Chapter 8 Regional Railway Master Plan

8.1 Long Term Regional Railway System Development Plan

8.1.1 Potential Railway Development Projects

(1) Commuter Trains

1) Semarang Metropolitan Area

Greater Semarang Region with a population of approximately 3 million functions as the largest core of the Central Java region. Semarang Tawang and Semarang Poncol are the top-ranked terminal stations in the whole island, yet the system has not been double tracked nor electrified. Inconsistent traffic control system confuses train operations and deteriorates the reliability of the service. Water invasion into the rail track and station makes the situation even worse.

In developing a regional railway system in the Central Java region, commuter trains can enhance service with frequent availability and extended network. The Study Team proposed following projects which will contribute to the achievement of these objectives..

a. Track Elevation inside Semarang City (CT-Sem-1)

Weak track foundations and frequent flooding around Semarang stations limit the travel speed of the trains to as low as 10 kph. Track elevation inside Semarang City appears to be the first priority to get the line functioning as commuter rail. The project targets the 7 km area within the primary ring road. Implementation includes elevated civil structures, elevated stations, ballastless tracks with new rails, modern signaling, telecommunication & traffic control, and electrified depot at ground level. The project will also avoid level crossings with local roads, which may be essential for the future development of the City's transport network.

Justifications for the "Elevated" alignment and "System Electrification" are given in section 8.1.2 (2) Development Alternatives.

b. Kendal Commuter Line (CT-Sem-2)

The proposed line will serve Kendal township, situated 28 km from Semarang Tawang. The project is construction of a 9 km branch line from existing Kaliwungu Station (Alternative – 1). Moreover, addition of a new accessible station on existing rail line plus providing convenient access road from Kendal (Alternative – 2) can be considered as optional case. Scope of the project encompasses double tracking of Semarang – Kaliwungu, upgrading of existing stations, construction of new stations, installation of modern signaling, telecommunication & traffic control system, and procurement of rolling stock. The line will be an electrified system and will meet the requirements of commuter service.

c. Demak Commuter Line (CT-Sem-3)

Eastern stretch of the commuter network will run into Demak, 29 km from Semarang Tawang. This abandoned rail corridor requires full construction of new tracks in an adjusted alignment, which may be situated on the trunk road with viaduct structure or embanked on open land. To avoid huge land acquisition and to assure easy access for the potential users, the line will have elevated track and stations. The project scope includes trackworks, installation of modern signaling, telecommunication & traffic control system, traction power supply system and electric railcars.

Justifications for the "Elevated" alignment are given in section 8.1.2 (2) Development Alternatives.

d. Brunbung Commuter Line (CT-Sem-4)

As part of the Semarang – Solo rail corridor, the southern stretch up to Brunbung (14 km from Semarang Tawang) will also provide commuter service. The project will cover rehabilitation of existing track (including foundations) and double tracking of the whole alignment. Also installation of modern signaling, telecommunication & train control system, and electric railcars will be undertaken.

2) Solo (Surakarta) Metropolitan Area

Solo (Surakarta), also known as Solo, is second largest city in the Central Java region with a population of 1 million. The city possesses three terminal stations: namely Solo Jebres, Solo Balapan and Purwosari. Accomplishment of double tracking project between Yogyakarta – Solo Balapan has triggered the introduction of Prameks trains, which operate hourly and serve the south main line. This modern, reliable and efficient service will soon expand to Sragen (29 km to the east) and to Semarang (109 km to the north). Future commuter network in and around

Solo City shall be in line with these on-going projects.

a. Klaten – Solo Commuter Line (CT-Sol-1)

Klaten, situated 29 km from Solo Balapan, is an intermediate station between Yogyakarta – Solo rail corridor. Increasing the number of stations and upgrading the existing stations (i.e. Solo Jebres, Solo Balapan, Purwosari, Klaten) will be done by the project to suit the requirements of commuter service. The project scope includes installation of modern signaling, telecommunication & traffic control system, traction power supply system and electric railcars.

b. Sragen Commuter Line (CT-Sol-2)

Existing single-tracked railroad runs into Sragen, 29 km to the east from Solo Balapan. The section awaits expansion of Prameks service. Double tracking with installation of modern traffic control system will link the two cities with high frequency. The project scope includes upgrading of existing stations, construction of new stations, installation of traction power supply system and electric railcars.

3) Yogyakarta Metropolitan Area

Yogyakarta City belongs to DIY (Yogyakarta Special Province) with a population of 1 million. Two terminal stations, Yogyakarta (Tugu) and Lempunyangan, plus renewed airport station Maguwo provide a variety of services including Prameks. Railway development in and around Yogyakarta has the advantage that routes have already undergone double tracking. Commuter trains will be planned in such a way that these systems can take advantage of the increased line capacity.

a. Klaten – Yogya Commuter (CT-Yog-1)

Klaten, situated 30 km east to Yogyakarta (Tugu), is an intermediate station between Yogyakarta – Solo rail corridor. To attract potential demand, the project will add new stations as well as upgrading the existing stations (i.e. Yogyakarta (Tugu), Lempunyangan, Klaten and the further development of Brambangan Station) to cater the tourist to Prambanan. Installations of modern signaling, telecommunication & traffic control system, traction power supply system, electric railcars and electrified maintenance facility will be executed at the same time.

b. Wates Commuter (CT-Yog-2)

Wates, 28 km east to Yogyakarta (Tugu), is located in Kutoarjo – Yogyakarta double-tracked section. Wates Station is one of the intermediate stations for Prameks. Similar to the other commuter projects, the project will increase the number of intermediate stations, install modern signaling, telecommunication & traffic control system, traction power supply system and procure electric railcars.

(2) Urban Railways

1) Semarang City

a. Semarang Monorail (UR-Sem)

The project aims to provide modern means of transportation for the passengers moving inside the metropolis, access to the city centre from hillside, as well as commuting from the outskirts of the City. The alignment starts near Semarang Poncol, crosses over Simpang Lima, passes across a tollway, climbs the hillside along Jl. Setiabudi and reaches Ungaran.

Elevated monorail system will be the first choice to overcome the steep gradient of the hillside. Linear metro system may be examined if the corridor and coverage area will be central to the City's development. The system can provide higher loading capacity than monorail system, although this is subject to capital cost increase.

2) Solo (Surakarta) City

a. Solo Tramway (UR-Sol)

The project will use a 6 km segment between Purwosari and Solo Kota of existing Wonogiri line. Tram-styled LRT will not affect the atmosphere of the historic city but benefit the tourism industry. The system may extend to several corridors if the first phase of the project is deemed highly feasible after implementation. The project scope includes construction of tram stops, track rehabilitation, and installation of traffic control system and tramcars.

3) Yogyakarta City

a. Bantul Tramway (UR-Yog)

The project premises reopening of the old alignment from Yogya to Bantul, situated 15 km south from Station Yogyakarta (Tugu) and has a new line between Bantul and Parangtritis., situated 15km south from Bantul , facing the Indian Ocean. Construction of the railroad in the section will require elevated structure nearby the Station Yogyakarta (Tugu) and in some congested areas. The project works include civil works, station (tram stop) works, traffic control systems and rolling stock (tram cars).

(3) Airport Link

1) Semarang City

a. Semarang Airport Link (AL-Sem)

Existing railway passes in front of the terminal building of Achmad Yani (Semarang) Airport, 6 km west of Semarang Tawang. However, the local government has confirmed that they would relocate the passenger terminal building into north of the Airport. To cater to airport passengers in an efficient manner, the project will provide 4 km branch line from the nearest railroad with single track at ground level. Rolling stock for the rail link will be procured in accordance with the development of commuter trains, since the service assumes direct through operation between them. Scope of the project also includes construction of an airport station, trackworks, installation of signaling, telecommunication & traffic control system.

2) Solo (Surakarta) City

a. Solo Airport Link (AL-Sol)

Adi Sumarmo (Solo) Airport, located about 10 km northwest of Solo Balapan, has a large potential for future development to meet the rapidly increasing demand of air passengers. The project will connect the existing railroad and the airport terminal by single track and allow “direct-through” operation to Solo and Yogyakarta. Suitably fabricated railcars will be dedicated to the service. Scope of the project includes trackwork, installation of signaling, telecommunication & traffic control system, and traction power supply system.

Alignment of the access has three options: either shortest link from Yogyakarta direction (Alternative – 1), tracing the airport-to-city road (Alternative – 2) or providing the spur line from the Solo – Semarang track (Alternative – 3). The characteristics of each alignment and evaluation of the same are given in section 8.1.2(1)1). Development Alternatives.

(4) Intercity Trains

1) Between Semarang and Yogyakarta City

Development of intercity trains will basically trace the old alignment between Semarang and Yogyakarta. Similar to other non-operational lines, abandoned facilities appear unrecoverable since they are paved by roads and encroached by buildings. Reconstruction of these lines will require a viaduct structure on the existing road or embankment on open land, which will involve several issues depending on the selected options, such as capital cost increase, land acquisition and accessibility of each station. The project outlines are prepared below in such a way to balance these factors.

a. Yogyakarta – Magelang Line (INT-1)

Magelang, 46 km to the north from Station Yogyakarta (Tugu), is a town in the mountainous area in the Central Java region. The alignment of the project will begin near Yogyakarta (Tugu) Station with elevated structure to pass the urbanized part of the City. After passing across the outer ring road, the alignment descends to the ground and runs on open land behind the houses and factories along Jl. Magelang. A challenge of the project is to maintain vertical gradient lower than 3% to suit the requirement of diesel cars. Since the gradient continues over almost the whole alignment, performance of the railcars needs careful review in subsequent stages. The work items include new construction of civil structures, trackworks, and installation of signaling, telecommunication & traffic control system, diesel railcars, and a maintenance facility.

b. Borobudur Access (INT-2)

Borobudur, the most famous tourist attraction in the Central Java region, is around 9 km to the west from the 30 km point of the Yogyakarta – Magelang Line. Providing the branch line with single track from the above intercity train will cater to the tourist demand. Scope of the work includes construction of civil structures, trackworks, and installation of signaling, telecommunication & traffic control system, and diesel railcars.

c. Magelang - Ambarawa Line (INT-3)

Ambarawa is 37 km to the north from Magelang and located in a mountainous area. Linking the two cities requires technical solutions for the steep gradients which reach over 6%. Preliminarily, it is proposed that NATM tunneling method will be employed in some critical sections. Scope of the project includes construction of civil structures, trackworks, and installation of signaling, telecommunication & traffic control system, and diesel railcars.

d. Ambarawa – Kedungjati Line (INT-4)

Single-track construction for 37 km between Ambarawa and Kedungjati will be the final segment of Semarang – Yogyakarta intercity corridor. Steep gradient of the vertical alignment will be the key issue in this section, and therefore NATM tunneling method is proposed similar to Magelang – Ambarawa Line. Scope of the project includes construction of civil structures, trackworks, and installation of signaling, telecommunication & traffic control system, and diesel railcars.

2) Between Semarang and Tegal City (INT-5)

Tegal is approximately 145 km to the west from Semarang and located in a costal area. As part of North main railway line, the western stretch up to Tegal (150 km from Semarang Tawang) is serving intercity trains known as “Kaligung”. The project aim to improve intercity service with installation of additional railcars. While the project will cover installation of diesel railcars; double tracking, rehabilitation of existing track of the whole alignment and modern signaling, telecommunication & train control system are assumed to be provided by North main line double tracking project which is funded by the central government.

3) Between Semarang and Cepu City (INT-6)

Cepu is approximately 135 km to the west from Semarang and known as a potential city due to oilfield exploitation. As part of North main railway line, the eastern stretch up to Cepu (139 km from Semarang Tawang) is serving intercity trains. The project aim to improve intercity service with installation of additional railcars. While the project will cover installation of diesel railcars; double tracking, rehabilitation of existing track of the whole alignment and modern signaling, telecommunication & train control system are assumed to be provided by North main line double tracking project which is funded by the central government.

4) Between Demak and Rembang City (INT-7)

Development of intercity trains will basically trace the old alignment between Demak and Rembang, passing Kudus, Pati, and Juwana. Similar to other non-operational lines, abandoned facilities appear unrecoverable since they are paved by roads and encroached by buildings. Reconstruction of these lines will require a viaduct structure on the existing road or embankment on open land, which will involve several issues depending on the selected options, such as capital cost increase, land acquisition and accessibility of each station. The project outlines are prepared below in such a way to balance these factors.

Rembang, 83 km to the east from Station Demak, is a town which faces the Java Sea in the Central Java region. The alignment of the project will begin near Demak Station at-grade and pass Kudus and Pati with elevated structure. The work items include new construction of civil structures, trackworks, and installation of signaling, telecommunication & traffic control system, diesel railcars, and a maintenance facility.

(5) Freight Trains

1) Intercity Freight Corridor

a. Semarang – Solo Freight Corridor (FC-1)

The project aims to improve the reliability of freight service by track rehabilitation and improvement of overall traffic control system over the whole alignment (109 km). Especially the existing section from Brumbung to Gundir (53 km) is bottlenecked in the corridor and therefore in need of special attention. Since the corridor services intercity trains and freight trains, number of tracks and stations will remain the same as existing conditions, scope of the project also includes procurement of new locomotives.

b. Wonogiri - Solo Freight Corridor (FC-2)

Wonogiri, 36 km south of Purwosari, is the terminal station of the existing feeder line for passenger rail transport. The project will include the construction of diversion line (3 km) from Solo Kota to Solo Jebres which allows the freight trains to skip Purwosari and link to Semarang – Solo Corridor. The concept is essential for avoiding traffic interruption due to the freight trains coming into the busy city. Scope of the project includes rehabilitation of existing track, improvement of signaling, telecommunication & traffic control system, and procurement of a new locomotive.

2) Around Semarang City

a. Semarang Port Access (FT-Sem-1)

Semarang Port, known as Tanjung Emas, is immediately north of Semarang Tawang. Dedicated accesses to the port were once constructed but remain unused due to several reasons. The project aims to reconstruct the access track and equip the rail yard with freight handling facilities. Elevated single track is proposed except the yard area, since serious sedimentation and associated water invasion is widely observed over the whole project area. Scope of the project includes installation of overall traffic control system.

b. Kendal SEZ Access

The Special Economic Zone planned in Greater Semarang Area is situated 10 km east of Kendal township and 5 km north of existing railroad. The project aims to construct 5 km of the branch line from existing track to cater to the new industrial park and provide a rail link with Semarang Port. Scope of the project includes construction of a freight handling yard, trackwork and installation of overall traffic control system, and a new diesel locomotive.

3) Around Solo (Surakarta) City

a. Kalijembe Dryport Access (FT-Sol)

Kalijembe, situated 14 km north of Solo City, is the proposed location of a new dryport. Scope of the project includes new construction of short access track from existing Kalioso Station, fabrication of a rail yard equipped with freight handling facilities, and installation of overall traffic control system.

4) Around Yogyakarta City

a. Yogyakarta Inland Port Access (FT-Yog)

New Yogyakarta Inland Port, around 24 km from Yogyakarta (Tugu) and located along the national road, is undergoing development. Scope of the project will include construction of a new access track (3 km) from existing track and rail yard equipped with freight handling facilities. Installations of overall traffic control system and a new diesel locomotive are also tasked to the project.

(6) Tourist Train

1) Ambarawa Town

a. Ambarawa Rail Museum (TT)

Ambarawa, 37 km to the north from Magelang, has a railway museum, where PT. KA offers lorry rides (regularly) and steam locomotive rides (upon request) on remaining tracks. The project aims to develop activity-based rail museum and create an amusement park targeting excursions of families, school students as well as rail fans from all over the world.

8.1.2 Profiles of Each Railway Project

This section clarifies the development phasing, identifies suitable alternatives of each project, and illustrates how the profiles of each railway project meet the requirements of each system.

(1) Development Alternatives

1) At Grade or Elevated Structure

Reopening of past alignments or constructing new lines will require reconfirmation of ROW (Right-Of-Way) and need to reserve the land to be acquired. In the event that procurement of the land is too difficult, two alternatives are worth considering:

- Constructing elevated structure in the median of the road – this will generate considerable capital cost increase, yet land acquisition problem can be canceled.

- Constructing at grade structure on open land – this may require additional land acquisition if the land is privately owned. Since open lands are generally at a distance from the trunk road, providing access road will be mandated to keep the accessibility to each station.

Selection of alternatives appears to depend on each system, as discussed below.

a. Commuter Trains

Track elevation will remove the level crossing with local roads, that generally becomes a bottleneck of the City's transport network. Alignment passing city centers shall basically undergo track elevation as a long-term vision. For the center of Semarang City (CT-Sem-1), the section will provide a terminal station for all commuter trains from Kendal, Demak, Brumbung which at the same will be operated in very short intervals. Also all freight and passenger trains will come from Yogya, Solo, Wonogiri. Therefore the section should provide highly reliable, efficient and well-maintained facilities to handle all of these trains.

Table 8.1.1 Preliminary Evaluation of Structure Types (CT-Sem-1)

	Alternative – 1	Alternative - 2
Type of Structure	Elevated	At Grade
Land acquisition for double tracking	Not required	Much required
Level crossings with local road	Removed	Remained
Safety control at level crossings	Not required	Required
Operation in flood condition	Tolerant	Much affected
Track maintainability	Easy	Fair
Investment cost	High	Low
Preliminary evaluation	Recommended	Fair

For the Demak Commuter (CT-Sem-3), double track on the trunk road at ground level will require huge land acquisition and this appears not feasible for the project. Remaining options are full elevated in the median of trunk road (Alternative – 1) or mainly at-grade running on open land (Alternative – 2). However, even in the case of alternative – 2, the track will be elevated inside congested cities. To minimize the social impact associated with land procurement, it is preliminarily presumed that the project will be fully elevated. In the meantime, all the remaining projects of commuter trains are assumed to be fully at-grade due to the quick review of site conditions.

Table 8.1.2 Preliminary Evaluation of Structure Types (CT-Sem-3)

	Alternative – 1	Alternative - 2
Type of Structure	Full Elevated	Mainly At Grade
Land acquisition	Not required	Much required
Access to station	Convenient	Not convenient
Access roads	Not required	Required
Investment cost	High	Low
Preliminary evaluation	Recommended	Fair

b. Intercity Trains

Site conditions are similar to the case of commuter trains, but since the traffic demand is still modest, it means that service to be provided will not be so frequent, and average distance between the stations will be much longer than that of commuter services. These projects, therefore, need effort to keep capital investment cost at the lowest possible level. To keep the capital cost low, only alternative – 2 is advisable.

Table 8.1.3 Preliminary Evaluation of Structure Types (INT-1, INT-2, INT-3, INT-4)

	Alternative – 1	Alternative – 2
Type of Structure	Full Elevated	Mainly At Grade
Land acquisition	Not required	Much required
Access to station	Convenient	Not convenient
Access roads	Not required	Required
Investment cost	Huge	Economic
Preliminary evaluation	Fair	Recommended

c. Freight Trains

Semarang Port Access (FT-Sem-1) is solely concerned with this issue among all the freight train projects. Since the ground sedimentation is large over the project area, the project should go with elevated structure except for the freight-handling yard at Semarang Port. The yard at ground level also needs embankment. It should be noted that Alternative - 1 may not be technically feasible if CT-Sem-1 selects the at-grade option.

Table 8.1.4 Preliminary Evaluation of Structure Types (FT-Sem-1)

	Alternative – 1	Alternative – 2
Type of Structure	Mainly Elevated	Fully At Grade
Operation in flood condition	Not affected	Crucially affected
Investment cost	High	Low
Preliminary evaluation	Recommended	No good

d. Airport Link

Solo Airport Link (AL-2) is concerned with this issue. If trains access to the airport from south, the elevated structure will face land acquisition problem (Alternative – 1, and Alternative – 3). The problem can be a minor one if trains access from the west of the airport (Alternative – 2). Considering the factors in Table 8.1.5, Alternative – 1 will be mainly studied and project cost of Alternative – 2 will be estimated as an option.

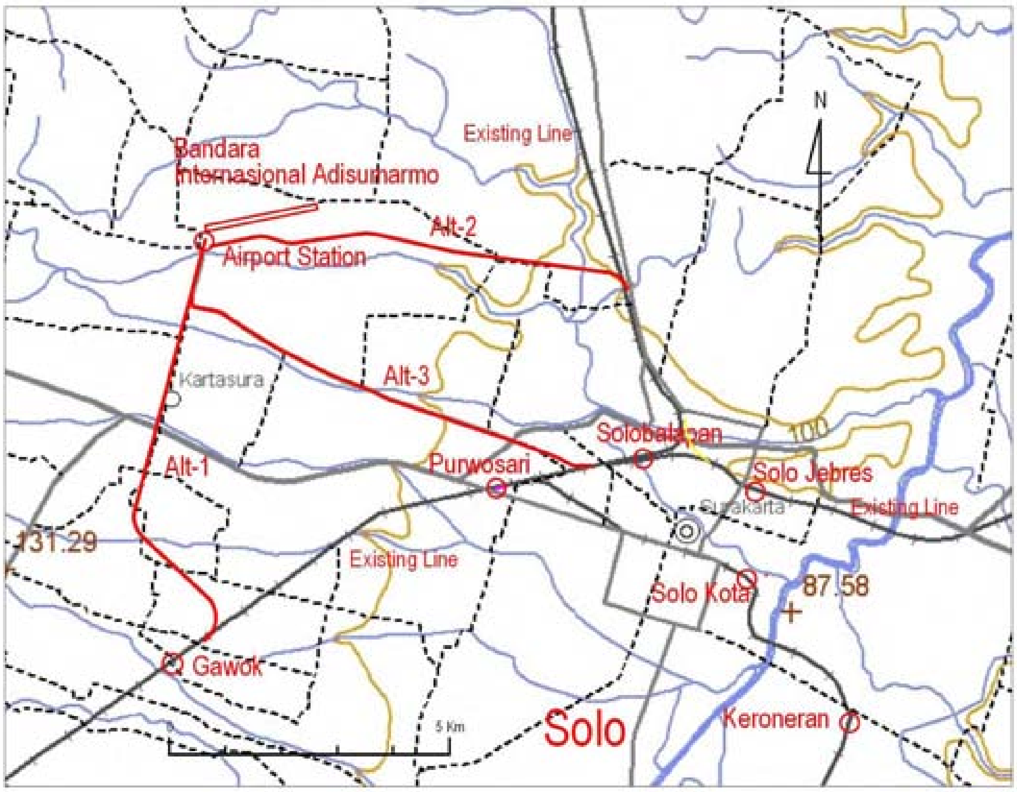


Figure 8.1.1 Alignment Alternatives (AL-2)

Table 8.1.5 Preliminary Evaluation of Structure Types (FT-Sem-1)

	Alternative – 1	Alternative – 2	Alternative – 3
Type of Structure	Partly Elevated	Fully At Grade	Fully Elevated
Land acquisition	Required	Required	Not required
Access from Solo/Yogya	Fair / Good	Fair / Fair	Fair / Fair
Investment cost	Fair	Low	High
Preliminary evaluation	Recommended	Fair	Not feasible

e. Urban Railways

Preliminary assumptions are that Semarang Monorail (UR-Sem) will be fully elevated to serve the city center and hillside, so Bantul Tramway (UR-Yog) needs to be elevated partially to provide access to Yogyakarta city center, but Solo Tramway (UR-Sol) remains at-grade level.

2) Electrified or Non-Electrified System

a. Commuter Trains

As a general practice, electrified system allows better acceleration and braking performance with lower energy consumptions in comparison with non-electrified (diesel) system. The advantage will become large when the system is operated over short-distance with frequent service conditions such as by commuter trains.

In addition, system electrification involves capital cost increase with the installation of substations, catenary systems, rolling stocks (Electric Multiple Unit, EMU) and associated depots and workshops. Therefore it is generally understood that non-electrified system will have cost advantage in the short term but electrified system will better suit the requirements of a busy metropolis in the long run.

Another point to consider is that, as seen in the JABOTABEK Railway system, they can introduce “secondhand” EMU trains from Japan at bargain price. If the situation continues, electric railcars will have a large cost advantage compared to diesel railcars. Also, procurement of electric railcars from overseas will not promote local production by PT. INKA, at least in short term. Therefore, in case the electric system is to be selected, some sort of technical transfer programs should take place at the earliest possible time so that the company can obtain the capabilities to produce electric railcars.

Table 8.1.6 Preliminary Evaluation of Railcars (All commuter train projects)

	EMU (New/Secondhand)	DMU (New)
Operation efficiency (acceleration/braking)	Efficient	Fair
Energy consumption	Economic	Fair
Traction power supply system incl. substations	Required	Not required
Additional maintenance facility	Required	Not required
Procurement cost of rolling stock	Fair/Economic	Fair
Total investment cost	High/Fair	Fair
Local production	Future option	Possible
Riding comfort	Good	Fair
Environment	Good	Fair
Preliminary evaluation	Fair/Recommended	Fair

Note: EMU: Electric Multiple Unit, DMU: Diesel Multiple Unit

Note: The projected demand for all the proposed projects of commuter trains indicated that both EMU and DMU are suitable in terms of transport capacity and traffic amount.

After the comparison between EMU and DMU system, cost advantage is observed in EMU system especially in the long term. Therefore, the Study Team proposes that development of commuter trains in the Central Java region should go with electrified system for commuter trains. The Airport link may take either option in that case, but electrified system will be preferred for the same reasons.

b. Intercity Trains

As discussed previously, intercity trains will have much importance on project economics. Since the line will not be operated so frequently, the system cannot take much advantage of the electrification. Even though savings in rolling stock procurement may be large with secondhand cars, it will not balance the cost for electrification (i.e. catenary system, power substations, electrified depot). In reality, introducing DMU system is the normal practice for such a provincial route. Electrification will be a matter to consider only when running performance of EMU will be the only solution for steep gradient section (i.e. Magelang – Ambarawa – Kedungjati), even if economic feasibility may be much lower.

c. Freight Trains

There is no technical or financial justification for electrifying freight trains, therefore, it is confirmed to employ diesel system.

d. Airport Link

Since the routes will introduce direct-through operation between nearest cities, decision on electrification will rely on that of commuter trains. It should be noted that electrified system will have several advantages over diesel system to provide dedicated high speed trains with variety of coaches, riding comfort, travel speed, reasonable operation and maintenance cost, etc. Therefore, electric system is preliminarily selected.

e. Urban Railways

Traction power of monorail system is supplied from the electricity collected from its guideway, whereas tram system may select from two alternatives: either electrified tram (with overhead catenary) or battery tram (which generates electricity with built-in battery). Since the battery tram, although ready to be promoted) is still under final testing, feasibility of it will be studied in subsequent stage (Overview of the system is made in **Appendix**).

3) Single or Double Track

a. Commuter Trains

As a recent nationwide trend, North and South Main Lines will undergo double tracking to increase transport capacity and operational safety. Development concept in the Central Java region will follow the policy, and Kaliwung – Semarang, Semarang – Brumbung, Solo – Sragen will require double tracking. Similarly, other commuter sections are assumed to use double tracking: Semarang – Demak. Remaining sections have already been double tracked as of 2008.

b. Intercity Trains

Since the service headway is far below the standard of double tracking, these projects all assume single track.

c. Freight Trains

Semarang – Solo section needs careful review of expected freight and passenger demand for the decision on double tracking. Since the study assumes development of freight transport (few round trips a day) and passenger trains (almost hourly), single track with improved train control system can handle the amount of traffic.

d. Airport Link

There will be no intermediate stations in Semarang Airport Link (AL-Sem), and Solo Airport Link (AL-Sol). Also operation headways will not become shorter than 30 minutes. Therefore these lines can handle the traffic with single track.

e. Urban Railways

To function as the City's spine, it is advisable to implement Semarang Monorail (UR-Sem) with double track. Also it should be emphasized that monorail system is not flexible like standard at-grade railways regarding future double tracking.

On the other hand, the proposed two tramways may begin with single track system as the space is limited (UR-Sol) and the demand modest (UR-Yog). However it is advisable in Bantul Tramway (UR-Yog) that only civil structure of 3 km elevated section should have provision for future double tracking.

4) Passenger Trains Only or With Freight Operation

a. Commuter Trains

Most of the commuter lines will allow the freight trains to run on their track. Operation of two types of trains shall be harmonized to avoid any delay of train schedule. Also, the use of freight trains is concerned in the design of vertical alignment, which shall be kept lower than 1.0 % if the line is shared with freight operation. Since potential demand is observed in Kudus - Pati - Rembang Corridor, Semarang – Demak section, it shall be designed to suit freight operation in the future.

b. Intercity Trains

There is very little possibility to operate freight trains on these lines mainly due to technical feasibilities, i.e. gradient cannot meet the requirement of freight operation.

c. Freight Trains

Freight train operation in Semarang – Solo Freight Corridor (FC-1) will be shared with passenger trains, but attention will be required since service frequency of these should be almost hourly. As discussed in item e. Urban Railways below, Wonogiri – Solo Freight Corridor (FC-2) will construct a new route for Solo Kota – Solo Balapan and therefore mixing of passenger and freight trains will be avoided in the same section. Designing the vertical alignment will not become the matter of concern since the existing alignment runs in flat areas over the entire route.

d. Airport Link

These projects will provide dedicated access for rapid trains; therefore, there will be no operation of freight trains over the project route.

e. Urban Railways

Existing Wonogiri – Solo Corridor overlaps with the proposed alignment of Solo Tramway. To avoid freight trains running into the city center, FC-2 project will be routed around the section and leave the Solo Kota – Pruwosari section for Solo Tramway (UR-Sol).

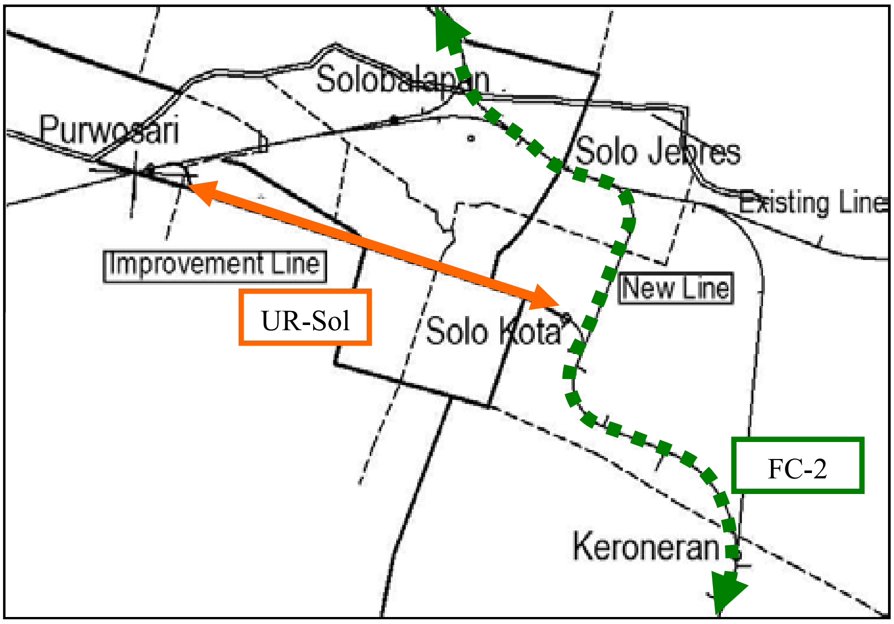


Figure 8.1.2 Proposed Alignment (FC-2, UR-Sol)

5) With or Without Express Trains

a. Commuter Trains

To serve the largest demand of commuters and reach the city in shortest time, these trains will provide both express and local trains using the same cars.

b. Intercity Trains

These projects have limited number of stops with long distance between two stations. Each train reaches nearly the limit of its performance, and therefore overtaking of a local train by an express train will hardly take place. Hence, only local train service is considered for intercity trains.

c. Others

Freight trains are generally operated as "non-stop". All the airport link trains will be serviced as special express. All the monorails and trams will be operated as "all-stops".

6) Needs of Barrier Free Environment

Especially in developed countries, there has been a constant effort towards creating a safe and comfortable railway for all users. Expanding barrier-free services is a vital element to provide opportunities for Persons with Disabilities (PWD) and aged people to participate in the society.

To ensure promotion of barrier free environment, Central Governments and Local Governments of many countries stipulate and enact "Barrier-Free Law". In Japan, for instance, The Law for Promoting Easily Accessible Public Transportation Infrastructure for the Elderly and Disabled Persons (Traffic Barrier-Free Law) was enacted in 2000. Similar Acts can be observed in most of Asian Countries. Development and promotion of barrier free environment is now a basic requirement in all transport projects, not only in developed countries, but also in developing countries.

a. Targeted Disabilities

Barrier free facilities shall ensure user-friendliness to wheelchair users, sight disabilities, hearing disabilities, ostomates, and other persons with low mobility such as aged persons, expecting mothers, small children, and persons carrying heavy luggage and others in order to create a comfortable environment for all potential users.

b. Steps to Introduce Barrier Free Facilities

Suggested methodology to introduce barrier free facilities for railway projects in the Central Java region are:

- **Step 1: Institutional Setup** – At least one responsible person for barrier-free issues should be identified under the Project Owner. Such person will hold responsibility for this issue and become a contact person for all concerned parties, such as local governments, railway agencies, consultants, contractors, and disabled persons organizations.
- **Step 2: Detailed Review of Applicable Laws and Regulations** - In the preparatory stage of each project, the responsible person of the Project Owner will review applicable laws and regulations on barrier-free environment to comprehend the necessity of their activities and develop the Project's basic policies for the program.
- **Step 3: Identification of and Coordination with Disabled Persons Organizations**

(DPOs) and other NGOs - Prior to the design stage, the responsible person of the Project Owner will hold consultations and workshops with design consultants, some DPOs and NGOs. During the consultations and workshops, accessibility issues for elderly and disabled persons will be discussed and consulted with DPOs and relevant NGOs.

- **Step 4: Conceptual Designs of Barrier Free Facilities (Design Phase)** - Appointed design consultants will reflect the result of above-mentioned workshops to their works in discussion with the responsible person of the Project Owner.
- **Step 5: Installation of Barrier Free Facilities (Construction Phase)** - The basic objective of activities in construction phase is to review, inspect and monitor if barrier free facilities are adequately installed by appointed contractors. The appointed consultants will conduct periodical monitoring, report trouble spots and make collective measures, if any, during his supervision service. He will also organize mid-term review and completion review with attendance of the responsible person of the Project Owner, contractors, DPOs and NGOs.
- **Step 6: Completion and Feedback Reviews (Operation Phase)** - To maintain user-friendliness for all passengers, the railway operator will be responsible for improving passenger services, including barrier-free issues. It is suggested to conduct questionnaire surveys periodically and obtain feedbacks from passengers for identifying the areas of improvement. Simultaneously the Operator will setup "Complaints Office" to receive comments in daily operation.

It must be emphasized that persons with disabilities shall participate in every phase of the activities. Also it is mandatory to include all types of disabilities (cross-disability) to ensure that all PWDs are equally considered in their barrier free designs.

c. Barrier Free Design Standard and Guidelines

It is highly recommended that passenger facility designs in each railway project should take account of the barrier free standards or guidelines. Several standards and guidelines are open to public, such as:

- Disability Discrimination Act (DDA)
- American with Disabilities Act (ADA)
- American National Standards Institute (ANSI)
- European Norm (EN)
- Barrier Free Guidelines, Japan

For reference, checklist provided in Barrier Free Guideline, Japan is given below. It should be understood that these items are presented as minimum requirements.

Table 8.1.7 Access Standards Check List (1/2)

2.1 Access standards checklist (Based on MLIT Law Enforcement Order)

Sample No. - see attached samples
N/A: Not Applicable

General standards

Facilities	Related Articles	Check Items	YES	NO	N/A	Sample Ref.	Remarks
Corridors	11	*Does the floor have …*					
		1) a non-slip surface?	☐	☐	☐		
		2) Tactile tiles etc. (at the section adjacent to the upper end of stairs or ramps)*1	☐	☐	☐	A	
Stairs	12	*Do the stairs have …*					
		1) handrails? (Excluding landings)	☐	☐	☐	A	
		2) a non-slip surface?	☐	☐	☐	B	
		Are the steps …					
		3) easy to distinguish from connecting area?	☐	☐	☐	C/D	
		Do the stairs have					
		4) Tactile tiles etc. (at landing section)*2	☐	☐	☐	C	
		Are the stairs					
		5) designed to prevent stumbling?	☐	☐	☐	C	
		6) non-circular stairs in principal?	☐	☐	☐		
Ramps	13	*Do the Ramps have*					
		1) handrails? (Exempt for sections with a grade of no more than 1/12 and a height less than 16cm)	☐	☐	☐	A	
		Does the floor have …					
		2) a non-slip surface?	☐	☐	☐	A/B	
		Is the ramp					
		3) easy to distinguish from connecting area?	☐	☐	☐	A	
		Does the Ramps have					
		4) Tactile etc.? (at landing section)*3	☐	☐	☐	A/B	
Toilets	14	1) Are there toilet cubicles for wheelchair users (at least one)?	☐	☐	☐	E	
		(1) Are seat-style toilets and handrails appropriately positioned for wheelchair users?	☐	☐	☐	E/F	
		(2) Is there sufficient space for easy access and use by wheelchair users?	☐	☐	☐	E/F	
		2) Are cubicles equipped with a rinsing device (one that accommodates ostomates) for ostomy disabilities (at least one)?	☐	☐	☐	G	
		3) Are floor-mounted urinals, wall-mounted urinals (those whose lips are 35cm or less from the floor) or similar urinals provided (at least one)?	☐	☐	☐	H	
Passageways	16	1) Does the floor have a non-slip surface?	☐	☐	☐	T	
		2) Areas with steps					
		(1) Have handrails been installed?	☐	☐	☐	S/T	
		(2) Are the steps easy to distinguish from connecting area?	☐	☐	☐	S	
		(3) Are the steps designed to prevent stumbling?	☐	☐	☐	S	
		3) Ramps					
		(1) Have handrails been installed? (Not applicable if grades less than 1/12 and heights less than 16cm, or ramps less than 1/20)	☐	☐	☐	A	
		(2) Is the ramp easy to distinguish from the passageway to connecting	☐	☐	☐	A	
Car parks	17	1) Are there parking spaces for wheelchair users (at least one)?	☐	☐	☐	I	
		(1) Is the width at least 350cm?	☐	☐	☐	I	
		(2) Are the facilities located close to the public rooms?	☐	☐	☐	I	
Signage	19	1) Are there user-friendly signs provided in prominent places, which inform elevators, escalators, toilet, parking facility, etc?	☐	☐	☐	J	
		2) Are the signs easy to understand (compliant with JIS Z8210)	☐	☐	☐	J	
Directory facilities	20	1) Are there user-friendly directory boards provided in prominent places, which inform the location of elevators, escalators, toilets, parking etc ? (Not applicable if these facilities can be seen easily)	☐	☐	☐	J	
		2) Are facilities arranged for sight disabilities to (easily) understand the locations of elevators, escalators, toilets, parking etc (using audio information etc) ?	☐	☐	☐	K	
		3) Are information desks provided (and alternative measure to 1) and 2))?	☐	☐	☐	L	

Path for sight disabilities

Facilities	Related Articles		YES	NO	N/A	Sample Ref.	Remarks
Access routes to the facility	21	1) Do the access routes have tactile or audio information? (Not applicable if accessible with going straight only)*4	☐	☐	☐		
		2) Are tactile tiles laid next to the road?	☐	☐	☐		
		3) Are tactile tiles laid at upper end of steps/ramp?*5	☐	☐	☐		

Table 8.1.8 Access Standards Check List (2/2)

Access routes

Facilities	Related Articles	Check Items	YES	NO	N/A	Sample No.	Remarks
Steps/stairs	18.2.1	1) Are there any stairs or steps? (Answer NO, if a ramp or an elevator etc is installed alongside)	☐	☐	☐	M	
Entrances	18.2.2	1) Are entrances at least 80cm wide?	☐	☐	☐		
		2) Are doors designed for wheelchair passage? Are there flat spaces (for wheelchai users) in front and behind the doors?	☐	☐	☐	N	
Corridors etc.	18.2.3	1) Are corridors at least 120cm wide?	☐	☐	☐	M	
		2) Are there enough spaces for wheelchair circling in every 50m or less?	☐	☐	☐		
		3) Are doors designed for wheelchair passage? Are there flat spaces (for wheelchai users) in front and behind the doors?	☐	☐	☐	N	
Ramps	18.2.4	1) Are ramps at least 120cm wide (at least 90cm when co-located with steps)?	☐	☐	☐	M	
		2) Is the grade no more than 1/12 ? (no more than 1/8 when the height is 16cm or less)	☐	☐	☐	M	
		3) Are there landings in every 75cm ramp-height or less? Are the landings at least 150cm wide? (Not applicable if grade is less than 1/20)	☐	☐	☐		
Elevator and elevator lobbies	18.2.5	1) Do elevators stop at every floor? (public rooms floor, toilets and parking floor for wheelchair users, aboveground floor, etc)	☐	☐	☐		
		2) Is the entrance to elevator cage at least 80cm wide?	☐	☐	☐	Q/R	
		3) Is elevator cage at least 135cm deep?	☐	☐	☐		
		4) Is the elevator lobby flat and wider than 150cm x 150cm (for wheelchair circling) ?	☐	☐	☐	Q	
		5) Are elevator-buttons in the elevator cage and lobby designed for wheelchair users (in lower height, etc) ?	☐	☐	☐	P	
		6) Are elevator cages equipped with displays showing current and destination floor?	☐	☐	☐	P	
		7) Are elevator lobbies equipped with displays showing destination floor?	☐	☐	☐		
		8) For elevators in buildings (over 2000m2) used by general public:					
		(1) Do they satisfy all conditions above from 1) to 7)?	☐	☐	☐		
		(2) Are their cages at least 140cm wide?	☐	☐	☐		
		(3) Are elevator cages shaped to allow wheelchairs circling ?	☐	☐	☐	R	
		9) Elevators for general public or especially for sight disabilities:*6					
		(1) Do they satisfy all conditions above from 1) to 8)?	☐	☐	☐		
		(2) Are elevator cages equipped with audio information indicating the arriving floor and that the door is closing?	☐	☐	☐		
		(3) Are elevator-buttons designed for sight disabilities (using braille, audio information, etc) ?	☐	☐	☐		
		(4) Are elevator cages and lobbies equipped with audio information that indicates the destination floor (for sight disabilities) ?	☐	☐	☐		
Passageways	18.2.7	1) Are passageways at least 120cm wide?	☐	☐	☐		
		2) Are there enough spaces for wheelchair circling in every 50m or less?	☐	☐	☐		
		3) Are doors designed for wheelchair passage? Are there flat spaces (for wheelchai users) in front and behind the doors?	☐	☐	☐		
		4) Ramps: (1) Are ramps at least 120cm wide? (at least 90cm when collocated with steps)	☐	☐	☐		
		(2) Is the grade no more than 1/12? (no more than 1/8 when the height is 16cm or less)	☐	☐	☐		
		(3) Are there landings in every 75cm ramp-height or less? Are the landings at least 150cm wide? (Not applicable if grade is less than 1/20)	☐	☐	☐		

*1 Excluding the following cases stipulated in the notifications.
- Adjacent to the upper end of an inclining section with an grade of no more than 1/20.
- Adjacent to the upper end of an inclining section with a height not more than 16cm and a grade of no more than 1/12.
- In a garage

*2 Excluding the following cases stipulated in the notifications. (Notification No.1497)
- In a garage
- When there is a handrail continuing from the steps

*3 Excluding the following cases stipulated in the notifications. (Notification No.1497)
- Adjacent to the upper end of an inclining section with an grade of no more than 1/20.
- Adjacent to the upper end of an inclining section with a height not more than 16cm and a grade of no more than 1/12.
- In a garage.
- When there is a handrail continuing from the inclining section.

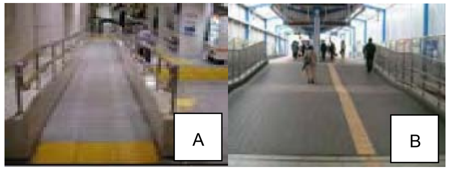
*4 Excluding the following cases stipulated in the notifications. (Notification No.1497)
when installed in a garage
when the building entrance is clearly visible from the reception area and tactile tiles or an audible guidance system provides guidance along the path from the road etc., to the entrance.

*5 Excluding the following cases stipulated in the notifications. (Notification No.1497)
Adjacent to the upper end of a inclining section with an grade of no more than 1/20
Adjacent to the upper end of an inclining section with a height not more than 16cm and a grade not more than 1/12
Landing with a handrail continuing from the steps or inclining section

*6 Excluding the following cases stipulated in the notifications. (Notification No.1497)
- When installed in a garage

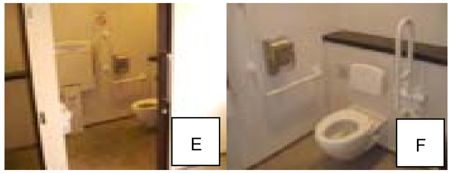
Figure 8.1.3 Barrier Free Design Image

Tactile at the section adjacent to upper end of stairs
Handrails (at normal and wheelchair height)



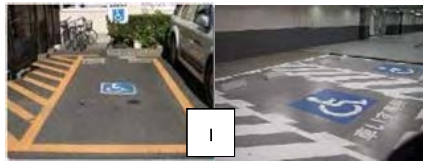
Steps easy to distinguish (for sight disabilities)
Anti-stumbling floors

Toilet cubicles for wheelchair users
Seat-style toilets and handrails



Toilet and rinsing device for ostomates
Floor-mounted urinals

Parking space for wheelchair users

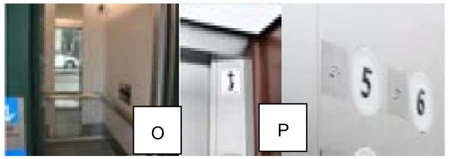


User-friendly signage and directory board
(elevator, escalator and toilet for all users)

Sound directory for sight disabled passengers
Information counter

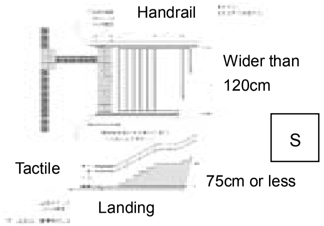
Access route (slopes with sufficient space and tactile, door for disabled passengers)

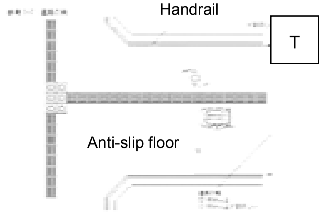
Elevator with controller and handrail at lower height
User-friendly floor indicator



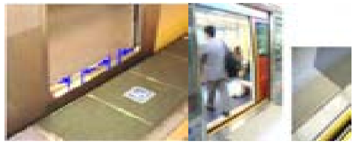
Lobby and cage with sufficient space for wheelchair circling and tactile

User-friendly passageway



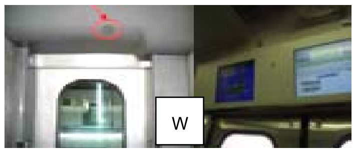


Non-step boarding with minimized horizontal platform (for wheelchair users)



Door wide enough (min 80cm) for wheelchai
Anti-slip and Braille at wheelchair boarding p

On-board audio & visual announcement to
opened, with a chime for people with sight di



d. Barrier Free Facilities for Passenger Railways in the Central Java region

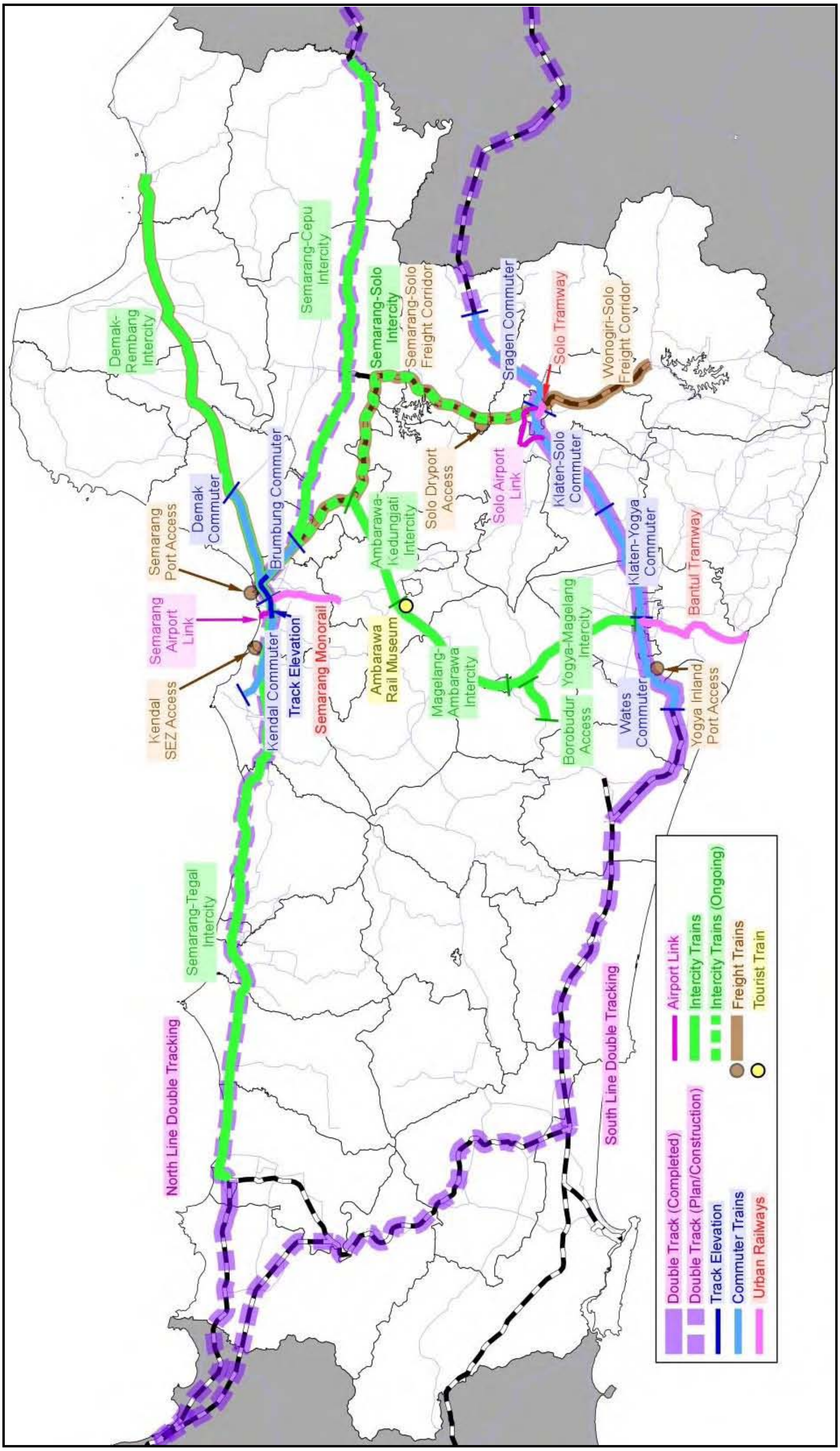
It is suggested that barrier free facilities for passenger railways in the Central Java region should include at least, but not be limited to the following:

- **Elevators** – to move from station entrance to platform and vice versa, say 2 units per station.
- **Slopes** – to provide seamless connection and remove vertical gaps, slopes not steeper than 1:12
- **Tactile tiles** – to notify difference in vertical level or guide the direction for persons with sight disabilities. At all station areas regardless paid/unpaid area, excluding the area dedicated to station staff.
- **Signage** – to provide easy-to-understand information on passenger facilities, train operations, and any others to enhance user-friendliness
- **Disabled person's toilet** – to provide multi-functioned toilet with sufficient space and handrails for mobility impaired and suitable equipments for ostomates, say 1 units per station.
- **Braille** – to provide information to the persons with sight disabilities, at most of the passenger service facilities such as ticket selling counter, train time and tariff tables,
- **Handrails** – to provide support for mobility impaired, at all slopes
- **Anti-slip floors** – to prevent any accidents from people loosing their footing
- **Sufficient width at passenger flow line –** to allow wheelchair users to travel, minimum 900mm shall be secured
- **Dedicated parking lot –** to provide sufficient space for wheelchair users to board and alight on/from their car.

(2) Project Location Map

Location maps of the proposed projects are depicted in the following figures.

Figure 8.1.4 Potential Railway Development Projects



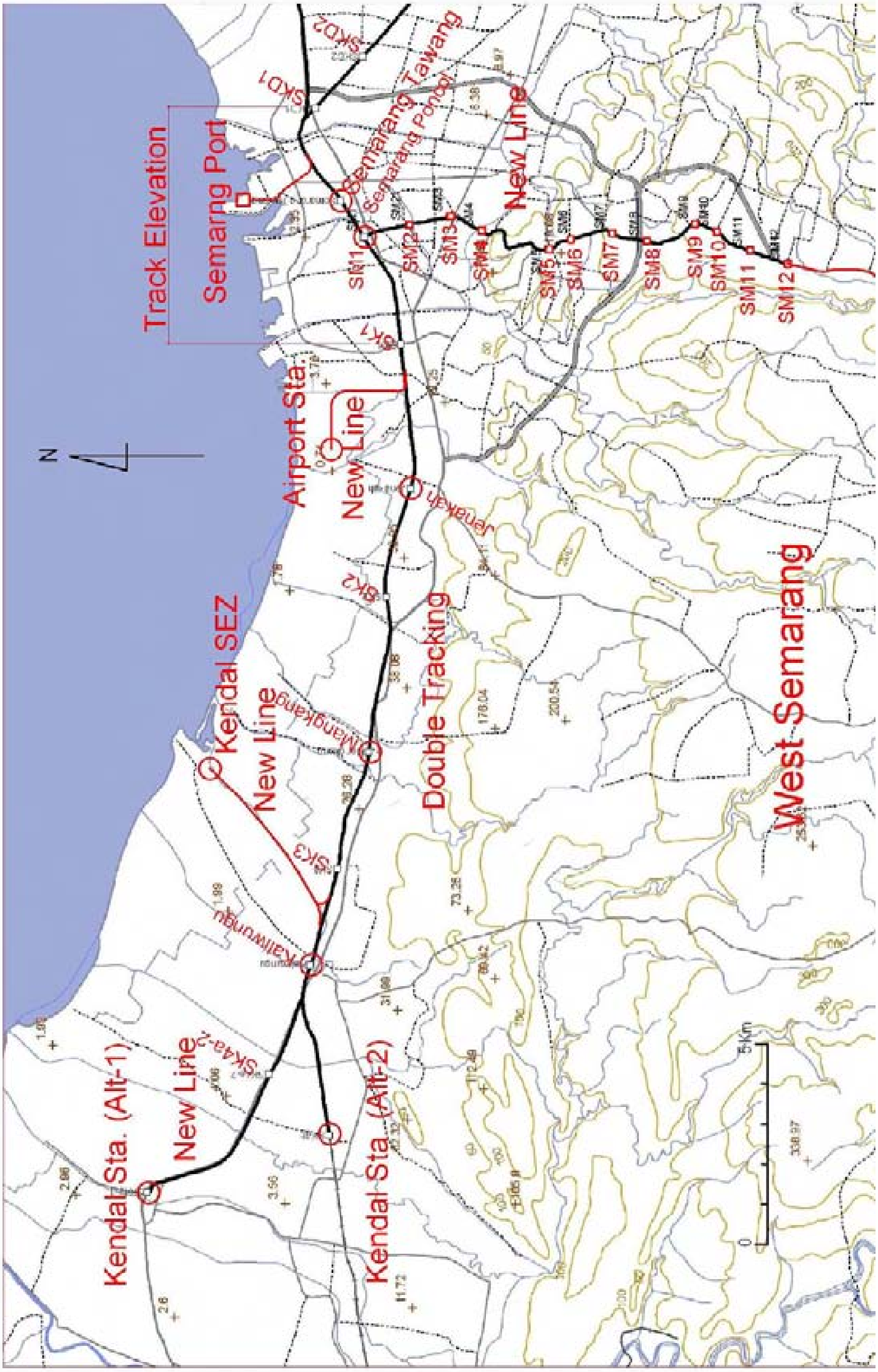


Figure 8.1.5 Project Map (CT-Sem-1, CT-Sem-2, UR-Sem, AL-Sem, FT-Sem-1 FT-Sem-2)

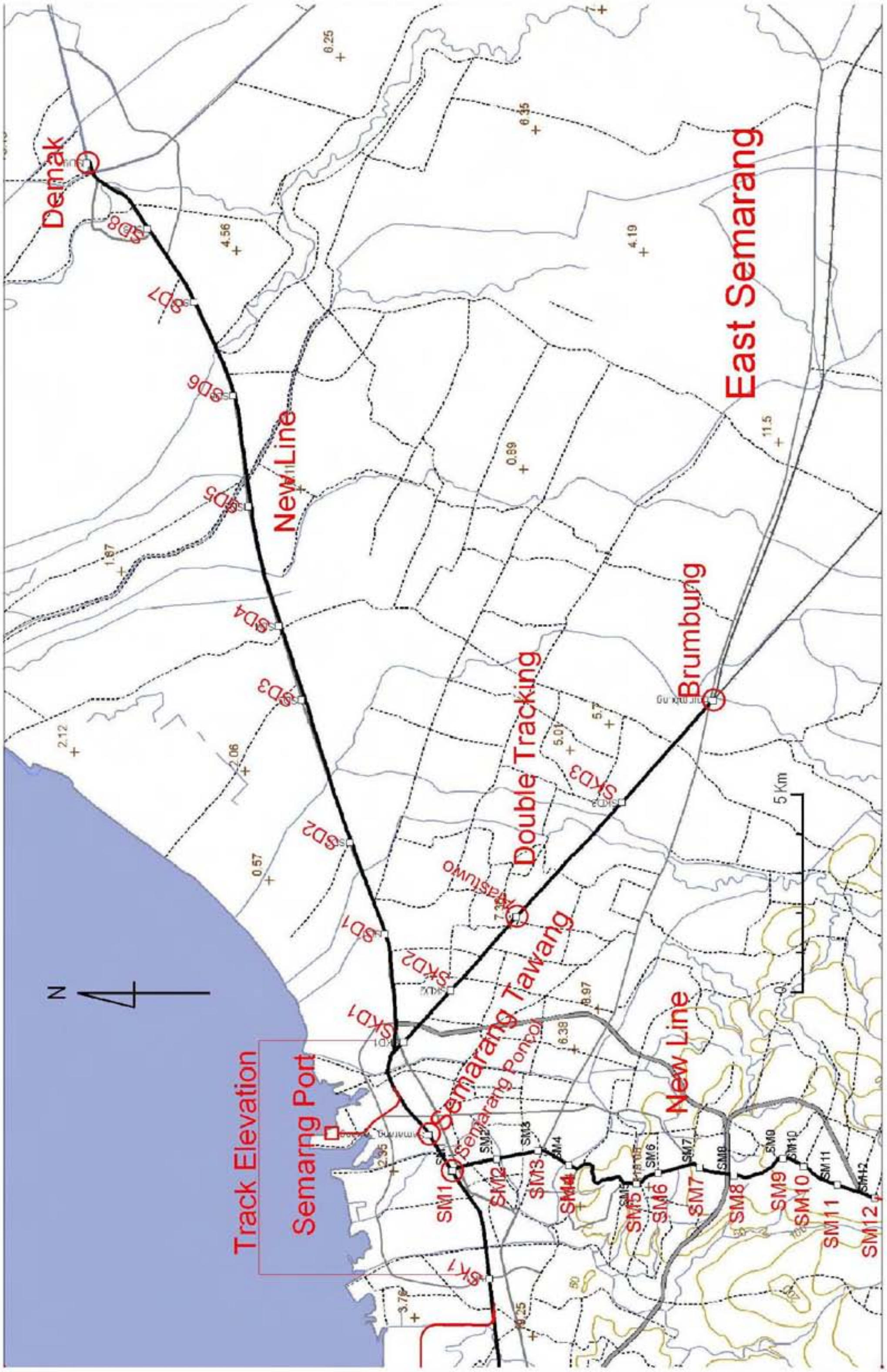


Figure 8.1.6 Project Map (CT-Sem-3, CT-Sem-4)

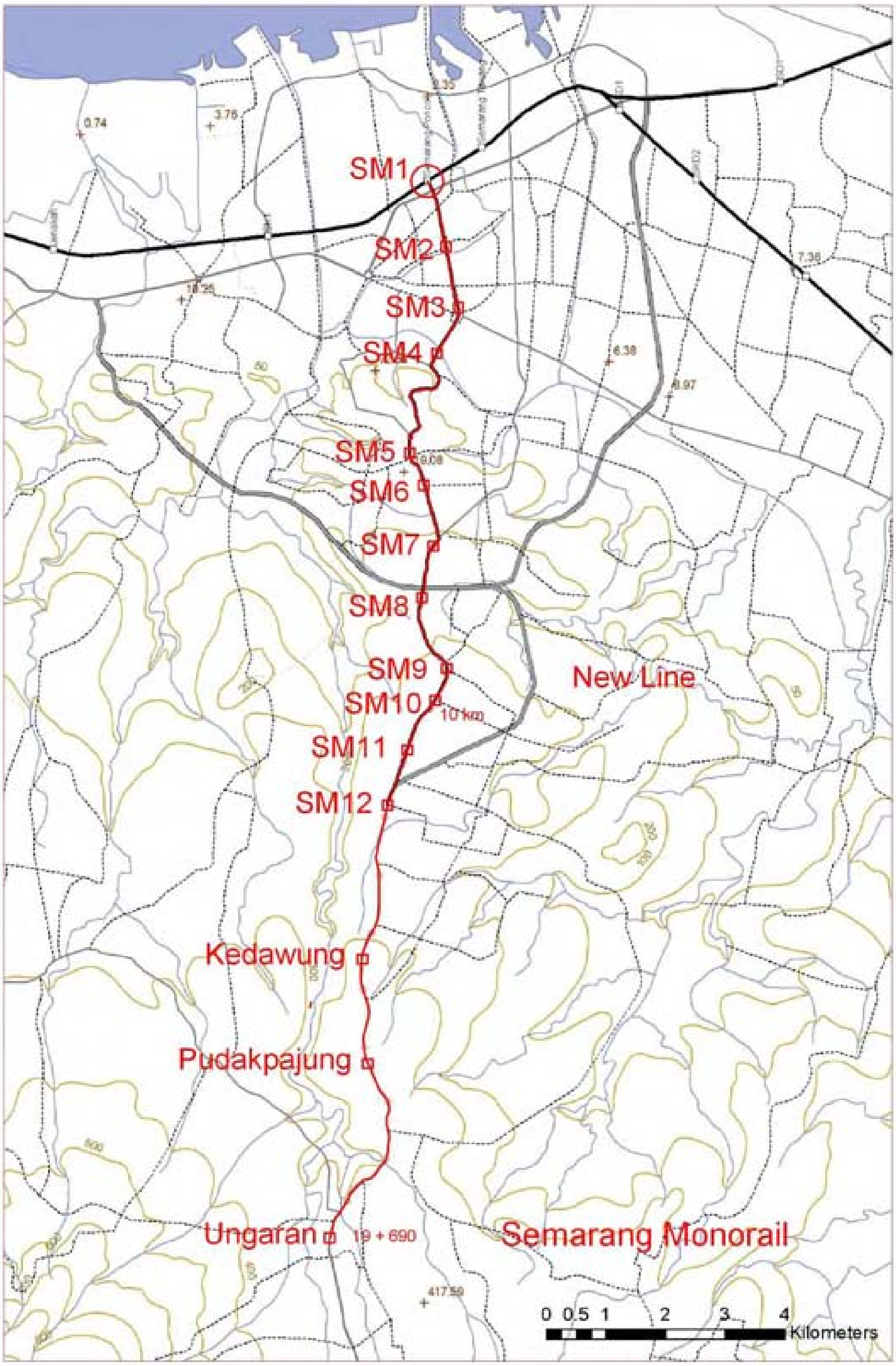


Figure 8.1.7 Project Map (UR-Sem)

Figure 8.1.8 Project Map (FT-1)

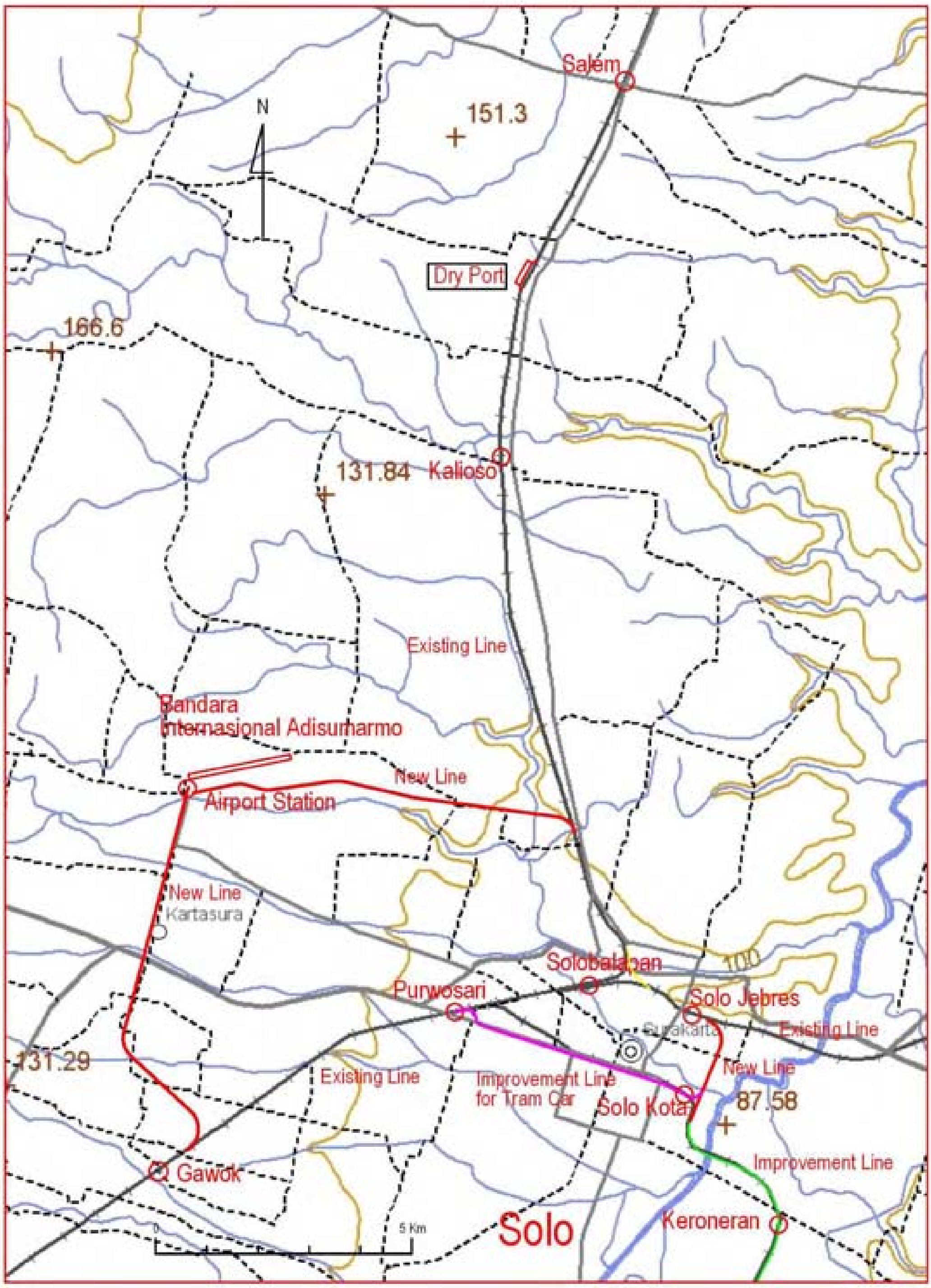


Figure 8.1.9 Project Map (UR-Sol, AL-Sol, FT-Sol)

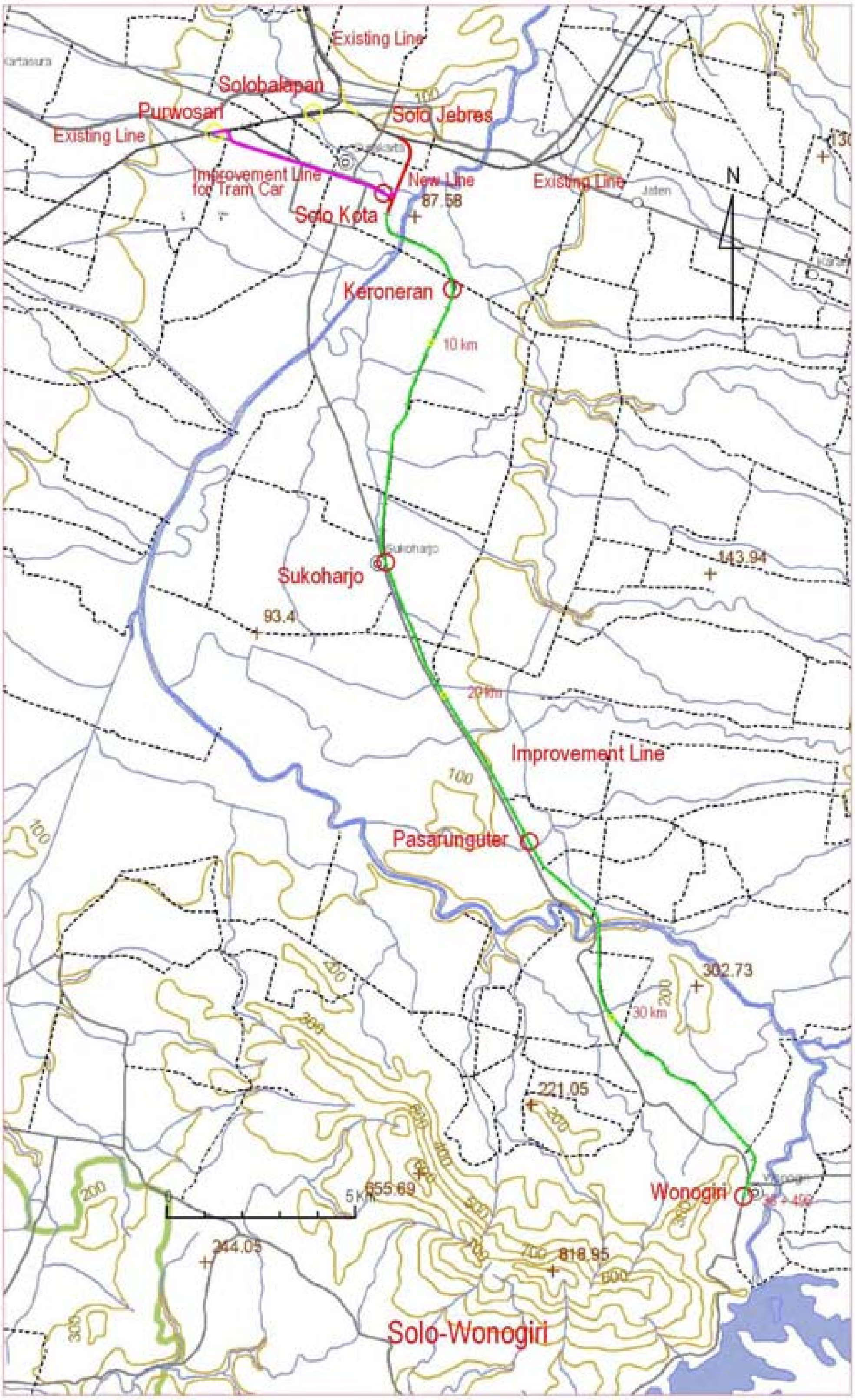


Figure 8.1.10 Project Map (FT-2)

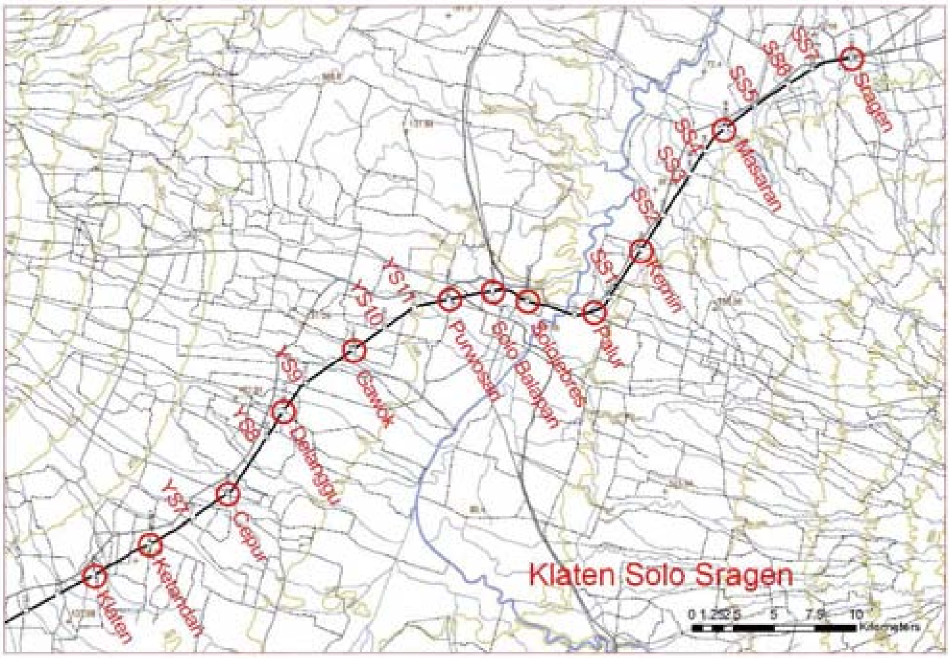


Figure 8.1.11 Project Map (CT-Sol-1, CT-Sol-2)

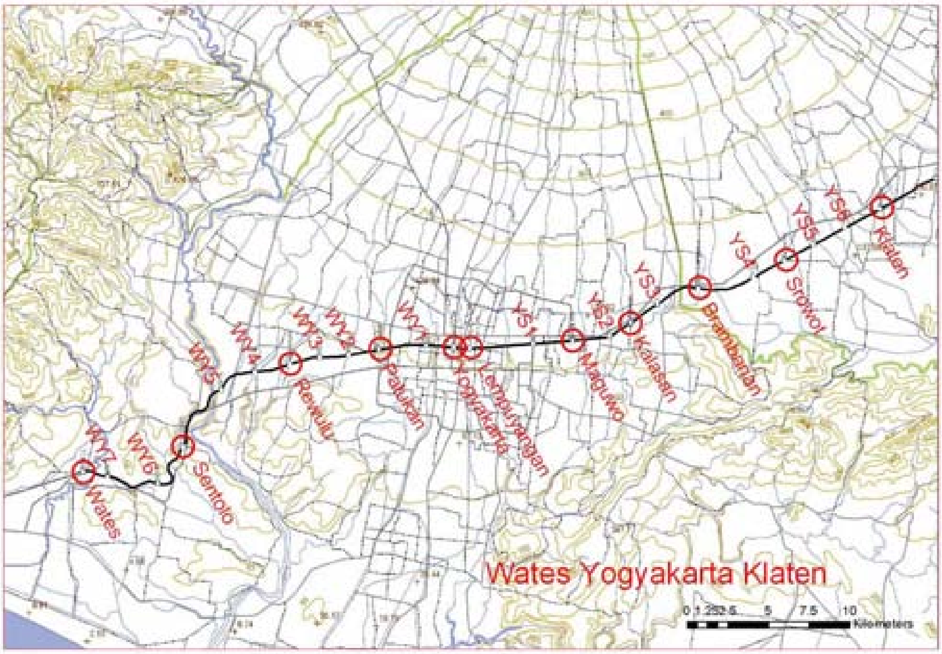


Figure 8.1.12 Project Map (CT-Yog-1, CT-Yog-2)

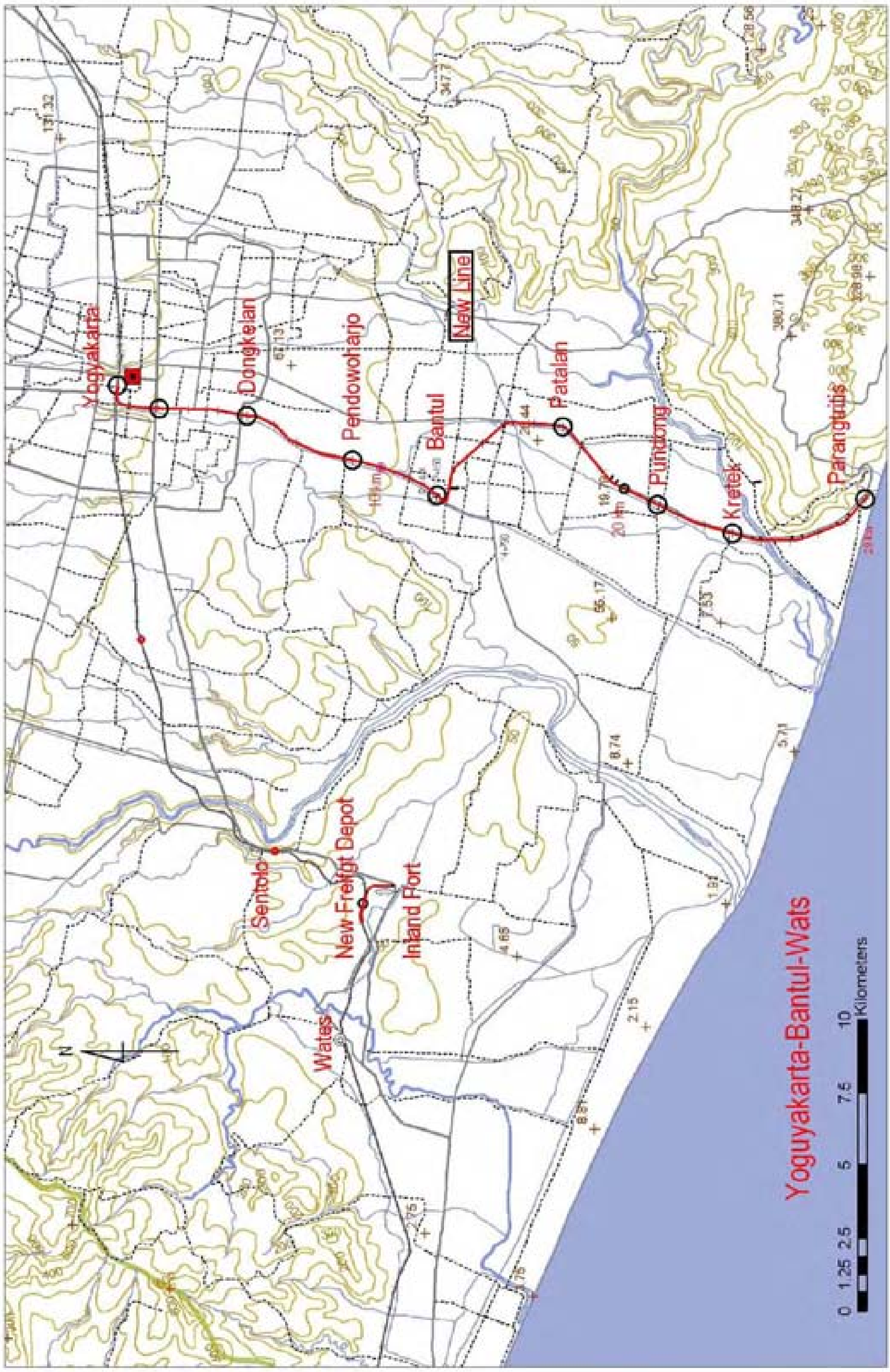


Figure 8.1.13 Project Map (CT-Yog-2, UR-Yog, FT-Yog)

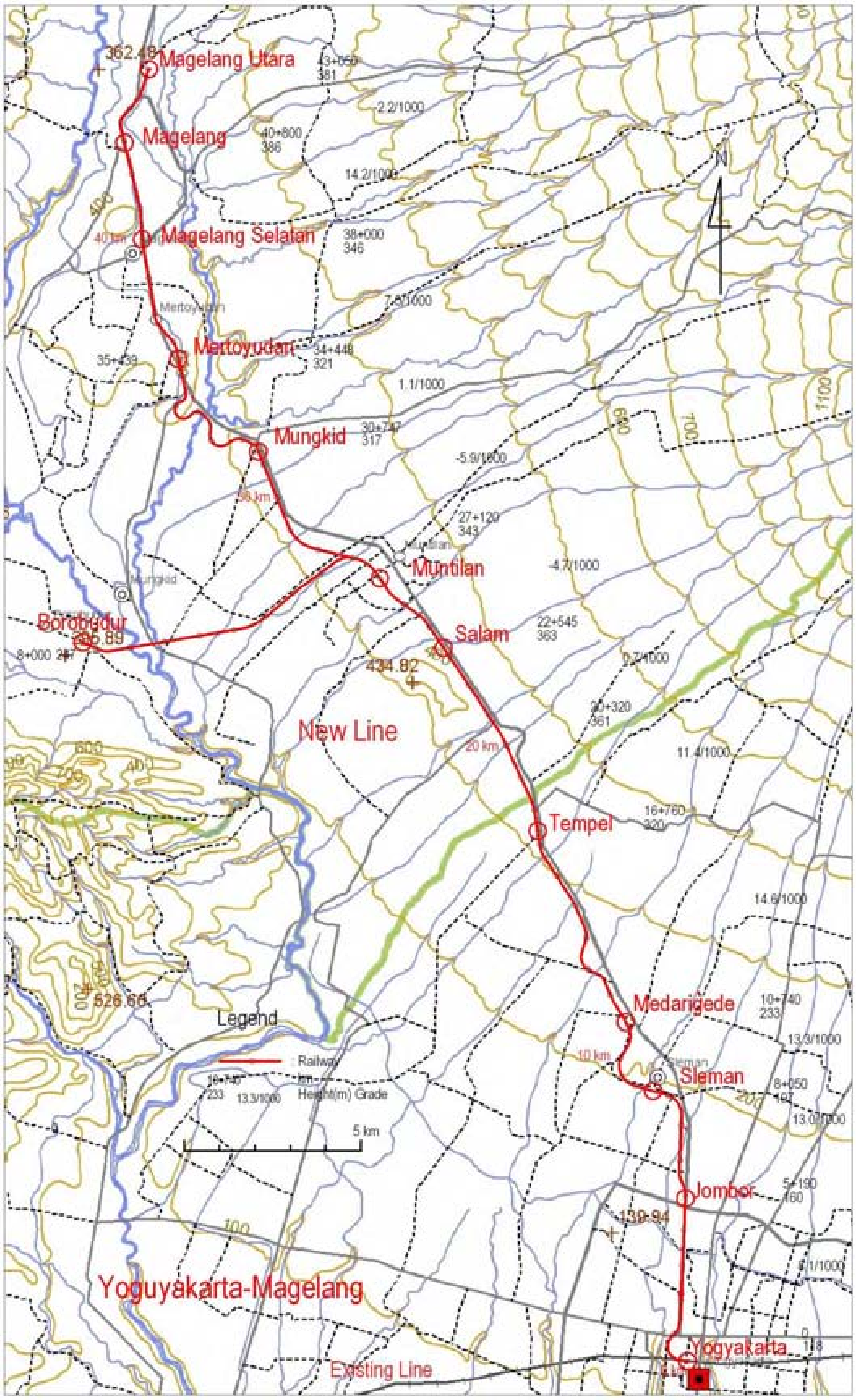


Figure 8.1.14   Project Map (IT-1, IT-2)

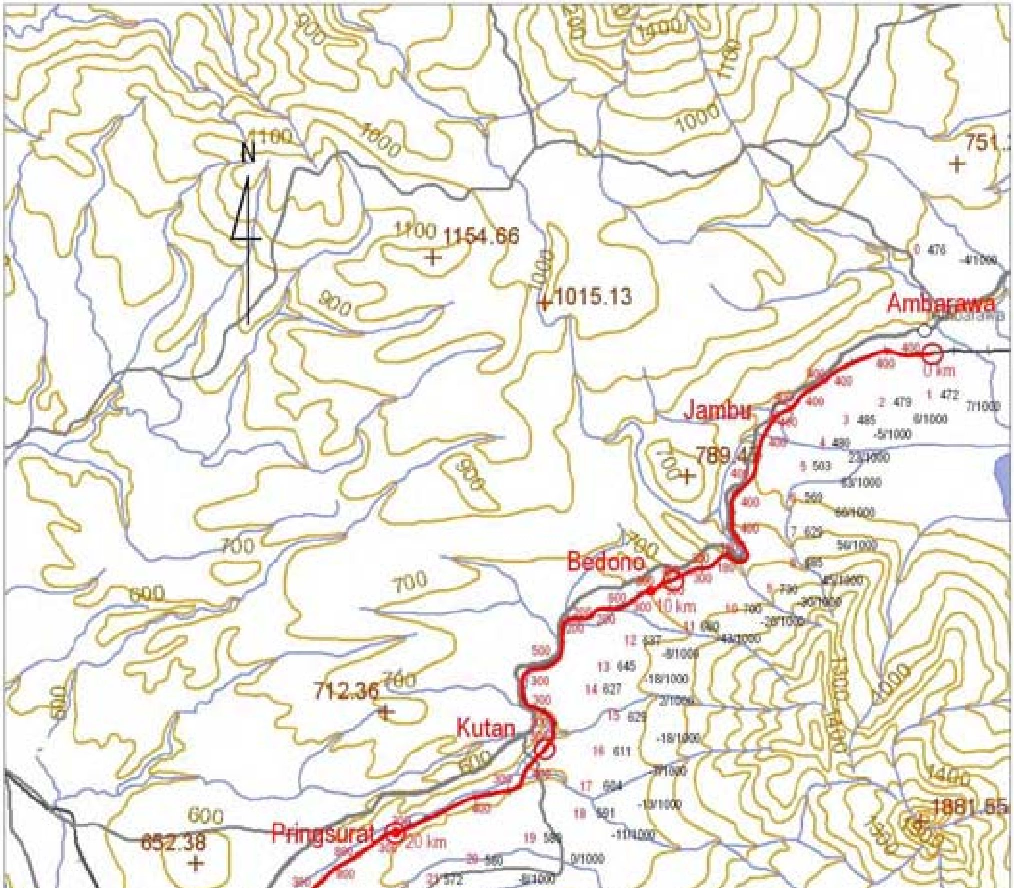


Figure 8.1.15 Project Map (IT-3)

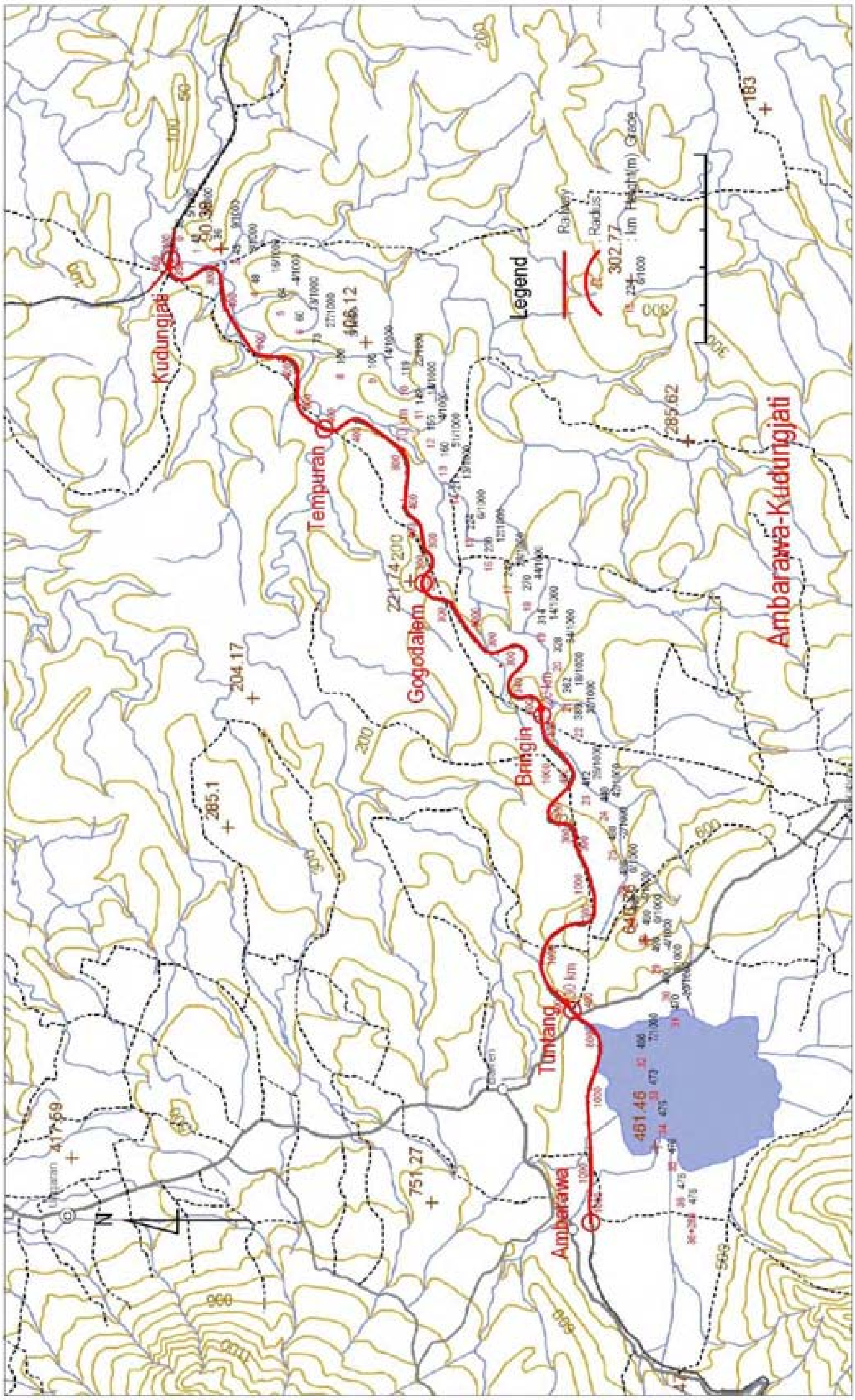


Figure 8.1.16 Project Map (IT-4)

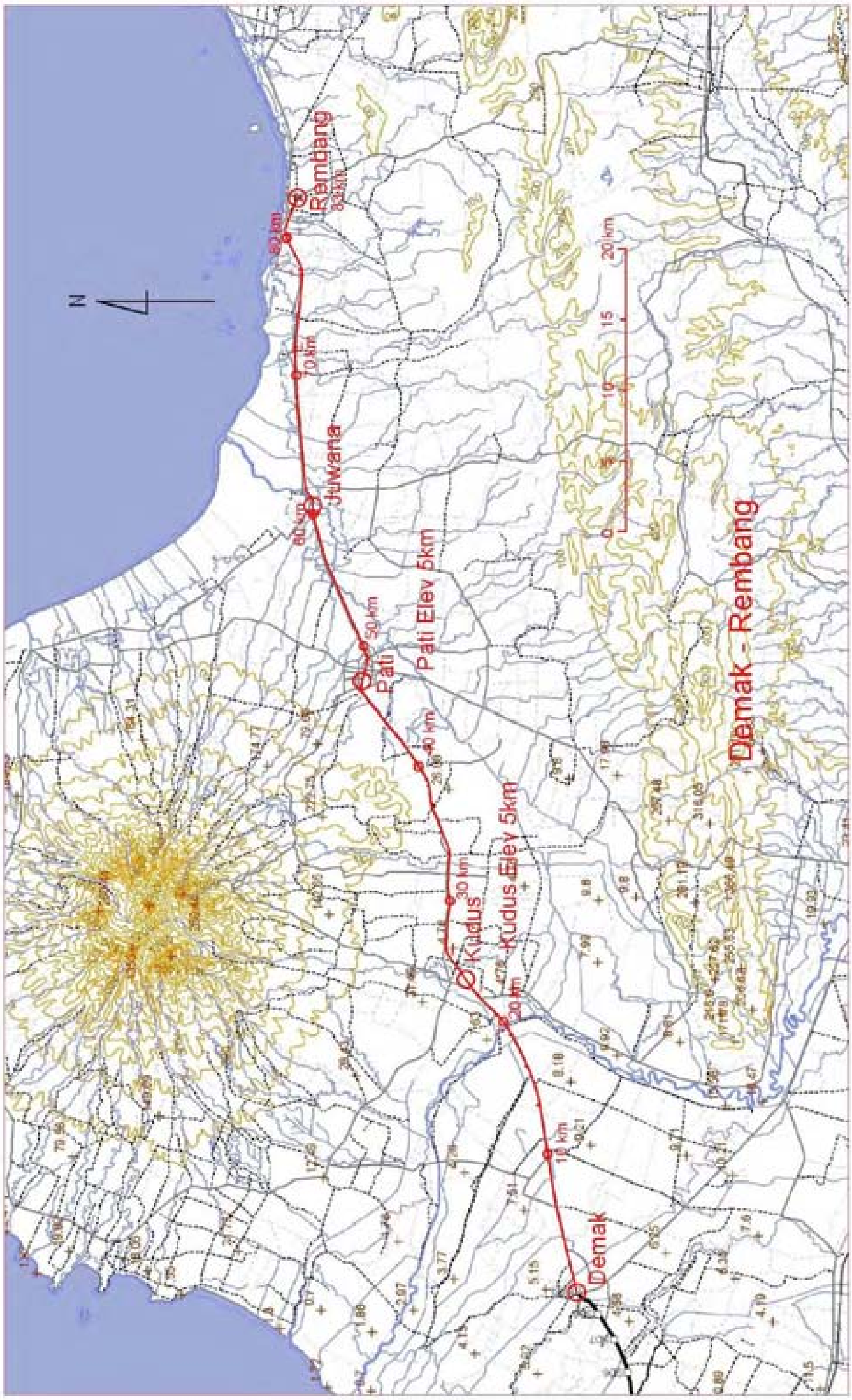


Figure 8.1.17 Project Map (IT-5)

(3) Salient Features

Based on the above development concepts, the Study Team has prepared salient features of each railway system as shown in the following tables.

Table 8.1.9 Salient Features – Commuter Train (1)

	Track Elevation inside Semarang City (CT-Sem-1)	Kendal Commuter (CT-Sem-2)		Demak Commuter (CT-Sem-3)	Brumbung Commuter (CT-Sem-4)
		Alternative - 1	Alternative - 2		
Route Length (Double Track Section)	7 km (DT 7 km)	29 km (DT 20 km)	24 km (DT 20 km)	24 km (DT 24 km)	14 km (DT 14 km)
Project Length	7 km (Elev. 7 km)	25 km (Ag. 25 km)	20 km (Ag. 20 km)	21 km (Elev. 21 km)	11 km (Ag. 11 km)
Number of Stations (Entire Route)	3 (Elev. 3)	10 (Elev. 2, Ag. 8)	9 (Elev. 2, Ag. 7)	11 (Elev. 11)	6 (Elev. 2)
New Construction	7 km (3 Sta.)	9 km	None	21 km	None
New Stations on New/Existing Route	0 Sta./1 Sta.	2 Sta. / 3 Sta.	None / 4 Sta.	9 Sta./ None	None / 2 Sta.
Rehabilitation/Upgrade	None	DT 16 km (3 Sta.)	DT 20 km (3 Sta.)	None	DT 11 km (2 Sta.)
Min. Curve Radius/Max. Gradient	200m/1% (approximate)	600m/1.5% (approximate)		200m/1% (approximate)	600m/2% (approximate)
Traffic Forecast (PHPDT 2015/20/25)	N/A	3,927 / 5,050 / 5,993		3,462 / 4,631 / 5,401	1,735 / 2,287 / 2,685
Design Headway	6 min	6 min (main), 10 min (branch)		6 min	6 min
Operational Headway (initial stage)	N/A	[peak] 30 min (Ex.), 20 min (Lc.) [off peak] 60 min (Ex.), 60 min (Lc.)		[peak] 30 min (Ex.), 30 min (Lc.) [off peak] 60 min (Ex.) 60 min (Lc.)	
Train Configuration	N/A	5 car (EMU), 6 car consist (DMU)		4 car consist (EMU), 5 car consist (DMU)	
Coaches Required (EMU/DMU)	None	45 / 54	35 / 54	35 / 54	20 / 25
Design Speed	120 km/h				
Commercial Speed	N/A	[EMU Option] 60 km/h (Express), 45 km/h (Local), [DMU Option] 55 km/h (Express), 40 km/h (Local)			
Permanent Way	Ballastless Track	Ballastless (Elev.), Ballasted (Atg.)		Ballastless Track	Ballastless (Elev.), Ballasted (Atg.)
Traction System	Traction System Voltage: DC 1500V, Current Collection: Overhead Catenary (EMU Option), Diesel Electric (DMU Option)				
Substation (EMU Option)	1 Nos.	1 Nos. + 3 Nos. (Additional)		1 Nos. + 3 Nos. (Additional)	3 Nos.
Rolling Stock (EMU Option/DMU Option)	N/A	[Type] Japanese Standard Type (secondhand)/PRAMEKS Type, [Traction System] Electric DC1500V/Diesel Electric, [Power] Motor Power 120 kW x 8 per train/Engine Power, [Pax. Capacity: Total (seated)] 560 (204)/562 (266) per 4 car train			
Maintenance Facility	1 depot at Semarang Poncol	1 depot at Semarang Poncol		1 depot at Semarang Poncol	1 depot at Semarang Poncol
Signaling, Telecommunication and Train Control System	Interlocking Devices, Power Supply, Colour Light Signal, Electric Point Machine, Track Circuits or Axle Counters, Optic Fiber Cable System (at stations), Telephone System (at stations and level crossings), Protection Equipments at level crossings (N/A to track elevation project), Train Control System				
Construction Methodology	Viaduct consisting of PC box girder (E)	Viaduct consisting of PC box girder (E) General embankment (Ag.)		Viaduct consisting of PC box girder (E) General embankment (Ag.)	General embankment (Ag.)
Capital Cost Estimate (mil. USD)	94.6 (EMU), 80.3 (DMU)	92.62(E), 142.3 (D)	76.6 (E), 124.4(D)	197.7(EMU), 222.8(DMU)	53.9 (EMU), 81.2 (DMU)

Table 8.1.10 Salient Features – Commuter Train (2)

	Klaten – Solo Commuter (CT-Sol-1)	Sragen Commuter (C-Sol-2)	Klaten - Yogya Commuter (CT-Yog-1)	Wates Commuter (C-Sol-2)
Route Length (Double Track Section)	29 km (DT 29 km)	29 km (DT 29 km)	30 km (DT 30 km)	28 km (DT 28km)
Project Length	29 km (Ag. 29 km)	29 km (Ag. 29 km)	30 km (Atg. 30 km)	28 km (Ag. 28 km)
Number of Stations (Entire Route)	12 (Ag. 12)	13 (Ag. 13)	13 (Ag. 13)	12 (Ag. 12)
New Construction	None	None	None	None
Additional Stations on Existing Track	5 Sta.	7 Sta.	6 Sta.	7 Sta.
Rehabilitation	None (6 Sta. incl. Solo Balapan)	DT 29 km (5 Sta.)	None (7 Sta. incl. Klaten)	None (4 Sta.)
Min. Curve Radius/Max. Gradient	1200m/1% (approximate)	450m/1% (approximate)	800m/1% (approximate)	400m/1% (approximate)
Traffic Forecast (PHPDT 2015/20/25)	1,581 / 2,244 / 2,553	2,037 / 2,829 / 3,248	1,661 / 2,263 / 2,619	2,221 / 2,887 / 3,410
Design Headway	6 min	6 min	6 min	6 min
Operational Headway (initial stage)	[peak] 30 min (Ex.), 30 min (Lc.) [off peak] 60 min (Ex.) 60 min (Lc.)	[peak] 30 min (Ex.), 30 min (Lc.) [off peak] 60 min (Ex.) 60 min (Lc.)	[peak] 30 min (Ex.), 30 min (Lc.) [off peak] 60 min (Ex.) 60 min (Lc.)	[peak] 30 min (Ex.), 30 min (Lc.) [off peak] 60 min (Ex.) 60 min (Lc.)
Train Configuration	4 car consist (EMU Option), 5 car consist (DMU Option)			
Coaches Required (EMU/DMU)	45 / 54	28 / 40	28 / 40	28 / 40
Design Speed	120 km/h			
Commercial Speed	[EMU Option] 60 km/h (Express), 45 km/h (Local), [DMU Option] 55 km/h (Express), 40 km/h (Local)			
Permanent Way	Ballasted Track	Ballasted Track	Ballasted Track	Ballasted Track
Traction System	Traction System Voltage: DC 1500V, Current Collection: Overhead Catenary (EMU Option), Diesel Electric (DMU Option)			
Substation (EMU Option)	1 Nos. + 2 Nos. (Additional)	1 Nos. + 2 Nos. (Additional)	3 Nos.	1 Nos. + 2 Nos. (Additional)
Rolling Stock (EMU Option/DMU Option)	[Type] Japanese Standard Type (secondhand)/PRAMEKS Type, [Traction System] Electric DC1500V/Diesel Electric, [Power] Motor Power 120 kW x 8 per train/Engine Power, [Passenger Capacity: Total (seated)] 560 (204)/562 (266)			
Maintenance Facility	1 depot at Klaten	1 depot at Klaten	1 depot at Klaten	1 depot at Klaten
Signaling, Telecommunication and Train Control System	Interlocking Devices, Power Supply, Colour Light Signal, Electric Point Machine, Track Circuits or Axle Counters, Optic Fiber Cable System (at stations), Telephone System (at stations and level crossings), Protection Equipments at level crossings, Train Control System			
Construction Methodology	N/A	N/A	N/A	N/A
Capital Cost Estimate (mil. USD)	77.3 (EMU), 101.0 (DMU)	107.7 (EMU), 110.2(DMU)	114.1(EMU), 162.9(DMU)	73.0(EMU),119.6(DMU)

Table 8.1.11 Salient Features – Urban Railway and Airport Link

	Semarang Monorail (UR-Sem)	Solo Tramway (UR-Sol)	Bantul Tramway (UR-Yog)	Semarang Airport Link (AL-Sem)	Solo Airport Link (AL-Sol)	
					Alternative - 1	Alternative - 2
Route Length (Double Track Section)	12 km (DT 12 km)	6 km	29 km	9 km (DT 5 km)	7 km	13 km
Project Length	12 km (Elev. 12 km)	6 km (Ag. 6 km)	29 km (Elev. 5 km, Ag. 24 km)	4 km (Elev. 4 km)	7 km (El.2/Ag.5)	7 km (Ag. 7 km)
Number of Stations (Entire Route)	12 (Elev. 12)	4 (Ag. 4)	9 (Elev. 3, Ag. 6)	2 (Elev. 2)	1 + 1 (Elev. 1)	1 + 1 (Ag. 1)
New Construction	12 km (12 Sta.)	None (2 Sta.)	9 (Elev. 3, Ag. 6)	4 km (2 Sta.)	7 km (1 Sta.)	7km (1 Sta.)
Additional Stations on Existing Track	None	None	None	None	None	None
Rehabilitation	None	6 km (2 Sta.)	None	None	None	None
Min. Curve Radius/Max. Gradient	150m/6.5% (approximate)	90m/Level (approximate)	100m/TBP (approximate)	200 m/Level (approximate)	400m/2%	400m/Lv.
Traffic Forecast (PHPDT 2015/20/25)	2,159 / 2,613 / 3,186	977 / 1,182 / 1,441	827 / 1,053 / 1,273	827 / 1,053 / 1,273	533 / 676 / 823	
Design Headway	4 min	10 min	10 min	20 min	20 min	
Operational Headway (initial stage)	[peak] 6 min, [off peak] 10 min	[peak] 12 min, [off peak] 20 min	[peak] 20 min, [off peak] 60 min	30 min	30 min	
Train Configuration	4 car consist	3 car consist	3 car consist	4 car consist (EMU and DMU Option)		
Coaches Required	40	18	12	12 / 12	30 / 30	
Design Speed	100 km/h	60 km/h	60 km/h	120 km/h		
Commercial Speed	45 km/h	30 km/h	30 km/h	70 km/h		
Permanent Way	Ballasted Track	Embedded Track	Embedded/Ballasted Track	Ballasted Track	Ballastless (E), Ballasted (Ag.)	
Traction System	Traction System Voltage: DC 1500V, Current Collection: Overhead Catenary (EMU Option), Diesel Electric (DMU Option)					
Substation (EMU Option)	2 Nos. (Additional)	2 Nos. (Additional)	2 Nos. (Additional)	None	None	
Rolling Stock	Monorail cars with capacity of 250 pax./train	Tramcars or Battery tramcars with capacity of 180 pax./train	Tramcars with capacity of 180 pax./train	[Type] Japanese Standard Type (secondhand)/PRAMEKS Type, [Pax. Capacity: Total (seated)] 560 (204)/562 (266) per 4 car train		
Maintenance Facility	1 depot	1 depot at Purwosari	1 depot at Yogyakarta	1 depot at Semarang Poncol	1 depot at Klaten	
Signaling, Telecommunication and Train Control System	(Details to be studied)	(Details to be studied)	(Details to be studied)	(Same as commuter trains)		
Construction Methodology	Viaduct consisting of PC box girder (E)	N/A	General Embankment (Ag.)	Viaduct consisting of PC box girder (E) Embankment (Ag.)	General Embankment (Ag.)	
Capital Cost Estimate (mil. USD)	218.6	60.6	213.3	12.2(EMU), 20.2(DMU)	81.8(E), 77.1(D)	66.0(E), 61.3(D)

Table 8.1.12 Salient Features – Freight Train

	Semarang – Solo Freight Corridor (FC-1)	Wonogiri – Solo Freight Corridor (FC-2)	Semarang Port Access (FT-Sem-1)	Kendal SEZ Access (FT-Sem-2)	Solo Dryport Access (FT-Sol)	Yogya Inland Port Access (FT-Yog)
Route Length	109 km (DT 14 km)	40 km	2 km	5 km	2 km	2 km
Project Length	95 km (Ag. 95 km)	40 km (Ag. 40 km)	3 km (Elev. 2 km, Ag. 1km)	5 km (Ag. 5 km)	2 km (Ag. 2 km)	2 km (Elev. 2 km)
Number of Stations (Entire Route)	N/A	N/A	N/A	N/A	N/A	N/A
New Construction	None	4 km	2 km	5 km	2 km	2 km
Additional Stations	N/A	N/A	N/A	N/A	N/A	N/A
Rehabilitation	95 km	33 km	1 km	None	None	None
Min. Curve Radius/Max. Gradient	400m/1% (approx)	200m/1% (approx)	100m/2.0% (approx)	(Details to be studied)	(Details to be studied)	200 m/1% (approx)
Freight Demand Forecast	(See Chapter 4)	(See Chapter 4)	(See Chapter 4)	(See Chapter 4)	(See Chapter 4)	(See Chapter 4)
Design Headway	N/A	N/A	N/A	N/A	N/A	N/A
Operational Headway	3 round-trips per day	3 round-trips per day	N/A	N/A	N/A	N/A
Train Configuration	1 Locomotives + 25 FEU wagons or 50 TEU wagons (maximum)					
Locomotives Required	2	1	None	1	None	1
Design Speed	100 km/h	100 km/h	60 km/h	60 km/h	60 km/h	60 km/h
Commercial Speed	60 km/h	60 km/h	20 km/h	20 km/h	20 km/h	20 km/h
Permanent Way	Ballasted Track	Ballasted Track	Ballasted Track	Ballasted Track	Ballasted Track	Ballasted Track
Traction System	Diesel Electric	Diesel Electric	Diesel Electric	Diesel Electric	Diesel Electric	Diesel Electric
Substation	None	None	None	None	None	None
Rolling Stock	Diesel Locomotive	Diesel Locomotive	Diesel Locomotive	Diesel Locomotive	Diesel Locomotive	Diesel Locomotive
Maintenance Facility	Solo Jebres, Sem. Poncol	Solo Jebres	Semarang Poncol	Semarang Poncol	Solo Jebres	Yogyakarta
Signaling, Telecommunication and Train Control System	Interlocking Devices, Colour Light Signal, Electric Point Machine, Track Circuits or Axle Counters, Optic Fiber Cable System (at stations), Telephone System (at stations and level crossings), Protection Equipments at level crossings (automatic blocking with computer based interlocking or COMBAT system)					
Construction Methodology	N/A	Embankment (Ag.)	Viaduct, PC box girder (E) General embankment (Ag.)	General embankment (Ag.)	Embankment (Ag.)	Embankment (Ag.)
Capital Cost Estimate (mil. USD)	88.1	34.4	9.4	11.1	2.5	8.5

Table 8.1.13 Salient Features – Intercity Train

	Yogya – Ambarawa Intercity (INT-1)	**Borobudur Access (INT-2)**	**Ambarawa – Magelang Intercity (INT-3)**	**Ambarawa – Kedungjati Intercity (INT-4)**
Route Length (Double Track Section)	46 km	8 km	34 km	37 km
Project Length	46 km (Elev. 16km, Ag. 30 km)	8 km (Ag. 8 km)	34 km (UG. 11km, Atg. 23 km)	37 km (UG. 2km, Ag. 35 km)
Number of Stations (Entire Route)	8(Elev.4, Ag.4)	1 (Ag. 1)	5 (Ag. 5)	5 (Ag. 5)
New Construction	46 km	8 km	37 km	37 km
Additional Stations on Existing Track	None	None	None	None
Rehabilitation	None	None	None	None
Min. Curve Radius/Max. Gradient	500m/2.5% (approximate)	500m/1% (approximate)	300m/over 2%(approximate)	300m/over 3%(approximate)
Traffic Forecast (PHPDT 2015/20/25)	1,753 / 2,353 / 2,741	535 / 676 / 823	608 / 934 / 1,029	692 / 1,036 / 1,153
Design Headway	15 min	20 min	20 min	20 min
Operational Headway (initial stage)	[peak] 20 min [off peak] 60 min	[peak] 30 min [off peak] 60 min	[peak] 30 min [off peak] 60 min	[peak] 30 min [off peak] 60 min
Train Configuration (DMU)	5 car consist	4 car consist		
Coaches Required	40	4	24	24
Design Speed	100 km/h			
Commercial Speed	45 - 60 km/h			
Permanent Way	Ballasted Track	Ballasted Track	Ballasted Track	Ballasted Track
Traction System	Diesel Electric (DMU Option)			
Substation	None	None	None	None
Rolling Stock	[Type] Existing standard DMU (rehabilitated), [Traction System] Diesel Hydraulic, Engine Power, [Passenger Capacity: Total (seated)] 562 (266)			
Maintenance Facility	Yogyakarta, Magelang	1 depot at Magelang	1 depot at Magelang	1 depot at Kedungjati
Signaling, Telecommunication and Train Control System	Interlocking Devices, Colour Light Signal, Electric Point Machine, Track Circuits or Axle Counters, Optic Fiber Cable System (at stations), Telephone System (at stations and level crossings), Protection Equipments at level crossings, Train Control System (automatic blocking with computer based interlocking or COMBAT system)			
Construction Methodology	Viaduct consisting of PC box girder (E) General embankment (Ag.)	General embankment (Ag.)	General embankment (Ag.) NATM tunneling (UG)	General embankment (Ag.) NATM tunneling (UG)
Capital Cost Estimate (mil. USD)	189.4	18.6	130.7	82.2

8.1.3 Preliminary Project Cost Estimate

This section examines the methodology and result of preliminary cost estimate of each railway project to develop each railway system. The estimate covers an overview of the capital cost, Operation and Maintenance (O&M) expenses, revenue estimates from farebox as well as other sources like property and real estate development along the route corridor.

(1) Base Assumptions and Methodologies

The project cost estimates for civil, electrical, signaling and telecommunication works, rolling stock, and O&M expenses have been estimated in 2008 prices.

All items related with alignment, whether in at-grade, elevated, or underground construction, permanent way, traction and power supply, signaling and telecommunication, whether in main lines or in maintenance depot, have been estimated on rate per route-km basis. The rate of station works excludes station structures, electrical and mechanical works.

Cost of elevated and station structures, and other electrical works at these stations have been assessed in terms of each station as a unit. Similarly, for items like rolling stock and substation, they have been estimated in terms of number of units required for each item.

The cost estimates for main items are assessed based on both the local standard (Jabotabek Railway Projects, Cirebon-Kroya Railway Rehabilitation Project) and international standard (Major projects in Thailand, Malaysia, Philippines and India similar to each of the proposed projects) depending on the item of the works.

1) Civil Works

Major lengths of alignment involved are in at-grade and elevated sections. Rates considered are based on the rates for major local and international projects, duly updated.

2) Station Works

Provisions of elevated station cost, is in addition to the viaduct cost, which is considered under the alignment. This rate cover cost of station structures and platforms does not cover electrical and mechanical works.

3) Trackworks

For elevated alignment, ballastless track has been planned. Unit rates adopted are based on the rates for similar works, with international standard. Ballasted Track will be provided in the depot as well as in at–grade portion, basically following the rate of local standard.

4) Signaling, Telecommunication and Traffic Control System

Rates adopted are based on rail corridors for international projects. These rates include escalation during manufacturing and supply of equipment and their installation at site.

5) Traction Power Supply System (EMU Option)

Provision has been made to cover the cost of traction and power supply, substations for elevated and at-grade alignments based on Route-km Costing. Cost of similar works under local projects has been referred.

6) Rolling Stock

Cost estimates for Rolling Stock are based on discussion with PT. KA for both DMU and secondhand EMU including adjustment and transport.

7) Maintenance Facility

All the stabling and maintenance facilities & equipments are proposed to be provided in this depot. Office building and Operation control center (OCC) facilities are also included in the item.

8) Other Costs

Land acquisition cost, design cost, project management cost, contingencies, loan interest during construction, tax and duties, are not included in the estimate.

(2) Capital Cost Estimate

The following tables show the results of capital cost estimate.

Table 8.1.1 Summary of Project Cost Estimate

Million USD in year 2008 price level

Projects	Route km	Project km	Capital Cost		Cost per km	
			Electrified	Diesel	Electrified	Diesel
Commuter Trains						
Track Elevation	7	7	89.7	78.2	12.8	11.2
Semarang - Kendal Commuter : Alternative 1	29	23	68.3	106.0	3.0	4.6
Semarang - Kendal Commuter : Alternative 2	24	18	60.4	89.6	3.4	5.0
Semarang - Demak Commuter	24	21	183.3	196.6	8.7	9.4
Semarang - Brumbung Commuter	14	11	37.9	63.4	3.4	5.8
Solo - Klaten Commuter	29	29	68.0	88.9	2.3	3.1
Solo - Sragen Commuter	29	29	75.9	88.4	2.6	3.0
Yogya - Klaten Commuter	30	30	77.9	95.9	2.6	3.2
Yogya - Wates Commuter	28	28	51.5	82.7	1.8	3.0
Urban Railways						
Semarang Monorail	12	12	181.0	-	15.1	-
Solo Tramway	6	6	51.9	-	8.6	-
Bantul Tramway	15	15	-	111.1	-	7.4
Airport Link						
Semarang Airport Link	9	4	32.7	26.7	8.2	6.7
Solo Airport Link - Alternative 1	7	8	69.3	83.0	8.7	10.4
Solo Airport Link - Alternative 2	12	8	59.5	75.2	7.4	9.4
Freight Trains						
Solo - Semarang Freight Corridor	109	95	-	85.3	-	0.9
Wonogiri - Solo Freight Corridor	36	36	-	25.8	-	0.7
Semarang Port Access	2	2	-	13.3	-	6.6
Solo Dryport Access	1	1	-	14.3	-	14.3
Yogya Inland Port Access	3	3	-	8.6	-	2.9
Kendal SEZ Access	5	5	-	20.9	-	4.2
Intercity Trains						
Yogya - Magelang Intercity	47	47	-	177.7	-	3.8
Borobudur Access	7	7	-	11.7	-	1.7
Magelang - Ambarawa Intercity	37	37	-	125.4	-	3.4
Ambarawa - Kedungjati Intercity	37	37	-	76.3	-	2.1
Semarang - Tegal Intercity	150	150	-	45.0	-	1.6
Semarang - Cepu Intercity	140	140	-	36.0	-	1.3
Demak - Rembang Inter icty	86	86	-	177.1	-	2.1
Tourist Trains						
Ambarawa Rail Museum	N/A	N/A	N/A	N/A	N/A	N/A

(3) Operation and Maintenance Cost

The Operation & Maintenance costs of each project consist of Staff Costs, Maintenance (routine and preventive including stores & spares and consumables) and energy costs. The O&M costs are estimated below.

1) Staff Costs

To study the benchmark for staff cost per kilometer, O&M staff strength for 60.0 km of route length was estimated for Wates – Yogya – Klaten Commuters. This works out to be 374 persons per 60 km (which equals 62.3 persons per route km). The staff cost based on the prevailing staff cost per 60 km is estimated at 0.9 million USD in 2008 price level (which equals 15,000 USD per route km per annum. as a base assumption).

2) Maintenance Cost

Maintenance cost has been assessed based on analysis of similar systems implemented by Japan Railway, but adjusted to suit the price level of Indonesian standard. In the case of Wates – Yogya – Klaten Commuters, the maintenance cost is estimated as 1.04 million USD for EMU and 1.49 million USD for DMU (which nearly equals 173,000 USD for EMU and 248,000 USD for DMU per route km per annum in 2008 price level).

3) Energy Costs

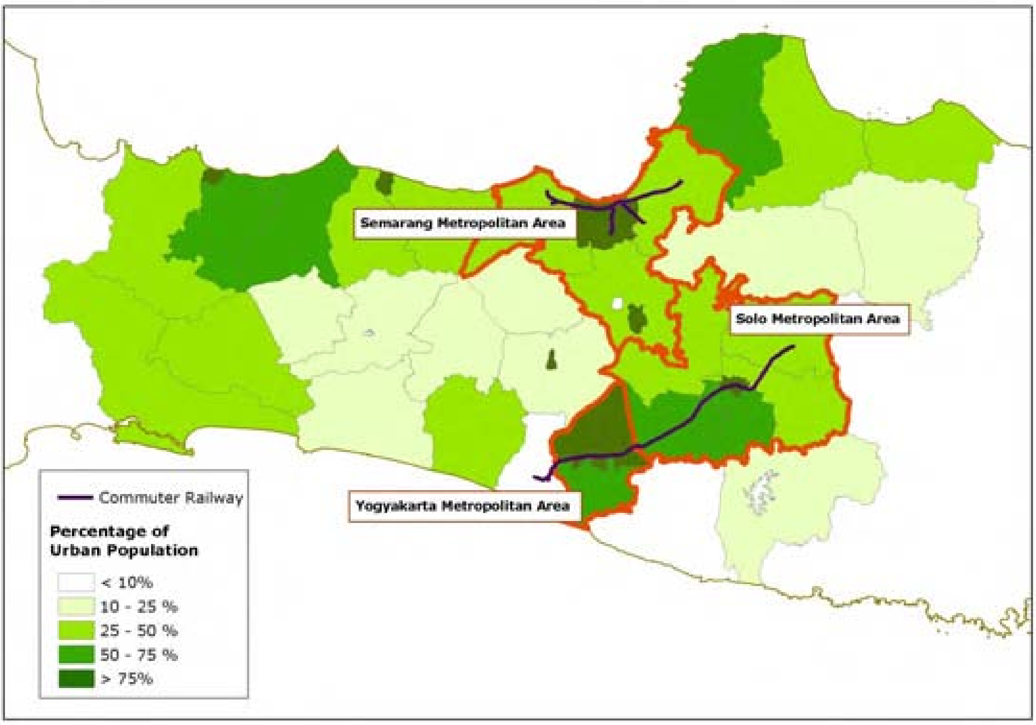
The power required for one EMU is assessed at 2.5 kWh/km per car, while one DMU and diesel locomotive consumes 0.5 liter and 5.0 liters of fuels per km respectively. The energy costs are considered at IDR 612 per kWh or IDR 4,950 per liter of diesel fuel. The annual charges for energy are estimated at USD 9,821 per km per annum for EMU, USD 23,836 per km per annum for DMU, and USD 3,970 per km per annum for diesel locomotive.

8.2 Railway-Related Development Projects

8.2.1 Housing Development with Railway System Development

(1) Background

Semarang, Yogyakarta and Solo are main cities driving the economy of the the Central Java region. They have been gradually accumulating population and business. In the future, the population is expected to overflow into the surrounding areas. Actually, the urban population ratio in 2005 indicates that such dynamic is already occurring. A new metropolitan area of each city is expected to be formulated in the future. The commuter railway will be considered based upon these new areas.



Source: CJRR Study Team based on Statistical Bureau (*Badan Pusat Statistik*, BPS) Central Java Province and DIY, SUPAS

Figure 8.2.1 Metropolitan Area and Urban Population

Unlike people employed in the primary sector such as agriculture, fishery and mining, urban dwellers are relatively free to choose the location of their residence. If transportation service is improved for commuting and meets their needs in terms of time, convenience, and cost, they could move their residence into suburban areas and commute to the city centre.

Demand for housing in Semarang, Solo and Yogyakarta has been growing. According to Purmunas Region V, housing growth of Semarang has been continuous especially in the southern and western parts of Semarang. In Yogyakarta and Solo, demand for housing is also high and people tend to seek new and spacious houses in the suburbs. In such a circumstance, small-sized housing developments by private firms are found in the urban fringe.

(2) Integration with Housing Development along the Corridor

In terms of the existing conditions and expected population growth and economic expansion in these three cities and surrounding kabupaten/kota, integrated development of railway system and housing development is recommended.

1) Objectives

The objectives of the integrated development are not merely to provide public transportation services for the residents in suburban areas, but also to strengthen the financial viability of the railway system development. Three specific objectives are discussed in more detail below:

1. To internalize development benefits of improving railway service from increase in land value in housing development
2. To increase passenger revenue which is brought about by increase of railway passenger demand by developing housing along the railway line
3. To prevent urban sprawl through well-planned housing development

2) To internalize development benefits of improving railway service from increase in land value in housing development

Integrated development of railway system development and real estate business such as residential area development has been implemented by private railway companies to finance both. In Japan, a railway company procured land for residential area development along the railway corridor at low price before railway system development. The railway company then converted the land into residential land with public facilities and infrastructure. The land value increased along the railway after the development of the railway service. The company obtained development benefits from the increased land values after development. This profit could be utilized for the railway system development and improvement of railway services.

3) To increase passenger revenue which is brought about by increase of railway passenger demand by developing housing along the railway line

Housing development along the railway corridor would increase residential population and as a consequence railway passenger demand as well. Increasing number of passengers and increase in fare revenue is essential for stabilizing the railway business. In order to secure railway passengers, railway service should be convenient for passengers and the development area should be selected in this regard. To be more precise, the railway station should be planned as the core of the housing development area.

4) To prevent urban sprawl through well-planned housing development

Integrated housing development brings about not merely basic social infrastructure such as education, medical, religious and welfare facilities, but also public transportation services at the same time. In contrast, a small-scale housing development has difficulty to provide such services due to the small scale of development. In addition, the small-scale development lead by private real estate companies probably would carry out land conversion from agricultural land to residence piece by piece. This would not allow organized land use and would probably lead to urban sprawl. Especially in agricultural areas, the productivity would be affected more or less by patchwork land use by residences and agriculture fields.

8.2.2 Urban Development at City Centre in Semarang and Yogyakarta

P.T. K.A. has locomotive workshops in city centre of both Semarang and Yogyakarta. These lands are located in the heart of cities, and the area has enough space for integrated urban redevelopment. The Study Team proposes the urban redevelopment of these lands and relocating the locomotive workshops to other places in order to more attractively improve the utilization of these lands.

Semarang and Yogyakarta are expected to be diversified as centres of businesses, culture, and citizens. For greater expanding of the urban functions, redevelopment of these workshops could provide the place for building a congress centre, office buildings, commercial and recreation facilities and houses. In addition, P.T. K.A. could obtain benefit from these facilities after development. This profit could be utilized for the railway system development and improvement of railway services.

(1) Relevant Projects in the City

1) Urban Drainage System Improvement and Water Supply Works for the Western Area of Semarang City

Semarang city is likely to suffer from flooding because of tidal inundation and land subsidence including the redevelopment area. For tackling these problems, the project has been conducted since 2006.

<u>Background of the Project</u>

Semarang has suffered from floods because of climate and geographic conditions. In recent three decades, large scale flooding has occurred four times due to overflowing of the rivers. In addition, flood by heavy rain has occurred in the city centre on a daily basis. The major reason is that serious land subsidence has been caused by pumping up deep wells. This is because the surface water is overused in Semarang city due to concentration of industrial factories and rapid population growth, and they try to get additional water from the deep wells. For tackling these problems, the project has been started since 2006.

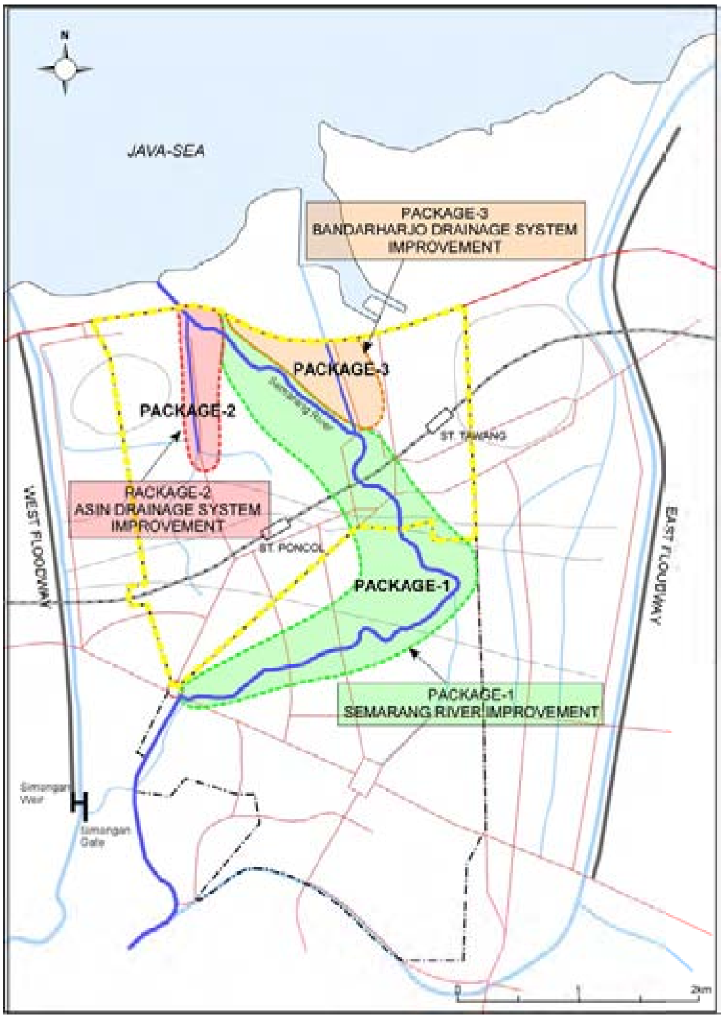
<u>Purpose of the Project</u>

In order to reduce damages by floods and provide stable water supply the following measures are targeted: floodway and river improvement, strengthening urban drainage system, and multipurpose dam construction in the Semarang city. The project consists of three packages as follows:

- Package 1 : Semarang River Improvement
- Package 2: Asin River Drainage
- Package 3: Bandaraharjo Drainage

<u>Project Design</u>

Study Area is shown in the following figure.



Source: CJRR Consultant Service Team

Figure 8.2.2 Study Area Map

- Project Area = 12.835 km2
- Gravity Drainage Area = 6.220 km2
- Pump Drainage Area = 6.615 km2
  - Asin Pump Drainage Area 4.430 km2
  - Bandarharjo Pump Drainage Area 2.185 km2

Project Outline

- Garang River Improvement Works
- Urban Drainage System Improvement
- Jatibarang Multipurpose Dam Construction
- Consultant Service

Project Schedule

- From 2006 to 2015

Implementation Agency

- Directorate General of Water Resources, Ministry of Public Works
- Directorate General of Human Settlements, Ministry of Public Works

2) Existing Urban Redevelopment Plan of Yogyakarta (Tugu) Station

U Urban redevelopment plan of Yogyakarta (Tugu) station has been started by Regional Development Planning Board (*Badan Perencanaan Pembangunan Daerah*, BAPPEDA) DIY Province and local consultant. This project site is close to the redevelopment site. Implementation agencies are recommended to coordinate their works.

The purpose of the project is to revitalise the Malioboro area by means of improvement required facilities such as parking spaces and parks. Road network is rearranged for smooth circulation near Yogyakarta (Tugu) station area. In addition, land adjustment of residential and commercial areas is expected in the plan. The target area is shown in Figure 8.2.3

Source: BAPPEDA DIY Province and P.T. LAPI ITB

Figure 8.2.3 Existing Conditions of Planned Area

Source: BAPPEDA DIY Province and P.T. LAPI ITB

Figure 8.2.4 Development Concept of Planned Area