Section 3
Project Description

3.1 INTRODUCTION

The main objective of the Project is to facilitate future travel demand in the Klang Valley and to complement the connectivity to Kuala Lumpur by improving the current rail coverage and increasing accessibility of public transport network to areas not currently served or covered by public transport. The SSP Line will serve the existing residential areas, minimize overlapping with existing rail service and provide convenient access to Kuala Lumpur city centre.

This section describes the Project in terms of the proposed alignment and stations, the planning and design basis, operation system and the construction methodology.

3.2 PLANNING AND DESIGN BASIS

The over-arching principles in the development of the KVMRT is even network coverage, entry into the city centre, location of stations in densely populated areas and ability to sustain future expansion. The GKL/KV PTMP has identified key issues in the rail network such as capacity and quality of existing systems, integration between modes, gaps in network coverage and mismatch in land use planning. Considering the gap in the network, particularly in the northwest – southern corridor, the SSP Line is designed to serve the city centre to Sg Buloh, Kepong, Serdang and Putrajaya areas.

The SSP Line will traverse through high density residential and commercial areas and has the capacity to move large volumes of people from the suburban areas to the employment and business centres. In terms of planning basis, the main objectives of the Project are as follows:-

- To meet the increasing demand for rail based urban public transportation
- To increase the railway network coverage and its capacity
- To provide better integration between the new SSP Line and existing rail lines such as LRT, Monorail, SBK Line and KTM lines as well as the future High Spee Rail.
- To alleviate traffic congestion through comprehensive, interconnected, reliable and safe MRT services;
- To encourage the urban public to switch their mode of transportation from private vehicles to public transportation

By 2022, the KVMRT comprising of the SBK Line and SSP Line is expected to carry a total of about 1 million passengers per day (**Table 3-1**).

Table 3-1 Total Daily Ridership for SBK and SSP Line

Line	Passengers/day (year 2022)
SBK Line	508,000
SSP Line	529, 000
TOTAL	**1,037,000**

3.3 KEY PROJECT COMPONENTS

The SSP Line is divided into four main segments for ease of description.

- ***Northern Elevated Segment*** (14km) – from Damansara Damai to Jalan Ipoh (**Figure 3-1**)
- ***Underground Segment*** (13.5km) – from Jalan Ipoh to Bandar Malaysia South (**Figure 3-2**)
- ***Southern Elevated Segment 1*** (11.7km) – from Bandar Malaysia South to Universiti Putra Malaysia (UPM) (**Figure 3-3**)
- ***Southern Elevated Segment 2*** (13km) – from UPM to Putrajaya Sentral (**Figure 3-4**)

3.3.1 Northern Elevated Segment (Damansara Damai – Jalan Ipoh)

The SSP Line starts just after the KTM Sg Buloh station (part of the SBK Line). After the KTM Sg Buloh Station, the line crosses over to the south side of Jalan Kuala Selangor towards the Damansara Damai area where **Station S01** is proposed **(Figure 3-1)**. The line continues along the southern side of Jalan Kuala Selangor, passes by Prima Damansara, TNB PMU Station, IWK facilities, and Bandar Sri Damansara to where **Station S02** is proposed near 8trium.

The line continues along Jalan Kuala Selangor and passes Sri Damansara Club and Damansara Avenue before crossing Jalan Kuala Selangor to the proposed **Station S03** along Persiaran Dagang. Nearby areas include Kepong Industrial Park, Taman Wangsa Permai and Bandar Menjalara.

The line continues along Persiaran Dagang towards the proposed **Station S04** near the Kepong Sentral KTM Station where there will be an interchange with the KTM. The line then crosses the KTMB railway track before it crosses the Selayang-Kepong Highway towards Jalan Kepong. The line continues along Jalan Kepong where it passes by the commercial area before reaching the proposed **Station S05** located near AEON Metro Prima.

After the proposed **Station S05**, the line continues along Jalan Kepong to **Station S06** near the Laman Rimbunan commercial area. From the proposed **Station S06**, the line will travel parallel to Jalan Kepong as it heads towards the proposed **Station S07** in Jinjang Utara.

From **Station S07** to the proposed **Station S08** near the Wisma TNB, the line will run parallel to Jalan Kepong and pass close to several government buildings (DBKL, Bomba). After **Station S08**, the line swings towards the Jinjang Flood Detention Pond and heads towards the Kg Batu Delima area. Then, the line crosses over Jalan Kuching and the KTMB Railway track towards the proposed **Station S09**. This station is located close to the existing Kampung Batu KTM Station and will be an interchange station with the KTM.

After the KTM station, the line swings towards the south and travels towards Jalan Ipoh where it will cross Sungai Batu and pass through a commercial area and SRK Batu 4 Jalan Ipoh. After the school, the line will travel along Jalan Ipoh until the proposed **Station S10** near Taman Rainbow. The residential areas along this stretch include Taman Impian and Taman Kok Lian.

The line continues along Jalan Ipoh and runs underneath the Duta-Ulu Klang Expressway (DUKE) before reaching the proposed **Station S11** near Kompleks Mutiara.

3.3.2 Underground Segment (Jalan Ipoh– Bandar Malaysia South)

After Jalan Ipoh, the alignment will run below Jalan Sultan Azlan Shah until the **Station S12** which is the first underground station near Viva Residency **(Figure 3-2)**. From **Station S12**, the alignment continues to run below Jalan Sultan Azlan Shah before it veers away from Jalan Sultan Azlan Shah near the SK Sentul Utama towards the proposed **Station S13**, placed within the proposed Taman Sari Riverside Garden City development or former Pekeliling Flat area. The **Station S13** will serve as an interchange with the existing Ampang LRT and KL Monorail.

From **Station S13**, the line passes next to the Respiratory Medical Insititute HKL and Pekeliling Mosque towards the Istana Budaya where the **Station S14** is proposed. The alignment then turn south to cross under Jalan Tun Razak towards the Football Field of Hospital Kuala Lumpur (HKL) and passes below the HKL open car park. The next underground station, **Station S15** is proposed in front of Setia Sky Residences along Jalan Raja Muda Abdul Aziz, north of Kampong Bharu.

The alignment continues east towards Jalan Gurney, Ampang-Kuala Lumpur Elevated Highway (AKLEH) and Jalan Damai (next to KL Trillion development), then it crosses Jalan Tun Razak and enters IMC Parkville development. **Station S16** is located at IMC Parkville development (currently abandoned) and Ampang Park Shopping Centre, next to Megan Avenue 1. This station will be an interchange with the existing Ampang Park LRT Station.

The alignment then crosses below Jalan Ampang towards the **Station S17** which is located along Jalan Binjai next to the Desa Kudalari Condominium. Several high rise buildings located along Jalan Binjai include The Oval, Naza Towers and Menara Felda.

The alignment continues to travel below Jalan Binjai towards Jalan Conlay. The next underground station, **Station S18** is located at the Kompleks Budaya Kraf at Jalan Conlay. Then the alignment continues south and crosses Jalan Bukit Bintang towards **Station S19** at the Tun Razak Exchange (TRX) development, where there will be an interchange with the SBK Line (currently under construction) at this station.

The alignment then heads south and crosses below Jalan Tun Razak and the SMART Tunnel then passes the edge of the Cochrane redevelopment area at Jalan Cochrane. The line veers right and goes below the Maju Expressway, Jalan Tun Razak and the SMART Tunnel. It passes the PPR Laksamana apartments and SMK Convent Jalan Peel on its left. It continues south towards the Jabatan Kerja Raya workshop where **Station S20** will be located. It will interchange with the existing Chan Sow Lin LRT Station (LRT Ampang Line). Located in the surrounding area are Fraser Business Park and HELP College of Arts and Technology.

After **Station S20**, the alignment heads south along Jalan Chan Sow Lin and passes Percetakan Nasional Berhad Malaysia and Chan Sow Lin industrial area. The alignment then crosses below Besraya Extension Highway onto Jalan Tiga and then crosses Jalan Sg Besi towards the launch shaft area at the north of the *Pengkalan Tentera Udara DiRaja Malaysia* (TUDM). **Station S21** is proposed after the launch shaft area. The line continues further south until the proposed **Station S22**, still within TUDM, where there will be an interchange with the proposed High Speed Rail (HSR) Station. This station is located next to the ERL and KTM Komuter Lines.

3.3.3 Southern Elevated Segment 1 (Bandar Malaysia South - UPM)

After the proposed **Station S22**, the line will run below the East West Link Highway and rises at the south portal near the Taman Danau Desa lake before the Desa Water Park area. It then runs close to the oxidation pond and along Kuala Lumpur-Seremban Expressway (E37) towards the Kuchai Lama industrial area where **Station S23** is proposed. The line veers left and continues south, crossing the Maju Expressway and Sg Besi Highway (E9). It passes Kampung Baru Salak South on its left and continues parallel to the Sg Besi Highway (E9) and crosses the highway near the SK Salak South towards Taman Naga Emas and Institute Sosial Malaysia where **Station S24** is proposed.

From **Station S24**, the line continues south and crosses the Kuala Lumpur-Seremban Expressway towards Taman Castlefield (near Pusat Industri Capital) in Bandar Baru Sri Petaling and Sg Besi Highway towards Kg Malaysia Raya. It then continues along the Sg Besi Highway towards Kg Muhibbah and crosses the KTM Komuter and KLIA Express Lines as well as the Middle Ring Road 2 (MRR2) towards the Sungai Besi LRT Station in Pekan Sg Besi. **Station S25** is proposed near the existing LRT Station. The nearby areas include Pangsapuri Permai, Taman Desa Tasik and Trillium commercial area.

After **Station S25**, the line crosses the KTM Komuter and ERL Lines again as it moves south and crosses the Bukit Jalil Highway and subsequently the Kuala Lumpur Seremban Expressway near Nouvelle Hotel. The line continues to run parallel and adjacent to the E37 until the proposed **Station S26** opposite the Serdang Raya Plaza. The line mainly passes through the commercial establishments located between Kuala Lumpur Seremban Expressway and Jalan Utama until the proposed **Station S27** which is located across the South City Plaza.

From **Station S27**, the line will cross Jalan Utama, Jalan Besar and Sg Kuyoh before it swings into Jalan Raya Satu in Seri Kembangan area. Some of the major landmarks along Jalan Raya Satu include Balai Polis Seri Kembangan and Balai Bomba dan Penyelamat Serdang. **Station S28** is proposed near the Balai Bomba. The line continues along Jalan Raya Satu and Jalan Raya Tiga as it passes the Kawasan Perindustrian Seri Kembangan before it reaches the proposed **Station S29** which is located within the Universiti Putra Malaysia (UPM) land.

3.3.4 Southern Elevated Segment 2 (UPM - Putrajaya)

After **Station S29**, the alignment travels along the Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI) compound and splits towards the proposed Serdang Depot. Then it comes to the proposed **Station S30** (Provisional) which is located on MARDI/UPM land to the south of Institut Latihan Perkembangan Pertanian (ILPP Selangor), operated by Jabatan Pertanian **(Figure 3-4)**. The alignment then starts to travel along Jalan Putra Permai, crosses the Maju Expressway and passes Taman Equine and Taman Pinggiran Putra. **Station S31** is located in Taman Equine, near the Petron petrol station.

After **Station S31**, the alignment continues to travel along Jalan Putra Permai, passing Pusat Bandar Putra Permai, Kompleks Pasar Borong Selangor and Giant Hypermarket before it reaches **Station S32** in Taman Putra Permai. This station is located near to “The Atmosphere” development. After this station, the line continues south towards the new development areas (D’ Alpinia and 16 Sierra). Within these new development areas, the line travels along Persiaran Alpinia and Persiaran Sierra Utama and comes to the proposed **Station S33** in Sierra 16, passing by new residential and commercial areas along the way.

At the end of Persiaran Sierra Utama, the line crosses Maju Expressway towards Cyberjaya. Within Cyberjaya, the line follows Persiaran Apec where **Station S34** is proposed near the Sky Park mixed development. After this station the line continues along Persiaran Apec, passes by Limkokwing University of Creative Technology and towards the vegetated area where **Station S35** is proposed. After **Station S35**, the line crosses the Putrajaya-Cyberjaya Expressway as it travels towards Putrajaya and ends at Putrajaya Sentral, where the proposed **Station S36** is located. There will be an interchange with the future HSR at this station.

3.4 STATIONS

The SSP Line will have 36 stations, of which 11 will be underground (**Table 3-2**).

Table 3-2 Summary of SSP Line Stations

Segment	Stations
Northern Elevated Segment	11
Underground Segment	11
Southern Elevated Segment 1	7
Southern Elevated Segment 2	7
TOTAL	**36**

Note : Includes interchange stations with KTM Komuter, Ampang LRT Line, Kelana Jaya LRT Line, Monorail Line, MRT SBK Line and ERL

To fully maximize ridership for each station, station placement was carefully planned with relation to the surrounding land use and proposed or future developments. The following factors were taken into consideration in determining station locations:

- Land Use
  - Current land use and changes proposed over time
  - Opportunities for transit oriented development or major developments
  - Special generators such as shopping centres or sports stadiums
  - Land use-related catchment distribution

- Network Design
  - Opportunity for modal interchange (bus, LRT, KTM, etc.)
  - Distances between stations along alignment corridor

- Engineering
  - Engineering constraints such as clearances and topography
  - Opportunities for station entrance placement
  - Implications on cost

- Social and Environmental Impacts
  - Disruptions to the public (e.g. special land uses such as hospitals, etc.)
  - Accesibility to station (eg. across roads, isolation of catchment, etc.)

Not every station can be ideally located as there would inevitably need to be a trade-off between some of these factors, for example ridership, cost and social impact.

Generally, each station would be equipped with Ticket Vending Machines, Public Information Displays as well as a Customer Service Office (CSO). The stations are designed for universal access including OKU-friendly facilities such as tactile tiles for the visually impaired, OKU-friendly washroom, ramps, low head ticket counter and elevators. Additional amenities and services such as retail convenience stores and automatic teller machines will be provided at major stations.

Of the 36 stations, interchanges are available at 10 stations:

- Two interchange stations with existing KTM Komuter Line (**Station S04** at Kepong Sentral and **Station S09** at Kampung Batu)
- One interchange station with existing Kelana Jaya LRT Line (**Station S16** at Ampang Park)
- Three interchange stations with existing Ampang LRT Line (**Station S13** at Titiwangsa, **Station S20** at Chan Sow Lin and **Station S25** at Sungai Besi)
- One interchange station with SBK Line (**Station 19 at** Tun Razak Exchange (TRX))
- One interchange station with existing Monorail Line (**Station S13** at Titiwangsa)
- Two interchange stations with proposed High Speed Rail (**Station S22** at Bandar Malaysia South and **Station S36** at Putrajaya Sentral)
- One interchange station with future Circle Line (**Station S12** at Sentul West)
- Two interchange stations with ERL (**Station S22** at Bandar Malaysia South and **Station S36** at Putrajaya Sentral)

The types of stations to be built depend on the location and site constraints (**Figure 3-5 to Figure 3-7, Table 3-3, Table 3-4)**.

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Table 3-3 Proposed Stations for the SSP Line

Station Name	Station Location	Type	Interchange
Northern Elevated Segment (14.0km)			
S01	Damansara Damai	Island	
S02	Sri Damansara West	Island	
S03	Sri Damansara East	Side	
S04	Kepong Sentral	Island	Interchange with KTM Komuter
S05	Metro Prima	Island	
S06	Kepong Baru	Island	
S07	Jinjang	Island	
S08	Sri Delima	Island	
S09	Kampung Batu	Island	Interchange with KTM Komuter
S010	Kentonmen	Side	
S011	Jalan Ipoh	Island	
Underground Segment (13.5km)			
S12	Sentul West	Island	Interchange with future Circle Line
S13	Titiwangsa	Island	Interchange with Monorail and APG LRT Line
S14	Hospital Kuala Lumpur	Island	
S15	Kampung Baru North	Island	
S16	Ampang Park	Stacked	Interchange with KLJ LRT Line
S17	KLCC East	Stacked	
S18	Conlay	Island	
S19	Tun Razak Exchange (TRX)	Double Stacked	Interchange with SBK Line
S20	Chan Sow Lin	Island	Interchange with APG LRT Line
S21	Bandar Malaysia North	Island	
S22	Bandar Malaysia South	Island	Interchange with ERL and proposed HSR
Southern Elevated Segment 1 (11.7km)			
S23	Kuchai Lama	Island	
S24	Taman Naga Emas	Island	
S25	Sungai Besi	Side	Interchange with APG LRT Line
S26	Serdang Raya North	Island	
S27	Serdang Raya South	Island	
S28	Seri Kembangan	Island	
S29	UPM	Island	
Southern Elevated Segment 2(13.0km)			
S30	Taman Universiti (Provisional)	Side	
S31	Equine Park	Island	
S32	Taman Putra Permai	Island	
S33	16 Sierra	Island	
S34	Cyberjaya North	Island	
S35	Cyberjaya City Centre	Island	
S36	Putrajaya Sentral	Island	Interchange with ERL and proposed HSR

Table 3-4 Station Types and Features

Station Name	Location	Station Type	Platform Type	Park & Ride Facilities	Daily Ridership in 2052	Serving Area
S01	Damansara Damai	Elevated	Island	Yes	9,300	Saujana Damansara, Damansara Damai, Prima Dm'sara, Sutera Dm'sara
S02	Sri Damansara West	Elevated	Island	Yes	8,500	Bandar Sri Damansara (SD 7, 8, 9,11,12,15)
S03	Sri Damansara East	Elevated	Side	Yes	18,000	Taman Wangsa Permai, Taman Wangsa Aman, Taman Bukit Maluri, Bandar Sri Menjalara, Desa Park City, Kuchai Industrial Park, SD 4, SD 5
S04	Kepong Sentral	Elevated	Island	Yes	43,600	Tmn Daya, Tmn Ehsan, Tmn Desa Jaya, Desa Aman Puri, Tmn Perindustrian Ehsan Jaya
S05	Metro Prima	Elevated	Island	-	31,200	Idaman Hills, Bandar Baru Selayang, Taman Selayang Jaya, Taman Intan Baiduri, Sri Edaran Idustrial Park, Taman Kepong
S06	Kepong Baru	Elevated	Island	-	8,800	Taman Rimbunan, Kepong Baru, Kepong Baru Tambahan, Taman Sri Kepong Baru, Taman Sri Sinar
S07	Jinjang	Elevated	Island	Yes	13,400	Taman Beringin, Jinjang Utara, Taman Fadason, KawPerusahaan Kepong, Taman Jinjang Baru, Jinjang Selatan Tambahan, Taman Sri Segambut
S08	Sri Delima	Elevated	Island	-	9,800	KiPark Sri Utara, Taman Wahyu, Taman Batu, Pekan Batu, Kg Sri Delima
S09	Kampung Batu	Elevated	Island	-	39,300	Perindustrian IKS, Taman Koperasi Polis, Kg Batu Muda Tambahan, Kg Batu Muda, Taman Tasik Indah, Taman Mas Tiara
S10	Kentonmen	Elevated	Side	Yes	18,400	Taman Bamboo, Taman Sri Kuching, Taman Kok Lian, Taman Eastern, Taman Segambut Indah, Taman Rainbow
S11	Jalan Ipoh	Elevated	Island	-	11,300	Kawasan Perusahaan Segambut, Taman Segambut, Taman Kaya
S12	Sentul West	U/ground	Island	-	35,900	Kg Sg Merali, Taman Setapak, Taman Dato' Senu, Taman Desa Gombak, Taman Million, Kg Kasipillay, Sentul Selatan
S13	Titiwangsa	U/ground	Island	-	81,100	Jalan Pahang Barat, Pekeliling re-development
S14	Hospital KL	U/ground	Island	-	16,900	KLGH, Kampung Baru North
S15	Kampung Baru North	U/ground	Island	-	28,400	Kampong Bharu
S16	Ampang Park	U/ground	Stacked	-	79,400	KLCC, Jalan Ampang
S17	KLCC East	U/ground	Stacked	-	56,200	KLCC, Jalan Binjai, KL City Centre Park
S18	Conlay	U/ground	Island	-	37,400	Kompleks Budaya Kraf, Jalan Conlay, Yayasan Tun Razak, Jalan Bukit Bintang East
S19	Tun Razak Exchange	U/ground	Double Stacked	-	73,900	Tun Razak Exchange, Pasar Rakyat, Jalan Tun Razak
S20	Chan Sow Lin	U/ground	Island		30,300	Pudu, Fraser Business Park, Taman Miharja, Chan Sow Lin

Table 3-4 Station Types and Features (Cont'd)

Station Name	Location	Station Type	Platform Type	Park & Ride Facilities	Daily Ridership in 2052	Serving Area
S21	Bandar Malaysia North	U/ground	Island	-	22,100	Bukit Petaling, Kampung Attap
S22	Bandar Malaysia South	U/ground	Island	-	52,100	Taman Desa Seputeh, Taman Bukit Desa, Bandar Sri Permaisuri
S23	Kuchai Lama	Elevated	Island	Yes	14,000	Kampung Baru Salak Selatan, Taman Sungai Besi, Kuchai Entrepreneurs Park, Taman Gembira, Taman United, Taman Serangkai, Taman Bukit Indah, Taman Overseas Union, Bandar Baru Sri Petaling
S24	Taman Naga Emas	Elevated	Island	Yes	11,700	Taman Naga Emas, Salak Selatan South Garden, Taman Salak Selatan, Bandar Baru Sri Petaling, Taman Sri Endah
S25	Sungai Besi	Elevated	Side	Yes	41,300	Kg Malaysia Raya, Pekan Sungai Besi, Bandar Tasik Selatan, Taman Desa Tasek, Taman Castlefield, Taman Tasik Damai
S26	Serdang Raya North	Elevated	Island	Yes	10,400	Taman Teknologi Malaysia, The Park, Taman Perindustrian Bukit Serdang, Taman Putera Indah, One South, Taman Serdang Perdana
S27	Serdang Raya South	Elevated	Island	Yes	9,600	Taman Bukit Serdang, Taman Serdang Utama, Kg Baru Seri Kembangan, Sun Villa Garden, Pusat Perdagangan Seri Kembangan
S28	Seri Kembangan	Elevated	Island	-	10,100	Taman Muhibbah, Taman Tembangan, Seri Kembangan, Taman Sri Serdang
S29	UPM	Elevated	Island	Yes	9,900	Taman Universiti Indah, UPM
S30	Taman Universiti (Provisional)	Elevated	Side	-	4,900	Taman Universiti Indah, UPM
S31	Equine Park	Elevated	Island	Yes	21,100	Taman Puncak Jalil, Kinrara Uptown, Taman Equine, Taman Pinggiran Putra, Taman Alam Putra
S32	Taman Putra Permai	Elevated	Island	-	14,500	Lestari Puchong, Kota Perdana, Pusat Bandar Putra Permai, O2 City, Taman Prima Tropika
S33	16 Sierra	Elevated	Island	-	13,800	D'Alpinia, 16 Sierra
S34	Cyberjaya North	Elevated	Island	Yes	13,200	Presint 11, Garden Residence
S35	Cyberjaya City Centre	Elevated	Island	-	20,000	LimKokWing University of Creative Technology, Cyberjaya, Neo Cycber, Cycber 8
S36	Putrajaya Sentral	Elevated	Island	Yes	47,300	Presint 1, 2, 3, 7, 9,10,16 & 18

3.5 DEPOT

The SSP line will have a depot (44ha) at Serdang, located within the compounds of Unversiti Putra Malaysia/MARDI (**Figure 3-8**). The depot will be equipped for the maintenance of electric trains, locomotives and works trains, traction power supply equipment, trackwork, signal equipment, telecommunications equipment and the automatic fare collection equipment. Some other essential functions of the depot, such as the Operation Control Centre (OCC), will be shared with the SBK Line depot at Sg. Buloh. The Serdang depot will cater for :

- Administration and management of SSP Line and facilities
- Back-up Operation Control Centre
- Maintenance, heavy cleaning and inspection facilities of trains
- Stabling of trains and storage of materials
- Base for various systems maintenance

The operation and maintenance activities that will be carried out at the Serdang depot are as follows:

- Electric trains, locomotives and works train scheduled routine maintenance
- Electric trains interior cleaning
- Electric trains car body exterior wash
- Routine inspection and repair centre for various infrastructure system components

Some of the track maintenance facilities that will be at the Serdang depot include:

- Diesel shunting locomotives
- Diesel fuel storage and pumps
- Multi-purpose vehicles
- Multi-function measuring vehicles
- Flat wagons
- Covered wagons
- Self-propelled rescue vehicles

The scheduling of the preventive maintenance activities, planning of the resources and monitoring of the inventory will be done by the Computerised Management System. All the heavy maintenance works will be carried out at the Sg. Buloh depot.

3.6 ROLLING STOCK

A 4-car train will be adopted for the SSP Line. Key dimensions of a typical car is 22m (length) x 3.1m (width) x 3.7m (height). Each car will have an estimated maximum carrying capacity of about 250 passengers, comprising 45 seated and 204 standing (density 4.8 persons/m^2).

The car body will be made of lightweight aluminium or stainless steel. The passenger area will be equipped with stanchions, handrails and wheelchair space. Free movement between cars is made possible by a walk through gangway at all intermediate car ends. There will be no driving cab as it operates on a driverless system. However, a manual driving console will be included at the end of each motored car to allow manual driving if needed.

Each car will have four pairs of bi-parting doors on each side with an interior emergency release. Audible and visual indication for door closing and opening will be provided. Each of the cars will be equipped with two ventilation and air-conditioning units, one at each end.

The limit for the exterior noise is defined as below 65 dBA from the track centre line when the train is stationary and 81 dBA from the track centre line at a distance of 25m when the train is moving on slab track at 80 kph.

In-saloon and cab front CCTV system, passenger emergency communication facilities and smoke detectors and fire extinguishers will be provided to enhance the safety and security of passengers. For emergency communication between passengers and the OCC, Passenger Emergency Communication (PEC) will be provided as an on-board two-way radio. The train will also be equipped with a CCTV System, which comprises an in-car CCTV camera, train end CCTV camera, video recording system and video transmission system.

International Design Codes or Standards or equivalent (**Table 3-5**) will be adopted wherever applicable. Accepted good industry practice will be followed where no such code or standard exists.

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Table 3-5 Train Design Standards

Standard	Title
2008/164/EC	Technical specification of inoperability relating to persons with reduced mobility
ASTM C501	Standard test method for relative resistance to wear of unglazed ceramic tile by taber abraser
BS 476: Part 6	Fire tests on building materials and structures – Part 6: Method of test for fire propagation for products
BS 476: Part 7	Fire tests on building materials and structures – Part 7: Method of test to determine the classification of the surface spread of flame of products
BS 476: Part 20	Fire tests on building materials and structures - Part 20: Method for determination of the fire resistance of elements of construction (general principles)
BS 476: Parts 22	Fire tests on building materials and structures – Part 22: Methods for determination of the fire resistance of non-loadbearing elements of construction
BS 1363-2	13 A plugs, socket-outlets, adaptors and connection units. Specification for 13 A switched and unswitched socket-outlets
BS ISO 3862	Rubber Hoses and Hose Assemblies
BS 5499 Part 5	Graphical symbols and signs- Safety signs, including fire safety signs- Part 5: Signs with specific safety meanings
BS 6853	Code of practice for fire precautions in the design and construction of passenger carrying trains
BS EN 286 Part 3	Steel pressure vessels designed for air braking equipment and auxiliary pneumatic equipment for railway rolling stock
BS EN1011-1	Welding – Recommendations for welding of metallic materials - Part 1: General guidance for arc welding
BS EN 1011-2	Welding – Recommendations for welding of metallic materials - Part 2: Arc welding of ferritin steels
BS EN 1011-4	Welding – Recommendations for welding of metallic materials - Part 4: Arc welding of aluminium and aluminium alloys
BS EN 15085-1	Railway applications. Welding of railway vehicles and components. General
BS EN 15085-2	Railway applications. Welding of railway vehicles and components. Quality requirements and certification of welding manufacturer
BS EN 15085-3	Railway applications. Welding of railway vehicles and components. Design requirements
BS EN 15085-4	Railway applications. Welding of railway vehicles and components. Production requirements
BS EN 15085-5	Railway applications. Welding of railway vehicles and components. Inspection, testing and documentation
BS EN 50124-1	Railway applications. Insulation coordination. Basic requirements. Clearances and creepage distances for all electrical and electronic equipment
BS EN 50155	Railway applications – Electronic equipment used on rolling stock
BS EN 60947-2	Specification for low-voltage switchgear and control gear, circuit breakers
BS EN 61373	Railway applications. Rolling stock equipment, Shock and vibration tests
BS EN ISO 9239 Part 1	Reaction to fire tests for floorings – Part 1: Determination of the burning behaviour using a radiant heat source
BS EN 62267	Railway applications- Automatic Urban Guided Transport- Safety Requirements
EN 286-3	Simple unfired pressure vessels designed to contain air or nitrogen. Steel pressure vessels designed for air braking equipment and auxiliary pneumatic equipment for railway rolling stock

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Table 3-5 Train Design Standards (Cont'd)

Standard	Title
EN 286-4	Simple unfired pressure vessels designed to contain air or nitrogen. Aluminium alloy pressure vessels designed for air braking equipment and auxiliary pneumatic equipment for railway rolling stock
EN 12299	Railway applications. Ride comfort for passengers. Measurement and evaluation
EN 12663	Railway applications. Structural requirements of railway vehicle bodies. Locomotives and passenger rolling stock (and alternative method for freight wagons)
EN 13103	Railway applications. Wheelsets and bogies. Powered axles. Design method
EN 13104	Railway applications. Wheelsets and bogies. Powered axles. Design method
EN 13272	Railway applications. Electrical lighting for rolling stock in public transport systems
EN 13749	Railway applications. Methods of specifying structural requirements of bogie frames
EN 14363	Railway applications. Testing for the acceptance of running characteristics of railway vehicles. Testing of running behavior and stationary tests
EN 14750-1	Railway applications. Air conditioning for urban and suburban rolling stock. Comfort parameters
EN 14750-2	Railway applications. Air conditioning for urban and suburban rolling stock. Type tests
EN 14752	Railway applications. Body entrance systems
EN 14813-1	Railway applications. Air conditioning for driving cabs. Comfort parameters
EN 14813-2	Railway applications. Air conditioning for driving cabs. Type tests
EN 15152	Railway applications. Front windscreens for train cabs
EN 15153	Railway applications. External visible and audible warning devices for high speed trains
EN 15227	Railway applications. Crashworthiness requirements for railway vehicle body
EN 15273-1	Railway applications. Gauges. General. Common rules for infrastructure and rolling stock
EN 15273-2	Railway applications. Gauges. Rolling stock gauge
EN 45545 Parts 1-7	Railway applications. Fire protection on railway vehicles
EN 50121-3-1	Railway applications. Electromagnetic compatibility. Rolling stock. Train and complete vehicle
EN 50121-3-2	Railway applications - Electromagnetic compatibility Part 3-2: Rolling stock -Apparatus
EN 50121-3-1	Electromagnetic Compatibility. Part 3.1: Rolling Stock -Vehicle & Complete Vehicle
EN 50121-4	Railway application. Electromagnetic compatibility. Emission and immunity of the signalling and telecommunications apparatus
EN 50126 / IEC 62278	Railway applications - The specification and demonstration of reliability, availability, maintainability and safety (RAMS)
EN 50128/ IEC62279	Railway applications - Communications, signalling and processing systems
EN 50153	Railway applications. Rolling stock. Protective provisions relating to electrical hazards
EN 50155	Railway applications - Electronic equipment used on rolling stock

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Table 3-5 Train Design Standards (Cont'd)

Standard	Title
EN 50207	Railway applications. Electronic power converters for rolling stock
EN 50238	Compatibility between rolling stock and train detection systems
EN 50553	Railway applications. Requirements for running capability in case of fire on board of rolling stock
EN 60077-1	Railway applications. Electric equipment for rolling stock. General service conditions and general rules
EN 60077-2	Railway applications. Electric equipment for rolling stock. Electrotechnical components. General rule
EN 60077-3	Railway applications. Electric equipment for rolling stock. Electrotechnical components. Rules for d.c. circuit-breakers
EN 60077-4	Railway applications. Electric equipment for rolling stock. Electrotechnical components. Rules for AC circuit-breakers
EN 60077-5	Railway applications. Electrotechnical equipment for rolling stock. Electrotechnical components. Rules for HV fuses
EN 60349-2	Railway applications. Rotating electrical machines for rail and road vehicles. Electronic converter-fed alternating current motors
EN 60529	Railway applications. Specification for protection provided by enclosures
EN 61287	Railway applications. Power converters installed on board rolling stock. Characteristics and test methods
IEC 269	Low voltage fuses
IEC 60077	Railway applications - Electric equipment for rolling stock
IEC 60332	Railway applications – Electric equipment for rolling stock
IEC 60349	Electric traction - Rotating electrical machines for rail and road vehicles
IEC 60529	Specification for classification of degrees of protection provided by enclosures
IEC 60571	Electronic equipment used on rail vehicles
IEC 60623	Secondary cells and batteries containing alkaline or other non-acid electrolytes -Vented nickel-cadmium prismatic rechargeable single cells
IEC 60850	Railway applications. Supply voltages of traction system
IEC 61082-1	Preparation of documents used in electrotechnology – Part 1: Rules
IEC 61124	Reliability Testing – Compliance tests for constant failure rate and constant failure intensity
IEC 61133	Railway applications - rolling stock - testing of rolling stock on completion of construction and before entry into service
IEC 61287-1	Railway Applications. Power converters installed on board rolling stock. Characteristics and test methods.
PD IEC/TR 62267	Railway applications- Automated Urban Guided Transport – Safety Requirements Part 2: Hazard Analysis at Top System Level
IEEE 1474.1	IEEE Standard for Communications Based Train Control (CBTC) Performance and Functional Requirements
IEEE 802.11	Wireless Local Networks
ISO 2631-4	Mechanical vibration and shock- Evaluation of human exposure to whole-body vibration
ISO 3095	Railway applications. Acoustics. Measurement of noise emitted by railbound vehicles
ISO 3381	Railway applications – Acoustics – Measurement of noise inside railbound vehicles
UIC 566	Loading of coach bodies and their components
UIC 651	Layout of drivers' cabs, in locomotives, railcars, multiple unit trains and driving trailers

3.7 TRACK WORKS

The trackwork provides support and guidance to the trains and will be a complete system that supports safe, reliable and comfortable train services. The major elements of the trackwork system include:

- Rail fastenings which include base plates, bolts, rail pads and insulators;
- Sleepers/plinth, rail bearers and non-ballasted track systems;
- Track foundations including ballast and any associated drainage and capping layers;
- Turnouts and crossovers which are located at appropriate locations to suit operational requirements;
- Derailment containment mechanisms where required;
- Measures to mitigate noise and vibration, at specific locations; where necessary.
- Ducts which lay beneath the track to accommodate railway control and communications equipment wiring;
- Stray current collection system where provided within the track form;
- Traction system track and cross bonding;
- Track permanent markers; and
- Buffer Stops

The trackform for main line will consist of non-ballasted direct fixation tracks and at sensitive locations, resiliently fastened. Within the depot and depending on the location, tracks will be ballasted track supported on pre-cast pre-stressed concrete sleepers or direct fixation non-ballasted track such as inside the maintenance workshop.

The rail standard for mainline and depot track will be UIC 60E1A4, continuously welded into strings by an electric flash-butt and strings of rails welded into position on site by alumino-thermic welds.

Trackwork for the railway will be designed to be a complete trackwork system that guarantees safe, reliable and comfortable train services to operate for twenty hours, each day of the year. The trackwork will be designed such that it requires minimal maintenance but is able to be maintained during short non-traffic hours, using simple maintenance procedures and minimal specialized plant or equipment.

The following international Design Codes or Standards or equivalent will be adopted wherever applicable (**Table 3-6**). Accepted good industry practice will be followed where no such code or standard exists.

Table 3-6 Design Standards for Trackwork

Standard	Title
EN 13674-1	Railway Applications – Track – Rail –Part 1: Vignole railway rails 46kg/m and above
EN 13674-2	Railway Applications – Track – Rail – Part 2: Switch and crossing rails used in conjunction with Vignole railway rails 46 kg/m and above
EN 13674-3	Railway Applications – Track – Rail – Part 3: Check rails
EN 13481-1, 2 and 5 to 7	Railway Applications – Track – Performance requirements for fastening systems
EN 13146-1 to 9	Railway Applications – Track – Test methods for fastening systems
EN 13230	Railway Applications – Track – Concrete sleepers and bearers
EN 50122-2	Railway applications – Fixed installations – Electrical safety, earthing and the return circuit Part 2: Provisions against the effects of stray currents caused by DC traction systems.
UIC Code 774-3	Track/Bridge Interaction
UIC Code 776-3	Deformation of Bridges
UIC Leaflet 719R	Earthworks and track bed construction for railway lines
BS 5400 Part 2: 2006	Steel, concrete and composite bridges
BS EN 1563:1997	Spheroidal graphite castiron
IEC 62278	Specification and demonstration of reliability, availability, maintainability and safety (RAMS)

3.8 SYSTEM OPERATION

The proposed 4-car trains will have maximum carrying capacity of 1000 passengers. The operating speed for the train is 100 km/hr. However, the average speed (speed for the whole stretch of the alignment) is estimated 40 km/hr. The total journey time from Sg Buloh to Putrajaya is about 84 minutes.

In terms of operation hours, SSP Line will operate daily from 6.00 am to 12.00am (midnight). At the initial stage of operation, the peak hour frequency for the train will be 200 seconds while the ultimate peak hour frequency of the train is 109 seconds.

3.8.1 Signalling and Train Control System

The Signalling and Train Control (S&TC) system's main function is to control the train operation automatically on the mainline and within the depots (except maintenance areas) in a safe and efficient manner. Part of the S&TC system is an Automatic Train Control (ATC) System that allows full bi-directional automatic control of trains over each track throughout the system from the OCC located at the Sg. Buloh depot.

The Automatic Train Protection system ensures that trains are able to move safely without having conflicts with other authorized movements and prevent trains from exceeding the limits of their authority. All moving or stationary trains will be positively detected and continuously located under all modes of operation on mainline and within depots (except maintenance areas).

The central train control functions such as train schedule supervision, automatic route setting, train tracking, automatic train regulation and operation indication will be within the S&TC System. All moving or stationary trains will be positively detected and continuously located under all modes of operation on mainline and within depots (except maintenance areas). A minimum signalled headway of 90 seconds will be allowed.

3.8.2 Traction Power Supply System

Traction Power Supply for the SSP Line will be supplied from Tenaga Nasional Berhad (TNB) to Bulk Supply Substations (BSS) at 132kV. Through an internal distribution 33kV network, the High Voltage AC power supply will be connected to all of the Traction Power Substations and Station Power Substations.

3.8.3 Communication & Central Control

The Communication System will provide voice, data and video signals between stations, the OCC and all other necessary facilities. This system will be designed to facilitate normal train and station operations. It will also assist in the management of any incidents during normal and abnormal operation as well as during emergencies.

The Communication System comprises the following subsystems:

- Backbone Transmission Network
- Master Clock system
- Telephone system
- Radio system including Government Integrated Radio Network (GIRN)
- Public Address (PA) system
- Passenger Information Display (PIDS) system
- Closed Circuit Television (CCTV) system
- Data Communication System
- Multiplexer

The system will be designed to cater for lightning protection and electromagnetic compatibility. British and European Standards will be used in the design, construction and testing of the lightning protection, earthing and bonding.

3.8.4 Automatic Fare Collection System

Automatic Fare Collection equipment will be user friendly and compatible with existing as well as future upgrading of the MRT, LRT, Monorail and KTM Komuter. There will be a high level of security against unauthorized entry and data access/modification.

Two types of tickets will be used:

- Token: Single/Return Journey Ticket,
- Contactless Smart Card: for others (eg. Season Pass)

Passengers will be able to get the contactless smart tokens for single-journey tickets at the Ticket Vending Machines, where they will also be able to add value to the ICPS contactless smart cards as stored-value tickets. The Customer Service Office will house the Office Ticket Processor which will enable the Operator to provide smart card related services to passengers.

At each station, there will be a Station Accounting Computer which will host communications with all ticketing equipment in the station. Data regarding fare, passenger volume and maintenance functions will be collected and stored in the SAC.

3.8.5 Operation Control Centre

The Operation Control Centre (OCC) for the SSP Line located at the Sg. Buloh depot co-located with the SBK line will be the primary control location for the SSP Line. There will be a Backup Control Centre at the Serdang depot in the event of failure of the OCC.

The functions of the OCC include:

- To monitor the equipment as well as control and handle train service at the degraded and emergency mode operations
- To monitor, control and dispatch train service
- To monitor status of the traction power supply
- To perform the switching and isolation of traction power supply sections
- To coordinate with maintenance departments for maintenance activities, recoveries and engineering works
- To conduct pre-recorded or live public announcements to inform and guide passengers.

3.9 FEEDER BUSES AND PARK AND RIDE FACILITIES

a) Feeder Buses

The feeder bus system is currently being planned to ensure connectivity with the current public transportation system. The buses will operate at a frequency of between 10-20 minutes and to serve areas within a 3-5km radius of the stations. For the SSP line, a total of 57 routes have been identified. There will be 4 types of feeder bus routes:

- ***2-way Line*** – An end-to-end route which operates between two points and follows the same roads in both directions except where one-way street systems necessitate minor deviations (**Plate 3-1**).
- ***1-way Loop*** – A circular route whereby the bus returns to the point of origin without traversing the same roads twice (**Plate 3-2**).
- ***2-way Loop*** – This is similar to the 1-way loop but with an additional reversed service, especially where circular routes are too long to be efficiently served by a 1-way loop only (**Plate 3-3**).
- ***2-way Line + 1-way Loop*** – This is mainly a 2-way line route but with a small part of the loop forming a 1-way loop at the start/end. However, the 1-way loop may also be in the middle, particularly in 1-way road systems.

To avoid any duplication of services as well as unnecessary competition between bus and rail transits, the rationalisation of existing bus routes may be necessary. The Project Proponent will liaise with SPAD to determine the optimum routes.

b) Park and Ride Facilities

Park and ride facilities will be provided at selected stations where there is land available for the construction of the multi-storey car park or at grade parking facilities. The aim is to capture potential passengers that have to get to their destination beyond walking distance and the feeder bus coverage. Therefore, the journey to and from the SSP station will be by private vehicle mode. These facilities would require good accessibility from the surrounding network.

A total of 15 park-and-ride facilities will be provided, with a total of 8,900 parking bays. Out of this, 13 will be Multi-storey Park and Ride (MSPR) sites and 2 will be at-grade park and ride (AGPR) sites. The proposed sites are as follows:

a. MSPR – Station S01, Station S03, Station S04, Station S07, Station S10, Station S23, Station S24, Station S25, Station S26, Station S29, Station S31, Station S34 and Station S36.

b. AGPR – Station S02 and Station S27.

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The locations for the Park and Ride facilities were chosen based on the following criteria:

- Lower-density areas that have limited service coverage
- Local areas factors such as community, environmental constraints and economic implications
- Future expansion potential
- Congested highway corridors
- Opportunity for joint use with existing or planned adjacent development
- Good visibility from primary roadways

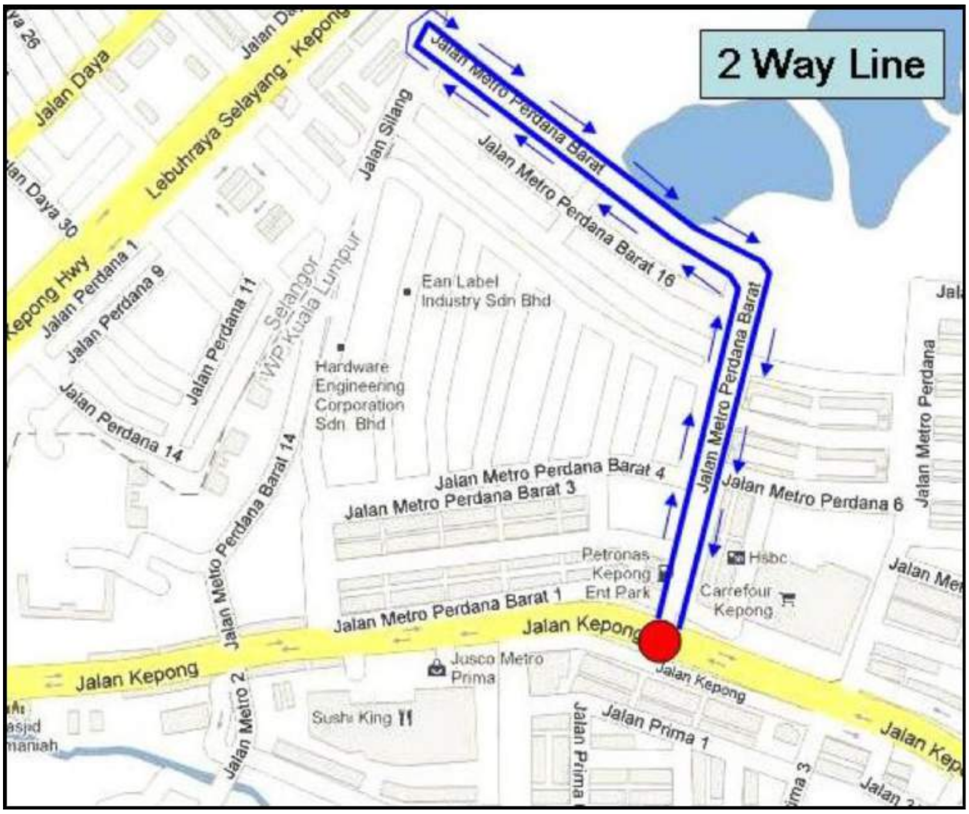

Plate 3-1 : Typical design of a 2-way line bus route at Station S05

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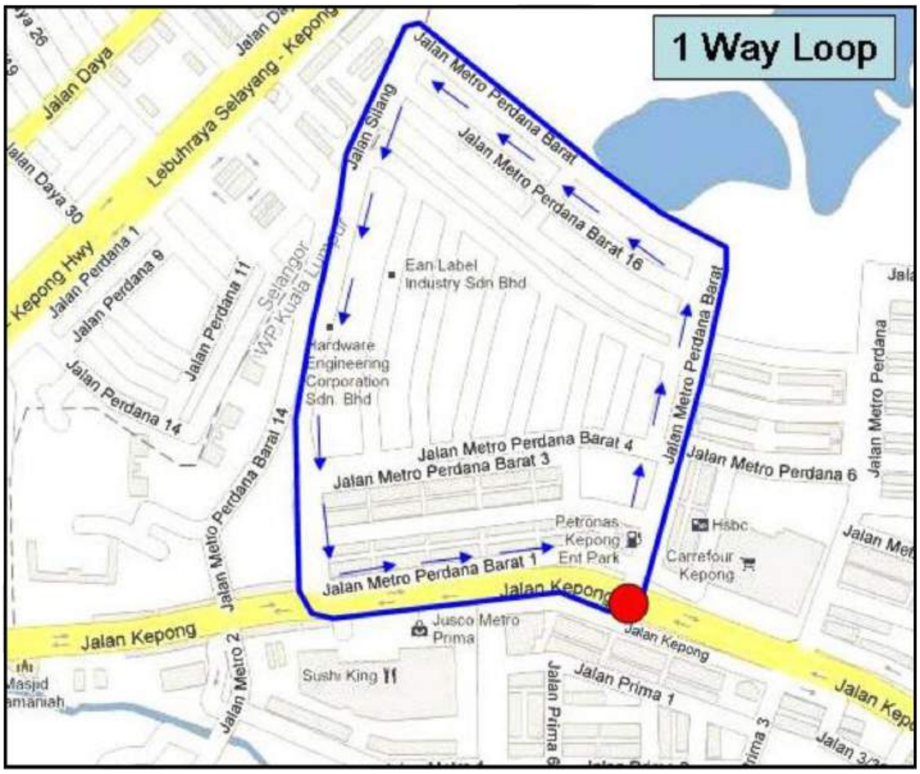

Plate 3-2 : Typical design of a 1-way loop bus route at Station S05

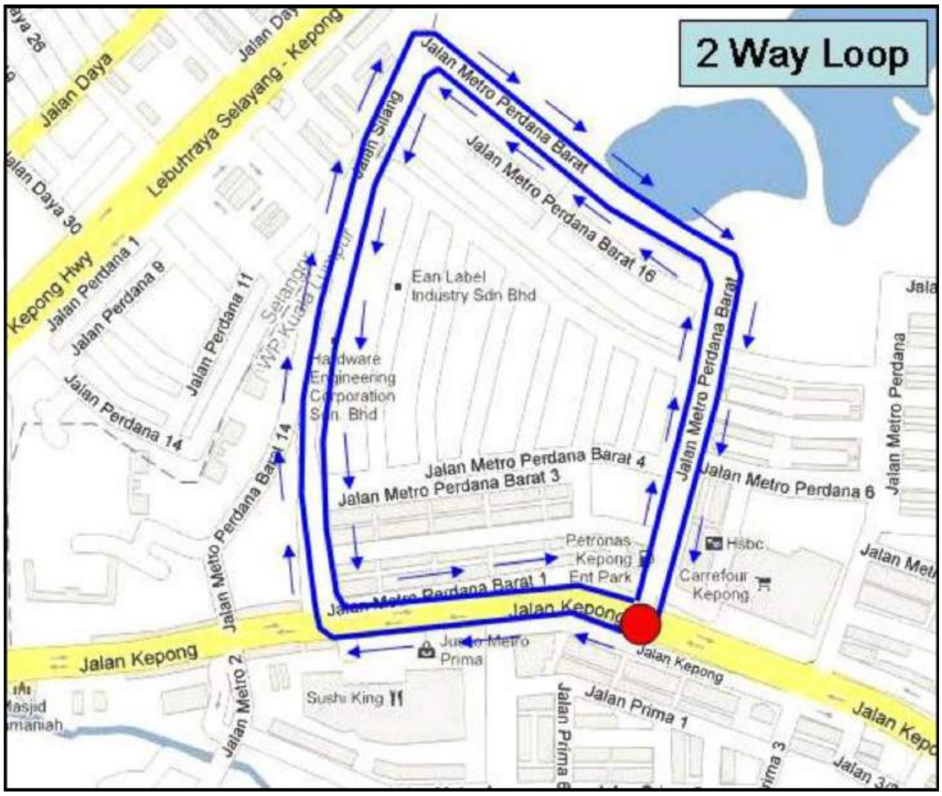

Plate 3-3 : Typical design of a 2-way loop bus route at Station S05

3.10 CONSTRUCTION METHODS

The construction methods that will be used for the Project are designed to be cost-effective and relatively quick in order to reduce the construction period. At the same time, it is important that the method adopted minimize disruption to road traffic and risks to public safety. The typical construction methods for the key components of the Projects are explained below:

- Utilities relocation
- Viaduct construction
- Tunnel construction
- Elevated station construction
- Underground station construction
- Depot construction

3.10.1 Utilities Relocation

Before the construction works commence, information pertaining to utilities located along the Project corridor was obtained by gathering the as-built drawings from the various agencies followed by geophysical scanning. This exercise is conducted in order to facilitate and further determine the utilities that need to be relocated along the corridor. The types of utilities include underground water and sewer mains, electrical cables, telecommunications cables, gas pipes and other underground cables.

The utilities detection and piloting works shall comprise the following works:

- Utilities detection and mapping
- Excavation of trenches using machineries or manpower.
- Removal of existing road pavement, roadside kerb, road shoulder and drains.
- Checking and recording the necessary data/ information.
- Backfilling of the excavated trench using the excavated materials (where possible)
- Reinstatement of any affected structure (if any)

The utilities relocation works will commence after the completion of the utilities detection and piloting works. Several detection methods can be used such as electromagnetic, magnetic and elastic wave depending on the site condition.

Some of these utilities detection, piloting and relocation works may cause traffic congestion and the impacts vary depending on the locations of work. In some cases, there may be temporary loss of parking spaces or temporary closure of road lanes. Where necessary, the Horizontal Direct Drilling method will be used to relocate the services as this method will minimize the need for trenching on the road surface.

Traffic management plans will be prepared for submission to the local authorities. Specific traffic management plans will be prepared for all the stations and other critical areas to minimize the impacts to the existing traffic condition.

3.10.2 Viaduct Construction

The elevated structures and viaducts will be generally located in the road median and sides. The construction will involve the following major components:

Sub-structure
Design of sub-structure will depend on the geotechnical conditions and site constraints. The sub-structures will typically be constructed using cast-in-situ bored piles ranging from 1.0m – 2.8m in diameter. In areas with tight working spaces or steep slopes, large diameter single or multiple caisson piles may be constructed.

The piers are typically single columns supporting the viaducts. In cases where a single column is not feasible due to space constraints caused by existing road lanes, waterways, utilities and permanent structures, portals or cantilever piers may be adopted. The portals may be reinforced or prestressed concrete members.

Superstructure
The viaduct will carry two non-ballasted tracks. Superstructure in the form of pre-stressed segmental has been determined as the most cost effective and time saving structural form for the viaduct deck. The elevated viaducts will generally consist of standard spans ranging up 39.8m.

Long Span Crossing
The long span will include design for spans up to 160m at some areas such as crossing existing expressways, rivers and bridges. These long spans deck shall be segmental box girders and the construction of the viaduct shall be by *balanced cantilever* solution (**Figure 3-9**).

For spans up to 100m, the deck shall be made up of precast units. However, viaduct spanning between 100m and 160m shall be constructed as in-situ structures due to the limitation of land transportation constraint on large pre-cast units.

Plate 3-4 - Plate 3-7 show examples of the viaduct construction for SBK Line.

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Plate 3-4

Example of the pier constructed at the median of the road for SBK Line

Plate 3-5

Example of completed guideway for SBK Line

Plate 3-6

Example of the portal piers along Jalan Cheras for SBK Line

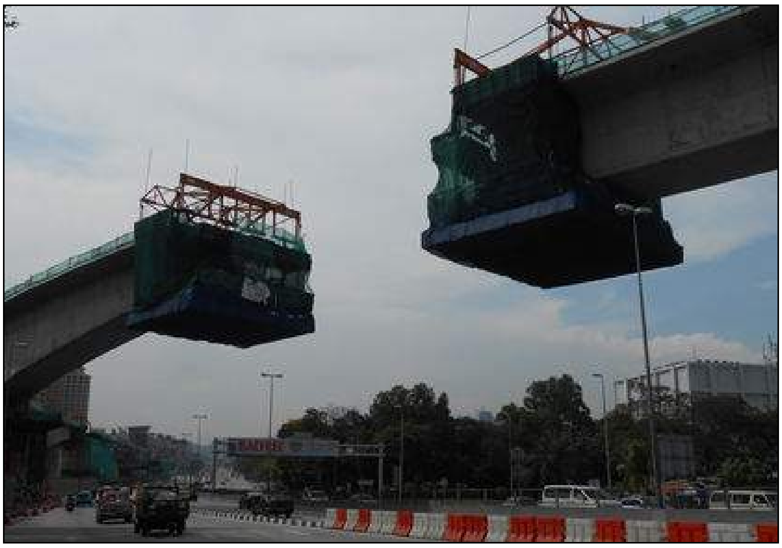

Plate 3-7

Example of the long span for SBK Line

3.10.3 Tunnel Construction

Tunneling Works

Two types of Tunnel Boring Machines (TBM) namely the Earth Pressure Balance TBM or Variable Density TBM (**Figure 3-10** and **Figure 3-11**) will be used depending on the geological conditions. Twin bored tunnels will be constructed to house the pair of tracks. In most areas, the tunnel will be designed to be parallel to each other. In areas where space is limited, the tunnels will be vertically stacked (**Figure 3-12**).

The launch shaft will be used to supply the TBM with all necessary materials to construct the tunnel. The bored material will be sent out using rail cars, slurry system or conveyor belts. Pre-cast concrete tunnel segments will be used to line the tunnel. The TBM will be operated 24 hours a day and seven days per week. Construction activities above ground associated with tunnel boring work may also occur concurrently (**Figure 3-10** and **Figure 3-11**).

The TBM technology offers the following advantages compared to conventional drill and blast tunnelling:

- Mechanical solution for temporary stabilization of the face area and able to erect permanent concrete lining behind the TBM after each excavation
- Reduction in over-break of the tunnel excavation
- Continuous and repetitive operation; safer working environment
- Automated process
- Higher excavation rate

Cut and cover tunnels followed by a series of reinforced concrete retaining U-troughs will be constructed at the transition zones from the tunnel to the surface level. Emergency exits from tunnels will be provided via emergency stairs or cross passage or both.

Other elements in the tunnel such as the ventilation system, drainage system, lighting system, air conditioning, communication system and fire-fighting system will be installed thereafter. The slurry treatment plants will be built within the launch shafts to treat the slurry material that will be discharged from the tunneling process.

Plate 3-8 - Plate 3-9 show examples of the tunnel construction for SBK Line.

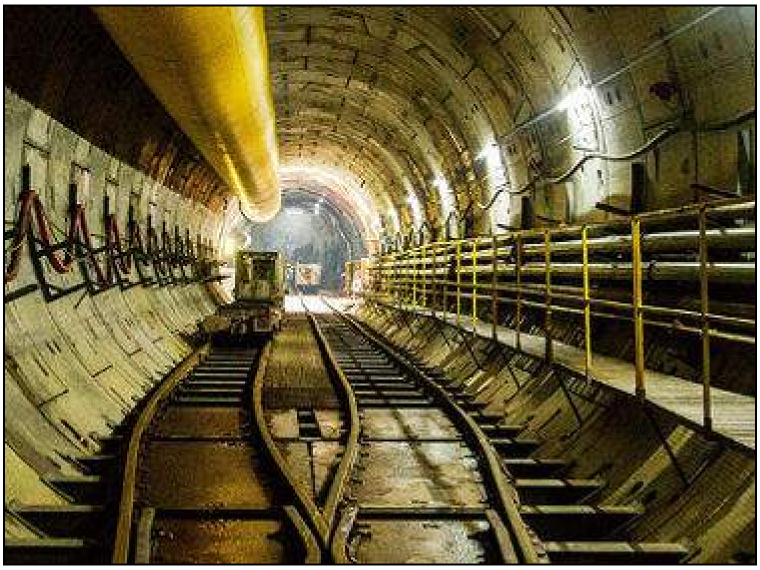

Plate 3-8

Example of the upper shaft from inside the excavated tunnel for SBK Line (Inai Launch Shaft)

Plate 3-9

Example of the retrieval shaft for SBK Line (Maluri Portal)

Risk management framework and measures to minimize impacts from tunneling works will be prepared and implemented to ensure that the most suitable type of tunneling taking into account the geological and groundwater regimes.

Estimated quantities of excavated material from the tunneling works are as tabulated in **Table 3-7**.

Shaft Construction

Launch shaft, retrieval shaft and escape shaft construction will involve construction of retaining wall using secant bored pile or diaphragm wall, installation of ground anchor and whaler beam after each stage of excavation followed by construction of base slab casting of tunnel eye.

Once launch shaft is ready the TBM will be assembled at the site. The TBM assembly will involve TBM main shield and TM cutter-head followed by preparation of works to launch the TBM for tunneling.

The launch shafts will be constructed at Titiwangsa, Crossover at General Hospital, Conlay, Chan Sow Lin and BM North. Retrieval shafts will be located at the North Portal, Crossover at General Hospital, Ampang Park, Conlay, Tun Razak Exchange and Chan Sow Lin. The escape shaft may be required between Sentul West – Titiwangsa, Kg. Baru – Ampang Park and between TRX – Chan Sow Lin.

Table 3-7 Excavated Material from the Launch Shaft, Underground Stations and Tunneling Works

Location	Excavated Material (m^3)
North Portal	5,000
Sentul West	145,000
Titiwangsa	150,000
Hospital Kuala Lumpur	232,000
Kg Baru North	145,000
Ampang Park	230,000
KLCC East	180,000
Conlay	150,000
Chan Sow Lin	150,000
BM North	145,000
BM South	145,000
Tunneling Works	980,000
TOTAL	**2,657,000**

3.10.4 Elevated Station Construction

The elevated stations will have multiple levels – namely the concourse level and the platform level. The platform arrangements can either be side platform or island platform. If the station is a side platform type, the alignment will be a twin track box girder or equivalent. If the station is a island type platform, the alignment will be on a single track box girder.

Elevated station construction consists of the following major components:

- Construction of pile cap, column and crosshead
- Installation of pre-cast beam that will be launched using mobile or crawler crane
- Construction of concourse and platform level
- Architectural finishes and mechanical and electrical works

For side platform station, the concourse slab is formed using the Pre-cast Post-tensioned cantilever beam tied to the spine beam, while, platform slab is formed by RC columns tied from the concourse level. The spine beams shall be cast in-situ and in stages to avoid full closure of traffic lanes on the road below.

Once pier head is cast and achieved sufficient compressive strength, pre-cast segmental crosshead on both sides shall be erected using Balance Pre-cast Segmental Cantilever Method. Next, pre-casted beams to be launched on the crossheads span by span. Concourse slab shall be cast using hybrid method comprising of placing the pre-cast floorboard to span between the beams, which act as permanent formwork to receive a layer of in-situ concrete topping without the need to erect any temporary staging beneath the structure which will cause disruption on any existing traffic flow.

The platform slab shall be cast in grids using conventional false work support to the concourse slab. The platform slab can only be cast after the installation of Precast-Segmental Box Girder. The station roof is supported by steel columns mounted from the platform slab. The steel roof structure shall be pre-fabricated off site and install using crane.

To ensure consistent quality finishes, pre-cast elements such as pre-cast partition walls and facades will be used to complement the cast-in-situ work.

Plate 3-10

Example of a station construction for SBK Line (Bandar Tun Hussein Onn Station)

3.10.5 Underground Station Construction

The construction methods adopted for the underground stations are summarized in **Table 3-8**.

Table 3-8 Construction Methods For Underground Stations

Station & Portal	Work Method	Description
S12, S14, S15, S16 and S17	Top Down	Excavation will be carried out from top to bottom in tandem with the casting of structural elements. Diaphragm wall and barrette pile will be installed. The main works include excavation, installation of strut, and casting of slabs at each level. Cast roof slab with opening at each level. The procedure will be continued until it reaches the bottom slab level. Cast the bottom for TBM to breakthrough.
S13, S18, S19, S20, S21, S22, North Portal, Crossover, and South Portal	Bottom Up	Construct retaining wall (usually diaphragm wall). Install struts for support and excavate until bottom level for the base slab. Cast base slab and construct station floors and wall. Once roof slab is constructed, remove the strut and backfill until surface environment is reinstated.

Plate 3-11

Example of the underground station construction for SBK Line (Cochrane Station) – Bottom Up Method

Plate 3-12

Example of the underground station construction for SBK Line (Bukit Bintang Station) – Top Down Method

3.10.6 Track Works

The track works generally consist of three elements namely the (i) rail, (ii) fastener; and (iii) trackform. The rail will be placed on top of the tie plates (fastening system assembly) and become the permanent rails at the design gauge. The Rail Fastening System is a screwed-type fastening system which can be pre-assembled onto the sleeper and can be laid fully automatically or mechanically installed. The rail fastening system will offer secondary stiffness as protection against rail rotation and deformation of the spring elements.

The trackform will consist of a pair of concrete sleepers connected together by reinforcement bars. The sleepers will be cast into the concrete slab in-situ after adjusting the alignment. Mass concrete is used to support the concrete slab on embankment, while the concrete slab is laid on the civil works base in tunnel. For viaducts, a makeup layer is placed under the concrete slab, and a shear key is used to restrain the movement of the slabs. Elastomeric bearings will be placed between the shear key and the slab to avoid direct contact and shearing of concrete.

Emergency Crossovers are placed strategically along the length of the line to facilitate degraded or emergency service turn backs, single line running for planned and unplanned events as well as train rescue operations. Crossovers will be provided at Sungai Buloh, Kampung Batu, Hospital Kuala Lumpur, Bandar Malaysia North, UPM, Taman Universiti and Cyberjaya City Centre.

3.10.7 Depot Construction

The depot covers an area of 44ha and will be situated at Serdang within the University Putra Malaysia/ MARDI area. The depot is mainly covered by shrubs and vegetation. The construction of the depot will involve the following works:-

- Site clearing
- Earthworks
- Construction of buildings and supporting infrastructure and utilities

3.10.7.1 Site Clearing

Site clearing involves the removal of vegetation within the Project site which consists mostly of secondary forest vegetation, residual trees, shrubs and patches of oil palm at the eastern part of the site. Site clearing will be carried out by means of bulldozers or equivalent machineries.

Around 44ha of vegetation will be felled and removed during site clearing works. The total volume of biomass excepted to be generated from the site clearing is about 8,100 tonnes.

The biomass generated from the site clearing may be used to cover the exposed area for the erosion measures. The remaining biomass will be disposed off to the approved dumping site that will be identified at a later stage.

3.10.7.2 Earthworks

The depot site is undulating with the ground level ranging from RL65m to RL120m. The estimated volume of earthwork to be **3,780,000m^3** for cut, **230,000m^3** for topsoil removal and **2,620,000m^3** for fill with an excess of **930,000m^3** in order to achieve the platform level of 79m. The excess material will be temporarily stockpiled at the site prior transporting out. Any suitable material will be used where possible and only unsuitable material will be disposed at approved dumping sites.

The cut area is mostly located at the western side of the depot. Filling will be carried out at the eastern side of the depot. Significant amount of slope treatment is anticipated.

The earthwork will be carried out in 2 phases which is expected to take about 1-2 years for completion. It will commence at southern end of the site. The cut material will be used to fill up the eastern part of the site. Excavators will be used for cutting, and loading onto dump trucks to transport and deposit the fill material at the site while bulldozers will be used to move and spread the fill material. Compactors will then be utilized to compact the fill material.

3.10.7.3 Construction of Buildings and Supporting Infrastructure and Utilities

The construction of the facilities within the depot site will entail erection works of the buildings, installation of mechanical and electrical components as well as construction of ancillary infrastructures.

The major activities during the construction stage would involve both substructure and superstructure construction which includes piling, structural, concreting and infrastructural works.

The construction of the infrastructure and utilities such as internal roads, drains, water pipes, sewerage pipes, telecommunication lines and electricity cables, would involve mostly localized excavation.

The majority of construction workers for the SSP Line are expected to stay the Central Labour Quarters.

3.11 PROJECT IMPLEMENTATION SCHEDULE

The Project construction is expected to commence in April 2016 assuming all regulatory approvals are obtained by then. It is scheduled for completion in July 2022.

The construction works have been divided into two phases. Phase 1, which covers construction from Sg. Buloh to Kampung Batu, is scheduled to start in April 2016 and end in July 2021. Phase 2, which covers construction from Kampung Batu to Putrajaya, is scheduled to start in June 2016 and end in July 2022 (**Table 3-9**).

Table 3-9 Planned Project Implementation Schedule

ACTIVITY	START	FINISH
Phase 1 : Sg. Buloh – Kampung Batu		
1. Elevated construction	April 2016	Jan 2021
2. System Installation	Feb 2019	Apr 2021
3. Testing & Commissioning	Jan 2021	Jul 2021
Phase 2 : Kampung Batu – Putrajaya		
1. Elevated Construction	Jun 2016	Feb 2022
2. Underground Construction	July 2016	Feb 2022
3. System Installation	May 2019	Apr 2022
4. Testing & Commissioning	Jan 2022	Jul 2022