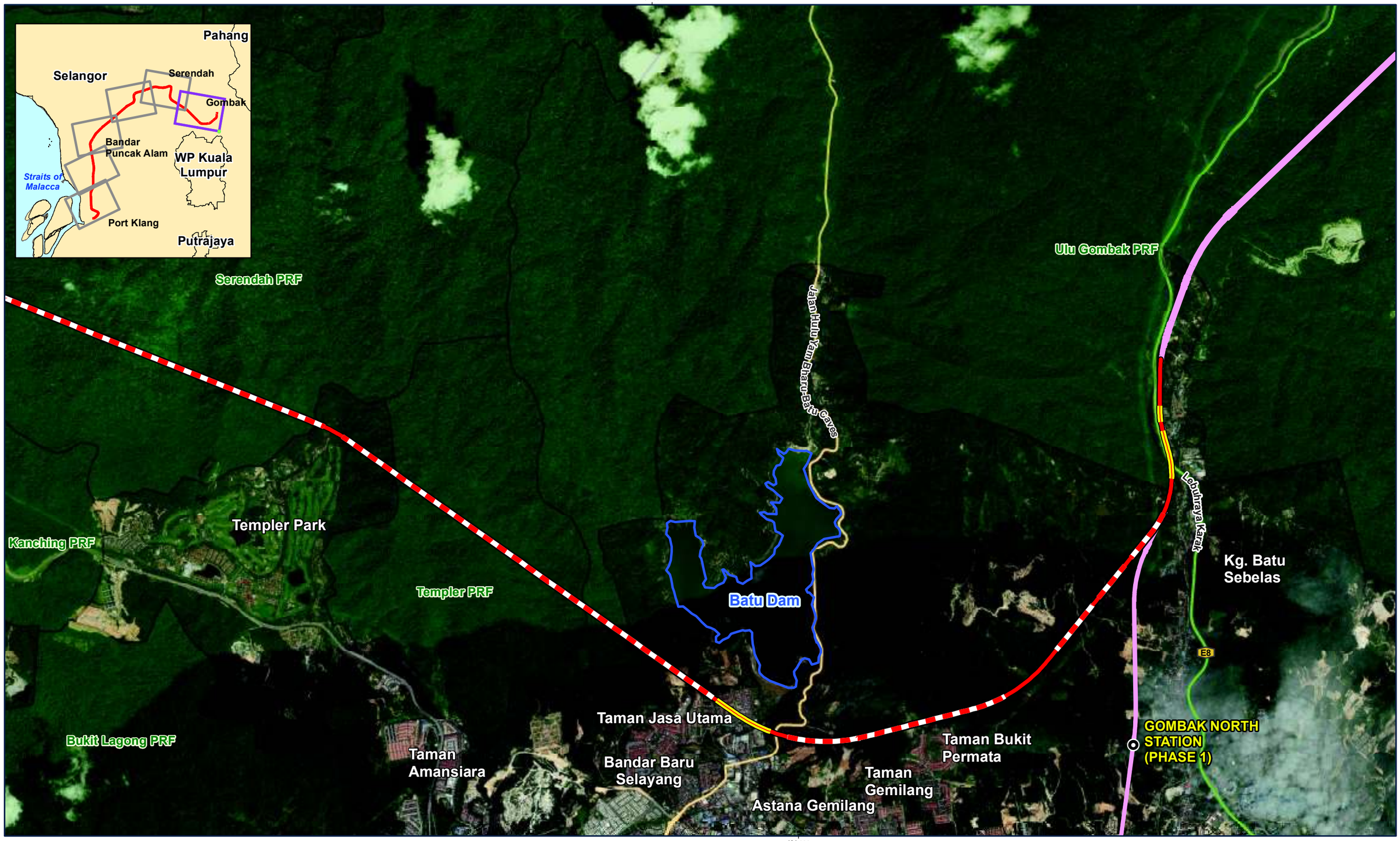

101.686

N

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0 0.5 1

km

Coordinate System:GCS WGS 1984
Units: Degree

Legend

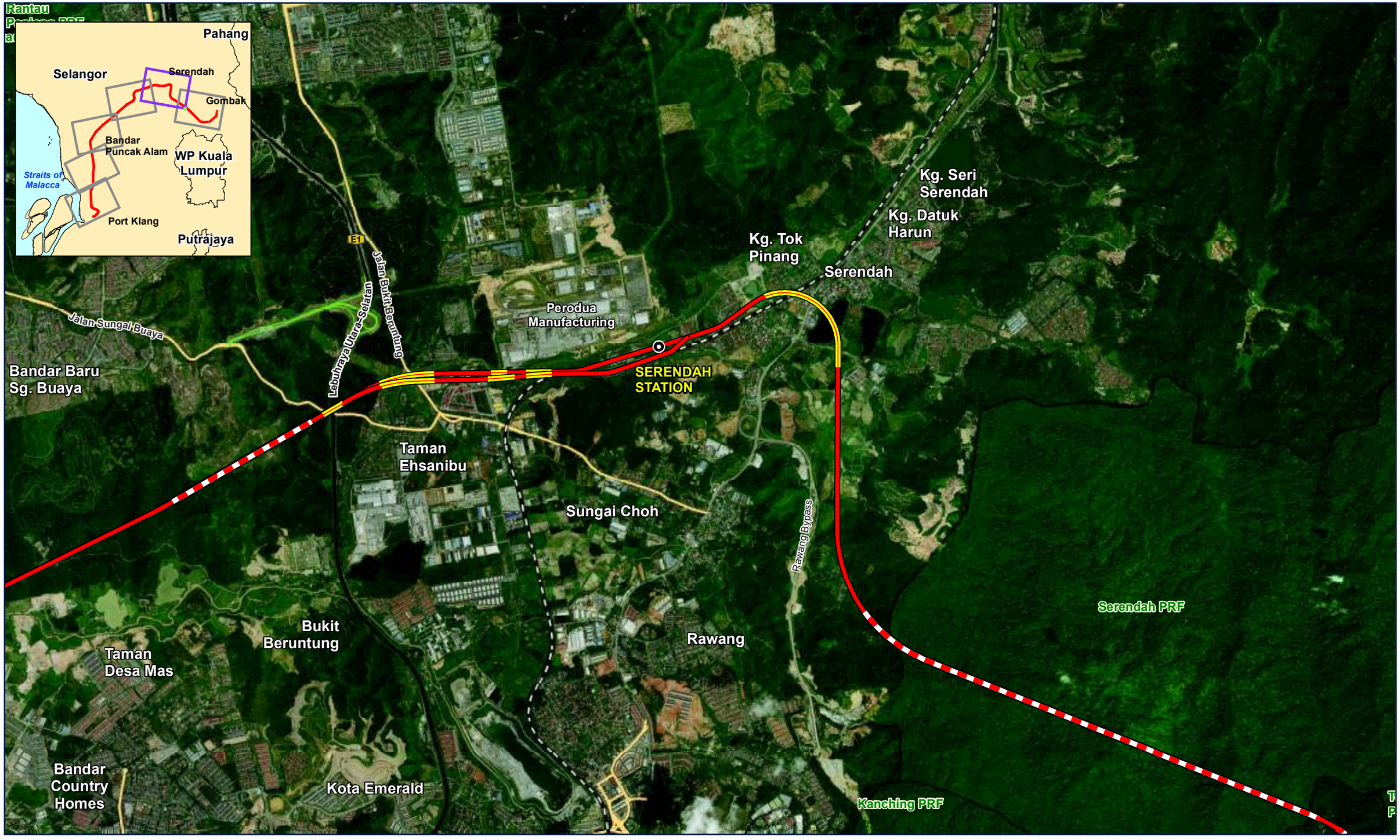
- Proposed Station
- Proposed Alignment (At-grade)
- Proposed Alignment (Elevated)
- Proposed Alignment (Tunnel)
- Existing Railway
- Highway
- Major Roads
- Permanent Reserve Forest
- ECRL Phase 1

Segment 2A: Gombak - Serendah

Date	04-10-2017
Project No	EJ 616
Produced by	AFZ
Revision	A

FIGURE 5.2-2a

Source: ERE Consulting Group (2017)., OpenStreet Map (2017), JPBD (2017), Satellite Imagery courtesy of USGS (2016) G:\Project\EJ 616 The East Coast Rail Link – Phase (2)\Maps\MXD\EIA\Fig5.2-2a-f_Segment_South.mxd



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0 0.5 1

km

Coordinate System:GCS WGS 1984
Units: Degree

Legend

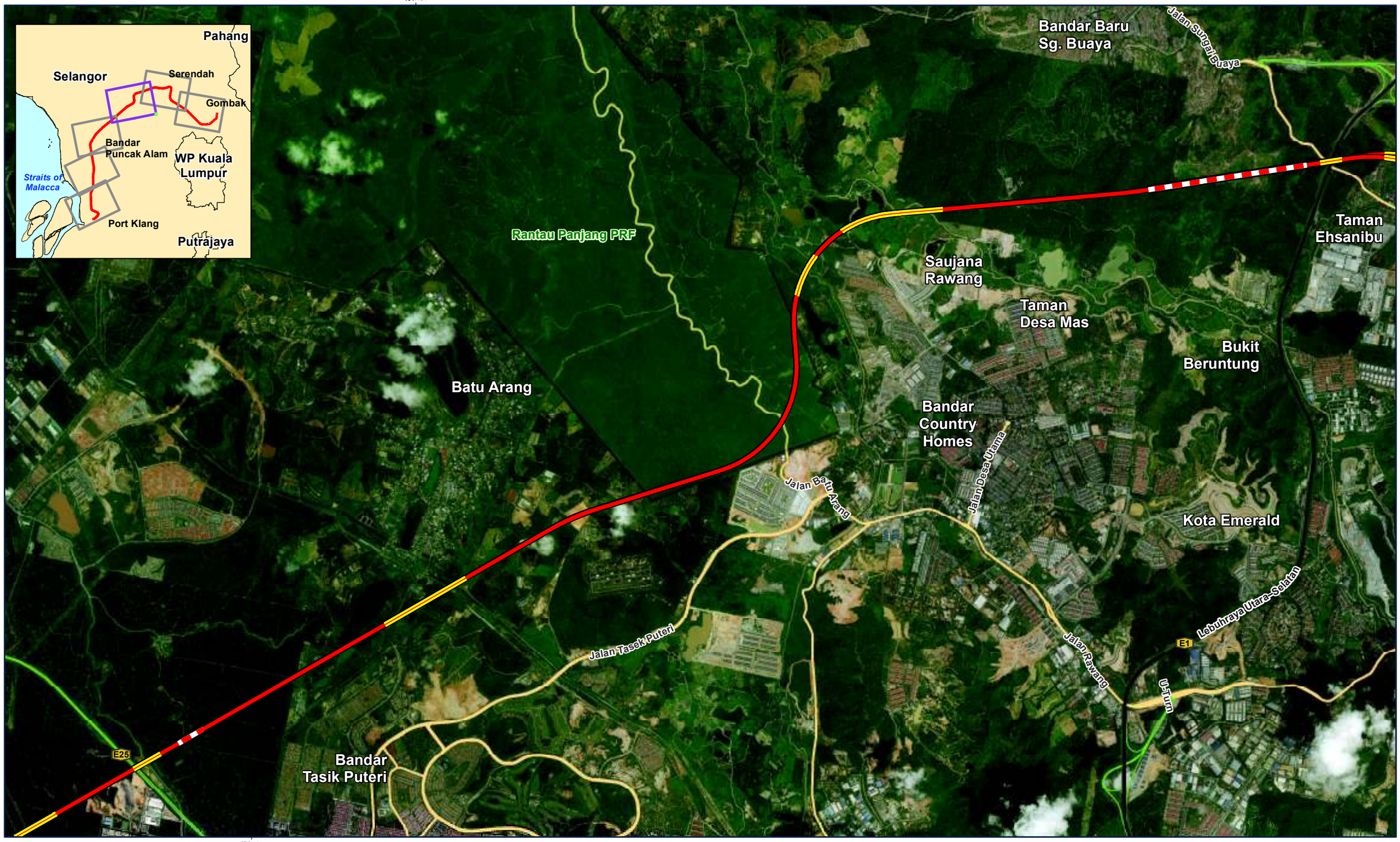
- Proposed Station
- Proposed Alignment (At-grade)
- Proposed Alignment (Elevated)
- Proposed Alignment (Tunnel)
- Existing Railway
- Highway
- Major Roads
- Permanent Reserve Forest
- North-South Highway

Segment 2A: Gombak - Serendah

Date	04-10-2017
Project No	EJ 616
Produced by	AFZ
Revision	A

FIGURE 5.2-2b

Source: ERE Consulting Group (2017)., OpenStreet Map (2017), JPBD (2017), Satellite Imagery courtesy of USGS (2016) G:\Project\EJ 616 The East Coast Rail Link – Phase (2)\Maps\MXD\EIA\Fig5.2-2a-f_Segment_South.mxd



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0 0.5 1

km

Coordinate System:GCS WGS 1984
Units: Degree

Legend

- Proposed Station
- Proposed Alignment (At-grade)
- Proposed Alignment (Elevated)
- Proposed Alignment (Tunnel)
- Existing Railway
- Highway
- Major Roads
- Permanent Reserve Forest
- North-South Highway

Segment 2B: Serendah - Bandar Puncak Alam

Date	04-10-2017
Project No	EJ 616
Produced by	AFZ
Revision	A

FIGURE 5.2-2c

Source: ERE Consulting Group (2017)., OpenStreet Map (2017), JPBD (2017), Satellite Imagery courtesy of USGS (2016) G:\Project\EJ 616 The East Coast Rail Link – Phase (2)\Maps\MXD\EIA\Fig5.2-2a-f_Segment_South.mxd

Legend

- Proposed Station
- Proposed Alignment (At-grade)
- Proposed Alignment (Elevated)
- Proposed Alignment (Tunnel)
- Existing Railway
- Highway
- Major Roads
- Permanent Reserve Forest
- West-Coast Expressway

1:40,000 @ A3 size paper

0 0.5 1

km

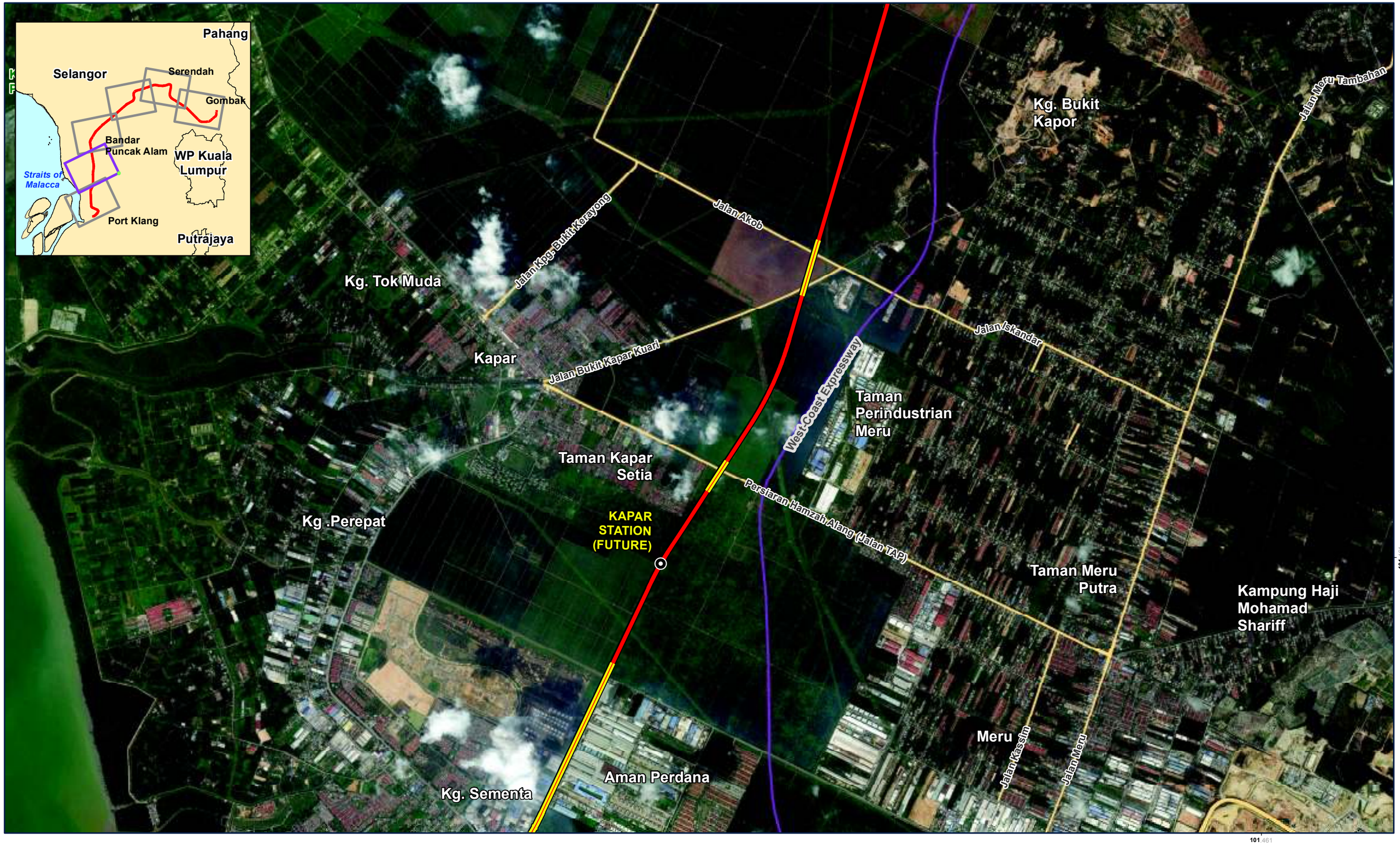
Coordinate System:GCS WGS 1984
Units: Degree

Segment 2B: Serendah - Bandar Puncak Alam

Date	04-10-2017
Project No	EJ 616
Produced by	AFZ
Revision	A

FIGURE 5.2-2d

Source: ERE Consulting Group (2017)., OpenStreet Map (2017), JPBD (2017), Satellite Imagery courtesy of USGS (2016) G:\Project\EJ 616 The East Coast Rail Link – Phase (2)\Maps\MXD\EIA\Fig5.2-2a-f_Segment_South.mxd



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0 0.5 1

km

Coordinate System:GCS WGS 1984
Units: Degree

Legend

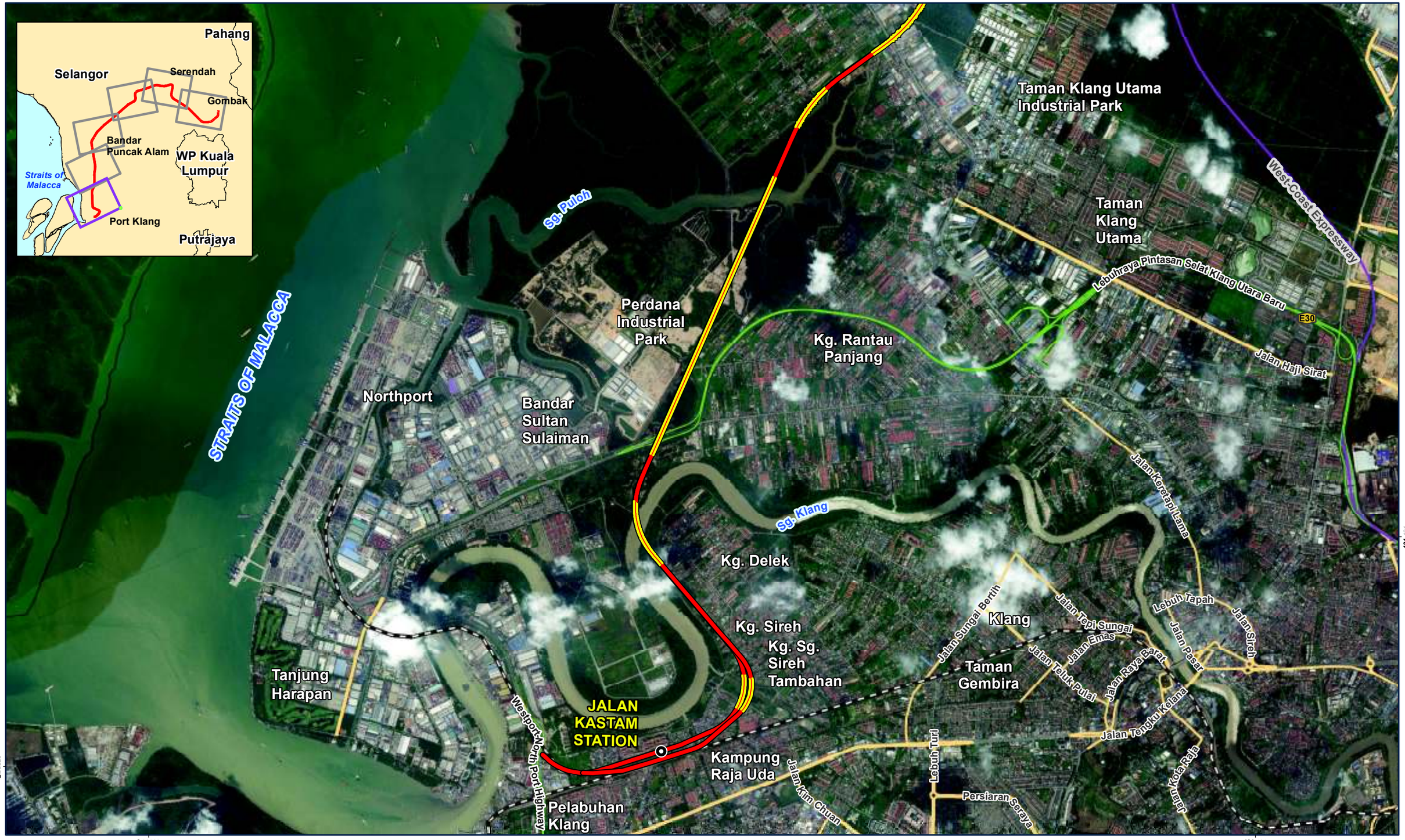
- Proposed Station
- Proposed Alignment (At-grade)
- Proposed Alignment (Elevated)
- Proposed Alignment (Tunnel)
- Existing Railway
- Highway
- Major Roads
- Permanent Reserve Forest
- West-Coast Expressway

Segment 2C: Bandar Puncak Alam - Port Klang

Date	04-10-2017
Project No	EJ 616
Produced by	AFZ
Revision	A

FIGURE 5.2-2e

Source: ERE Consulting Group (2017)., OpenStreet Map (2017), JPBD (2017), Satellite Imagery courtesy of USGS (2016) G:\Project\EJ 616 The East Coast Rail Link – Phase (2)\Maps\MXD\EIA\Fig5.2-2a-f_Segment_South.mxd



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0 0.5 1

km

Coordinate System:GCS WGS 1984
Units: Degree

Legend

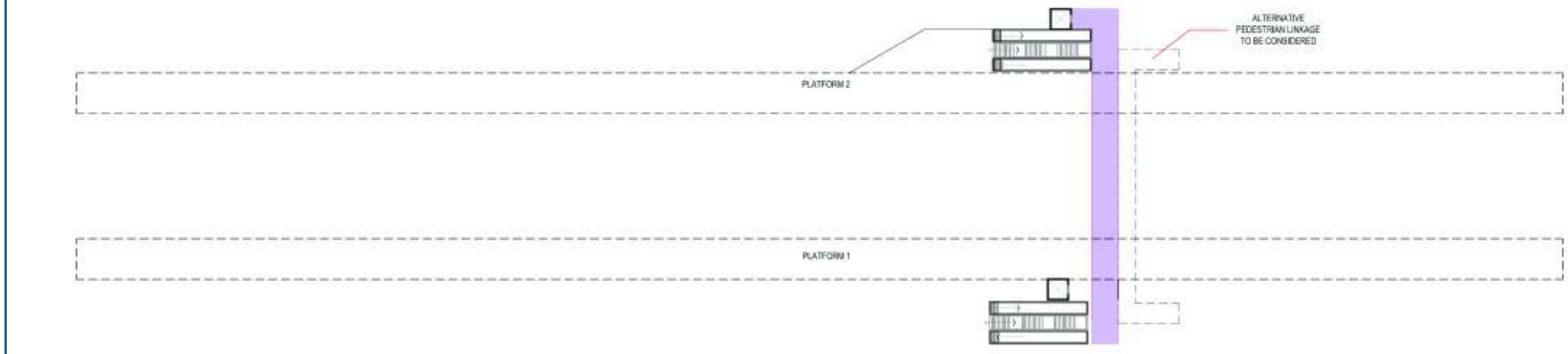
- Proposed Station
- Proposed Alignment (At-grade)
- Proposed Alignment (Elevated)
- Proposed Alignment (Tunnel)
- Existing Railway
- Highway
- Major Roads
- Permanent Reserve Forest
- West-Coast Expressway

Segment 2C: Bandar Puncak Alam - Port Klang

Date	04-10-2017
Project No	EJ 616
Produced by	AFZ
Revision	A

FIGURE 5.2-2f

Source: ERE Consulting Group (2017)., OpenStreet Map (2017), JPBD (2017), Satellite Imagery courtesy of USGS (2016) G:\Project\EJ 616 The East Coast Rail Link – Phase (2)\Maps\MXD\EIA\Fig5.2-2a-f_Segment_South.mxd



1ST FLOOR LEVEL

Not to scale

LEGEND

- PWD AREA
- UNPAID AREA
- AMENITIES
- BACK OF HOUSE
- OFFICES

At-Grade Platform Station

Date	28-09-2017
Project No	EJ 616
Produced by	FCZ
Revision	A

FIGURE 5.3-1

Source: Railway Scheme for The East Coast Rail Link Project, MRL 2017
EJ 616 ECRL Phase 2\Drawing\EIA\Fig 5.3-1