ANNEXURE-6

PROJECT BRIEF

0.1 INTRODUCTION

Chennai is the fourth-largest city in India. It is a coastal city with the second largest beach in the world. The climate is hot and humid but the breeze blowing from the sea makes the climate bearable. It is India's major leather-producing center and the quality of leather compares with the finest in the world. The City with its present population of about 8 million generates about 11 million trips in a day, with about 6 million vehicular trips. The ever growing vehicular and passenger demands coupled with constraints on capacity augmentation of the existing network have resulted in chaotic condition during peak hours of the day.

POPULATION

The population of Chennai in1639 was 40000 and today the city is estimated to have a population of 7.5 million, which gives a population density of about 6482 per sq. km. It is observed that with the population growth between 1921 and 1981 has been very rapid and similar trend continues.

INDUSTRIAL AND EMPLOYMENT SCENARIO

Economic growth of CMA has been slower in the large-scale formal industrial sector compared to the growth in the small and marginal sectors in trade, commerce and transport. Per capita income in CMA is rather low compared to other metropolitan cities; it was Rs. 1760 per capita /month as per the house hold survey carried out in 2005. About 65 percent of the population can be classified as economically weaker section.

Chennai is considered as the “Detroit” of India with many automobile companies having their manufacturing facilities including the luxury brands such as BMW,Ford, Nissan, Mitsubishi. Many automobile ancillary units have also set up the facilities in and around Chennai. This apart, mobile phone manufactures such as Nokia, Samsung and Motorola have established sprawling complexes to cater to the domestic market as well as for export to developed countries . The development of IT corridors along the OMR, GST and Ambattur is the pride of Chennai with many multinational as well as domestic IT companies having their presence.

LAND USE POLICY

In 1973, the Chennai Metropolitan Development Authority (CMDA) was set up and it was entrusted the task of implementation of the Master Plan. The detailed plan,

which was prepared for a time frame of over 20 years commencing from 1971, deals with land development, traffic and transportation, housing and slum clearance. At present the Master Plan for the year 2026 is under finalization. The Detailed Project Report is based on the draft Master Plan 2026.

RAIL NETWORK

The rail infrastructure in the Metropolitan area basically comprises of following sections of railway which are treated as suburban sections:

(I) North-East line towards Gummidipoondi (BG line)

(II) South-West line towards Arakkonam (BG line) and

(III) Southern line towards Villupuram,

(IV) Suburban System In Chennai.

a. Chennai Central - Gummidipundi (48km, 16 stations)

b. Chennai Central to Pattabiram (25 km, 15 stations) and for a further distance of 34 km (14 stations upto Arakkonam).

c. Chennai Beach to Tambaram (30km, 18 stations)

Apart from the above, a Mass Rapid Transit System (MRTS) on north-south corridor along Buckingham Canal alignment from Chennai Beach to Velacheri also exists as Broad Gauge Double Line with 25 kV AC Traction and with conventional EMU trains. The extension from Velacheri to St. Thomas mount is sanctioned and is being taken up for execution.

ROAD NETWORK AND TRAFFIC

The road layout in the metropolitan area is of radial pattern with 3 principal radial arterials, viz. NH-5, NH-4, NH-45, to the north, west and south respectively. In addition, there are two more radial arterials,(i) along the coast on the northern side (Thiruvotriyur High Road) and (ii) between NH-4 and NH-45 (Arcot Road).

TRANSPORT PROBLEMS

Previous study in 1992 showed that 33.8 percent of total road length has a Volume /Capacity Ratio of more than 1.0 in the peak hours. Most of the roads in CBD are congested and roads in older areas have inadequate or poor geometries. An inadequate orbital road system, with lot of missing links, has put tremendous strain on the radial network.

PAST STUDIES

A number of transportation studies were carried out in the past for Chennai Metropolitan Development Authority (CMDA). These studies discussed travel pattern, network characteristics and the degree of traffic saturation on the existing roads in the Study Area. The following studies which recommended transportation improvements in CMDA , have been reviewed.

Comprehensive Traffic and Transportation Study (CTTS) for Chennai

The Study was carried out in 1992-95 for Chennai Metropolitan Authority (CMA) along with the preparation of Second Master plan. As part of the CTTS study short, medium and long-term measures for improvement of road and transport infrastructure were identified and prioritized for investment purpose.

Multi modal Outer ring Road Project

The Study as carried out by SOWIL (Sir Oven Williams India Ltd.) indicate the modalities of implementing 62 km long ORR(Outer Ring Road) project as a multi-modal corridor with area development on one side to a depth of 50 meters at an approximate cost of Rs. 900 Crores in the public-private-partnership mode.

0.2 SELECTION OF CORRIDORS

A feasibility study was carried out in 2003 to select and priortise the corridors for Chennai metro. Based on detailed traffic surveys, following corridors were identified for further study:-

Corridor-1: NH-45 (Airport)- Guindy- Sardar Patel Road- Kotturpuram High road - Cenotaph Road- Anna Salai – Gemini – Spencers - Tarapore Towers - Along Cooum River upto Rippon building - Central Station - Broadway (Prakasam Road) – Old Jail road - Tiruvottiyur High Road (upto Tiruvottiyur)

Corridor-2: Along Poonamallai High Road (Corporation limits) - EVR Periyar Salai - Rajaji Road (North Beach Road) covering Koyambedu - Anna Nagar Arch - Aminjikarai – Kilpauk Medical College – Egmore - Central-Fort- Beach

Corridor-3: Ambathur Industrial Area (Mogapair) - Ring Road - Arcort road - Panagal Park - Theagaraya road - Eldams road - Luz Church Road - RK Mutt Road - Adyar Bridge - Lattice Bridge Road - Tiruvanmiyur

Corridor-4: Porur – Kodambakkam (Arcort Road) - Panagal Park - Theagaraya road - Eldams road - Luz Church Road - Kutchery Road - Kamrajar Salai

Corridor-5: Ring road

Corridor-6: Radhakrishnan Salai **-** Nugambakkam High Road- Mc. Nickols Road - KMC

Corridor-7: Along NH 5 Road

Out of these corridors, following 2 corridors have been selected in consultation with state govt. for phase 1:-

1. Corridor-1 Airport to Washermenpet
2. Corridor-2 Fort - Anna nagar- Ring road- St. Thomas Mount

0.3 TRAFFIC FORECAST

A detailed household survey was carried out to assess traffic demand. A detailed model was developed and calibrated and traffic demand forecast made based on land use planning and detailed surveys.

Summary of total boarding, passenger kilometers, average trip length and passenger km/km for various years is presented in **Table 0.3.1.**

Table 0.3.1
Summary of Transport Demand

Year	corridors	Daily Pass	length km	Pass-km	Av. Lead km	Pass km/Km in lakh
2011	Corr-1 (Airport to washermenpet)	318532	22.5	2632748	8.27	1.2
	Corr-2 (Fort - Anna nagar- Ring road- St. thomas Mount)	254144	21.3	2137984	8.41	1.0
	Total	572676	43.8	4770732	8.33	1.1
2016	Corr-1 (Airport to washermenpet)	403169	22.5	3280363	8.14	1.5
	Corr-2 (Fort - Anna nagar- Ring road- St. thomas Mount)	353297	21.3	2866624	8.11	1.3
	Total	756466	43.8	6146987	8.13	1.4
2026	Corr-1 (Airport to washermenpet)	542444	22.5	4575592	8.44	2.0
	Corr-2 (Fort - Anna nagar- Ring road- St. thomas Mount)	521605	21.3	4323905	8.29	2.0
	Total	1064048	43.8	8899496	8.36	2.0

The traffic demand by taking 5.2% growth rate (as indicated by govt. of Tamilnadu) is as follows:-

Year	2011	2016	2026
Total Trips (in Lakhs)	5.73	7.74	12.85

0.4 SYSTEM SELECTION

A. PERMANENT WAY

CHOICE OF GAUGE

Standard Gauge (1435mm) is invariably used for metro railways world over. During the last decade, many metros such as Cairo, Madrid, Bangkok, Manila, and Beijing etc. have been constructed in various cities of the world. All these metros have gone in for Standard Gauge even though the national gauge for mainline railways in some of these countries was different from Standard Gauge. In India the national gauge is Broad Gauge (1676mm).The reasons for selection of Standard gauge are described in the Detailed Project Report.

TRACK STRUCTURE

Track on Metro Systems is subjected to intensive usage with very little time for day-to-day maintenance. Thus it is imperative that the track structure selected for Metro Systems should be long lasting and should require minimum or no maintenance and at the same time, ensure highest level of safety, reliability and comfort, with minimum noise and vibrations. Ballastless track with long welded head hardened rails has been proposed as mainline track and in Depot, (except inside the Workshops, inspection lines and washing plant lines) in under ground and elevated stretches. The track will be laid with 1 in 20 canted rails and the wheel profile of Rolling Stock should be compatible with the rail cant and rail profile.

B. TRACTION SYSTEM

The alignment of proposed corridors is on elevated viaducts in southern section (near airport) of Corridor – 1. The height of metro structure including train heights needs to be restricted to less than 12 meter in air funnel area. Also 25 kV AC traction with overhead wires provides cluttered looks to the system. Keeping in view the ultimate traffic requirements, height restrictions, aesthetics, standardization and other techno-economic considerations, 750V dc third rail traction system is considered to be the best trade-off and hence, proposed. The third rail will be provided with suitable shrouds for safety of passengers as well as maintenance personnel.

C. SIGNALING AND TRAIN CONTROL

Metro carries large number of passengers at a very close headway requiring a very high level of safety enforcement and reliability. At the same time heavy investment in infrastructure and rolling stock necessitates optimization of its capacity to provide the best services to the public. These requirements of the

metro are planned to be achieved by adopting 'Distance to go' ATP (Automatic Train Protection) and ATS (Automatic Train Supervision) signaling systems.

D. TELECOMMUNICATION

The telecommunication system acts as the communication backbone for Signaling systems and other systems such as SCADA, AFC etc and provides telecommunication services to meet operational and administrative requirements of metro network.

The telecommunication facilities proposed are helpful in meeting the requirements for

1. Supplementing the Signaling system for efficient train operation.
2. Exchange of managerial information
3. Crisis management during emergencies
4. Passenger information system

The proposed telecom system will cater to the following requirements:

- Train Traffic Control
- Assistance to Train Traffic Control
- Maintenance Control
- Emergency Control
- Station to station dedicated communication
- Telephone Exchange
- Passenger Announcement System and Passenger Information and Display System within the station and from Central Control to each station.
- Centralized Clock System
- Train Destination Indicator
- Instant on line Radio Communication between Central Control and Moving Cars and maintenance personnel.
- Data Channels for Signaling, SCADA, Automatic Fare Collection etc.

E. AUTOMATIC FARE COLLECTION

Mass Rapid Transit Systems handle large number of passengers. Ticket issue and fare collection play a vital role in the efficient and proper operation of the system. To achieve this objective, ticketing system shall be simple, easy to use/operate and maintain, easy on accounting facilities, capable of issuing single/multiple journey tickets, amenable for quick fare changes and require overall lesser manpower. In view of above, computer based automatic fare collection system is proposed.

AFC system proves to be cheaper than semi-automatic (manual system) in long run due to reduced manpower cost for ticketing staff, reduced maintenance in comparison to paper ticket machines, overall less cost of recyclable tickets (Smart Card/Token) in comparison to paper tickets and prevention of leakage of revenue.

F. ROLLING STOCK

Rolling stock for Chennai Metro is similar to the one adopted for Delhi Metro. Rolling Stock has been selected based on the following criteria:

- Proven equipment with high reliability
- Passenger safety feature
- Energy efficiency
- Light weight equipment and coach body
- Optimized scheduled speed
- Aesthetically pleasing Interior and Exterior
- Low Life cycle cost
- Flexibility to meet increase in traffic demand
- Anti-telescopic

The controlling criteria are reliability, low energy consumption, lightweight and high efficiency leading to lower annualized cost of service. The coach should have high rate of acceleration and deceleration.

The following optimum size of the coach has been chosen for this corridor as mentioned below.

Size of the coach

	Length	Width	Height
Driver Motor Car	21.64 m	2.9 m	3.9 m
Motor/Trailer car	21.34 m	2.9 m	3.9 m

0.5 CIVIL ENGINEERING

GEOMETRIC DESIGN NORMS

The design parameters related to the Metro system described herewith have been worked out based on a detailed evaluation, experience and internationally accepted practices. Various alternatives were considered for most of these parameters but the best-suited ones have been adopted for the system as a whole. Horizontal curves are provided with

	Underground Section	**Elevated Section**
Desirable Minimum	300 m	200 m
Absolute minimum	200 m	120 m
Minimum curve radius at stations	1000 m	1000 m

Maximum permissible cant (Ca)	125 mm	125 mm
Maximum cant deficiency (Cd)	100 mm	100 mm

Underground sections

Rail level at midsection in tunneling portion shall be kept at least 12.0 m below the ground level so that a cover of 6m is available over the tunnels. At stations, the desirable depth of rail below ground level is 12.5m, Track centre in underground section to be constructed by Tunnel Boring Machine (TBM) is 13.05m to accommodate a 10m wide island platform.

Gradients

Normally the stations shall be on level stretch. In limiting cases station may be on a grade of 0.1 %. Between stations, generally the grades may not be steeper than 2.0 %. However, where existing road gradients are steeper than 2 %, gradients or for Switch Over Ramps upto 4% (compensated) can be provided in short stretches on the main line.

Design Speed

The maximum sectional speed will be 80 km/h. However, the applied cant, and length of transition will be decided in relation to normal speeds at various locations, as determined by simulation studies of alignment, vertical profile and station locations.

DESCRIPTION OF ALIGNMENT

NOTE: The following description is based on the DPR and is tentative. It may under go changes**.**

Corridor 1

The corridor- 1 starts from Washermanpet and ends at the Chennai Airport. Dead end to dead end length of Corridor is 23.055km, out of which 14.250km is underground, 0.200km is at grade (Switch Over Ramps) and remaining 8.605km is elevated. Total 18 nos. of stations have been planned along this corridor.

The alignment starts from old Washermanpet on southern side of old Washermanpet Railway Station, for reversal tracks have been extended from 400m toward north after crossing railway tracks.

On exit from Washermanpet station alignment passes under old Jail road at km 0.261 and runs under Seven Wells North and Bander Rama Garden localities, after having a left turn through 300m radius curve Alignment turns right at km 1.161 along Prakasham Road (Broadway). It passes under Broad way as well Esplanade road for a length of about 1.0 km.

At the end of Esplanade Road it turns right, passes for a short distances under

Muthuswami Road, enters Government Dental College and Hospital area and after crossing Frazer Bridge road, it enters old Bus terminal land (where Chennai fort station is proposed) before aligning parallel to the Government General Hospital Railway Station Road.

Corridor – 1 and Corridor –2 are parallel to each other on Government General Hospital Road for a length of about 500m. Corridor – 1 is underground, whereas Corridor – 2 is elevated. Chennai Central metro station is proposed under the parking area of Chennai Central Station. Location of Chennai Central Metro Station has been decided keeping in view its integration with Chennai Central Railway Station, Chennai Central Railway Station (Sub-urban) and Chennai Park Railway Station. Chennai Metro Station shall cater to the dispersal of local as well as long distance traffic.

Corridor further moves forward and after having left turn with 250m-radius curve, crosses Poonamalle High Road, Railway lines and align itself along Kuvam River. Egmore Station has been planned on the Western Bank of Kuvam River. It crosses Kuvam River in underground position at km 5.959 and aligns along Dams Road and after having a 210m-radius right hand curve aligns itself along Anna Salai (Mount Road). Further it runs below Mount Road and by the side of Gemini Fly over up to Adayar River. Alignment has been deviated from road on the approach of Adyar River to off road position on the East of Mount Road. It emerges out from under ground position and crosses Adyar River at Grade and achieves elevated position at Little Mount Junction. Further the Alignment runs upto Airport on center of Road except Guindy and Alandur where it is “Off road” position. Alandur is an interchange Station between corridor 1 & 2. A stabling area is provided at Trisulam opposite to Airport. Available ROW of Mount Road varies from 25m to 40m, which is sufficient to accommodate metro corridor. Detailed route alignment has been shown in the drawings ***No. RITES/CMRC/Chennai/2105-21-corr-1/Align.plan and L.S. Sheet 1 to 31***, which may be seen in the office of CMRL.

Breakup of Alignment length

Total Elevated length	=	8.605km
Total Underground length	=	14.250km
Total SOR length	=	0.200km
Total Alignment length	**=**	**23.055km**

Corridor 2

Corridor – 2 starts from Chennai Fort and ends at St. Thomas Mount. Dead end to Dead end Corridor length is 22.501 km. Entire Corridor is elevated. First station is Chennai Fort, which has been provided on Muthuswami Road, and last station is St Thomas Mount. Corridor leaves Muthuswami Road just after Chennai Fort station and runs on central median of Government Hospital Road & Periyar EVR Salai, up to Shenoy Nagar. It turns right along Pulla Avenue Road &

Thiru V. K. Park. It further takes left and aligns itself along 2nd Avenue Road of Anna Nagar and it reaches Tirumangalam after crossing Anna Nagar Roundtana. It further takes left at Tirumangalam Junction and follows central verge position on Jawaharlal Nehru Road up to Kuvam River.There is a proposal to modify the elevated alignment to underground from Thiru. V.K Park to Thirumangalam a distance of 4.5 KM, subject to the technical feasibility It turns right and runs on the Southern bank of Kuvam River. It turns left and aligns along the median of Tiruvalluvar Street in Koyambedu. It further take left turn and runs straight, crosses Kaliamman Koil street at km 13.016, passes over bus sheds of Moffusil Bus Terminal and aligns itself along the median of Jawaharlal Nehru Road at km 13.876. It follows road median path upto Ashok Nagar. It deviates from Central verge position beyond Ashok Nagar Station, turns left & then right (reverse curve) between km 17.576 to km 18.176, further it follows Jawaharlal Nehru Road median upto Adayar River, crosses this River on the Western side of existing Road bridge and it again takes central verge of Jawaharlal Nehru Road from km 19.126 onward. It runs straight after SIDCO Industrial Estate along Jawaharlal Nehru Road up to km 20.630 and places on the Southern Side of Kathipara Junction. It crosses to Mount Road at km 21.290 and aligns parallel to the Mount Road in Alandur Area where Alandur Station has been planned. It takes left turn beyond Alandur station and runs West of Railway Station Road up to St. Thomas Mount. Here it turns right and became parallel to the Southern Railway lines where St. Thomas Mount Station has been planned. Detailed route alignment has been shown in the drawings ***No. RITES/CMRC/Chennai/2105-21-corr-2/Align.plan and L.S. Sheet 1 to 32***, which may be seen in the office of CMRL.

Break-up of alignment length

Entire alignment is elevated and alignment length is 23.449 from dead end to dead end.

1. Inter Connection: Two corridors are proposed to be Inter connected at Alandur for transfer of rakes from corridor 1 to corridor 2 for taking to Koyambedu Depot.
2. Govt. of Tamilnadu also desired to consider the Anna Nagar section of corridor as underground, subject to the technical feasibility.

STATION LOCATION AND PLANNING

The Stations on the two corridors with their characteristics are as follows:-

Table 0.5.1
STATION LOCATION CHARACTERISTICS

Name of Station	Chainage (in km)	Distance from Previous Station (in km)	Rail Level (RL in m)	Height/ Depth from Adjacent Ground	Platform Type and Nos	Alignment Description

Name of Station	Chainage (in km)	Distance from Previous Station (in km)	Rail Level (RL in m)	Height/ Depth from Adjacent Ground	Platform Type and Nos	Alignment Description
Corridor 1 *Washermanpet - Chennai Central- Airport*						
1. Washermanpet (m)	0.0		-8.2	-12.009	Island Platform	Underground, straight
2. Mannadi	1560.2	1560.2	-10.5	-13.469	Island Platform	Underground, straight
3. Chennai Fort (m)	2888.5	1328.3	-10.0	-12.499	Island Platform	Underground, straight
4. Chennai Central (m)	3940.8	1052.4	-13.6	-17.203	Island Platform	Underground, straight
5. Egmore (m)	5101.1	1160.3	-11.5	-14.190	Island Platform	Underground, straight
6. LIC Building	6653.4	1552.3	-9.5	-14.096	Island Platform.	Underground, straight
7. Thousand Lights	7833.8	1180.4	-8.2	-13.853	Island Platform	Underground, straight
8. Gemini	8998.9	1165.1	-8.0	-14.569	Island Platform.	Underground, straight
9. Teynampet	10313.4	1314.5	-7.3	-14.069	Island Platform	Underground, straight
10. Chamiers Road	11582.4	1269.0	-7.0	-13.917	Island Platform	Underground, straight
11. Saidapet	13317.0	1734.6	-4.5	-12.482	Island Platform	Elevated, straight
12. Velacheri Road	14503.3	1186.3	20.5	12.382	2 Side Platforms.	Elevated, straight
13. Guindy (m)	15743.6	1240.3	24.0	13.468	2 Side Platforms	Elevated, straight
14. Alandur	17343.6	1600.0	23.9	9.343	Island Platform	Elevated, straight
15. Officer's Training Institute	18385.7	1042.1	28.6	13.382	2 Side Platforms	Elevated, straight
16. Indian Airlines Colony	20087.8	1702.1	26.7	11.838	2 Side Platforms	Elevated, straight
17. Meenambakkam (m)	20999.5	911.7	30.6	12.929	2 Side Platforms.	Elevated, partly in curve,
18. Chennai airport	22338.3	1338.8	22.4	8.918	2 Side Platform	Elevated, straight
Corridor 2- *Chennai Fort- Anna Nagar- St Thomas Mount*						
1. Chennai Fort (m)	0.0	-	16.500	13.642	2 Side Platforms	Elevated, straight
2. Chennai Central (m)	997.1	997.100	16.806	13.229	2 Side Platforms.	Elevated, partly in curve, r=1000m
3. Vepery	2205.0	1207.900	16.206	13.233	2 Side Platforms	Elevated, straight

Name of Station	Chainage (in km)	Distance from Previous Station (in km)	Rail Level (RL in m)	Height/ Depth from Adjacent Ground	Platform Type and Nos	Alignment Description
4. Shastri Nagar	3512.1	1307.100	17.924	12.302	2 Side Platforms.	Elevated, straight
5. Kilpauk Medical College	4429.3	917.200	19.802	13.515	2 Side Platforms.	Elevated, partly in curve, r=1150m
6. Aminjikarai	5718.0	1288.700	21.098	12.988	2 Side Platforms	Elevated, partly in curve, r=2000m
7. Shenoy Nagar	7000.0	1282.000	20.100	12.518	2 Side Platforms.	Elevated, straight
8. Anna Nagar- East	8003.2	1003.200	20.700	13.538	2 Side Platforms	Elevated, straight
9. Anna Nagar Tower	9257.5	1254.300	21.590	12.726	2 Side Platforms.	Elevated, straight
10. Tirumangalam	10150.8	893.300	22.640	13.020	2 Side Platforms.	Elevated, straight
11. Koyambedu	11987.0	1836.236	23.200	13.274	2 Side Platforms	Elevated, straight
12. Chennai Mofussil Bus Terminal (CMBT)	13407.1	1420.100	22.900	13.029	2 Side Platforms.	Elevated, straight
13. Arumbakkam	14941.4	1534.300	22.225	13.395	2 Side Platforms	Elevated, straight
14. Vadapalani	16014.8	1073.400	23.817	13.180	2 Side Platforms.	Elevated, partly in curve, r=1000m
15. Ashok nagar	17165.1	1150.300	22.405	13.365	2 Side Platforms.	Elevated, straight
16. K K Nagar	18312.5	1147.400	22.101	13.297	2 Side Platforms	Elevated, straight
17. Sidco Industrial Estate	19985.9	1673.400	22.461	13.224	2 Side Platforms.	Elevated, straight
18. Alandur (m)	21479.4	1493.464	29.400	14.843	Island Platform	Elevated, straight
19. St Thomas Mount	22478.6	999.200	19.700	8.782	2 Side Platforms	Elevated, straight

Geotechnical Investigations

A total of 75 Boreholes were carried out along the corridors. A separate geotechnical report has been submitted as part of DPR.

The area under study constitute a part of the Peninsular India, this is basically composed of Archean Rocks as well as fossiliferous rocks intercalated in some

places with marine beds of Neocomian age and earliest marine transgression beds of middle Cretaceous of Upper Albian age. These formations have been found intersected by Doleritic dykes and are covered generally with younger alluvium of varying thickness place to place from 3.00 m to 30.00 m or more at some places has found during investigation. The Archeans are generally composed of Granites and Gneisses of Peninsular Gneissic Complex, composition of duke is mainly Doleritic whereas sedimentary formations are mainly of shale and sand stone with or without fossiliferous beds. The general geological stratigraphic succession may be summarized as:

Recent	Younger Alluvium
Cretaceous	Shale and Sandstone intercalated with
	Fossilliferous marine beds
Precambrian	Dykes mainly doloritic
Archeans	Dharwar super group
	Charnockite series
	Unconfirmatory
	Granite & Gneisses

Utility Diversions

Besides the details of various aspects e.g. transport demand analysis, route alignment, station locations, system design, viaduct structure, geo-technical investigations etc. as brought out in previous chapters, there are a number of other engineering issues, which are required to be considered in sufficient details before really deciding on taking up any infrastructure project of such magnitude. Accordingly, following engineering items have been studied and described in this chapter:

- Existing utilities and planning for their diversion during construction, if necessary.
- Land acquisition necessary for the project both on permanent basis as well as temporary, including its break up between Government and private ownership.

Details of utility provided in the report are based on information provided by utility agencies and need to be physically verified before talking up construction work.

Land Requirements

Abstract of land requirements for different components of the project is given below. Most of the land proposed for the project is Govt. land.

Table 0.5.2
Summary of Permanent Land Requirement

Ownership	Purpose and Area of Land requirement in Ha.				Total (Ha)
	Corridor 1		Corridor 2		
	Station	Running	Station	Running	
Govt.open	9.19	6.41	39.01	2.46	57.07
Pvt RES	0.15	0	2.07	0.47	2.69
Pvt Com	2.11	0	2.65	2.53	7.29
Maintenance Depot	3.68		20.98		24.66
				Total	**91.71**

In addition to above 5.81 Ha Govt. land and 1.94 Ha Pvt. Land is required to be acquired Temporarily for construction depots. The details of land requirement is provided in the Detailed Project Report.

0.6 MAINTENANCE DEPOTS

Two depots are proposed in phase-I. The Koyambedu Depot-cum-Workshop will be the main depot and located on corridor 2. the second depot is at Minambakkam on corridor 1 for stabling & inspection. Koyambedu Depot-cum-Workshop will be used for stabling of Trains and other services, their cleaning, scheduled inspections, wheel re-profiling and minor & major repairs as well as Overhaul.

0.7 Train Operation Plan

Any public transport system, particularly a Metro system, is made attractive by providing high frequency service both during peak and off-peak hours. For this purpose 4 Car trains with different headways of 2.5 minutes to 15 minutes has been examined. The frequency can be brought down to 2.5 minutes in future depending upon the demand. The detailed train operation plan is provided in the report.

Salient Features of the proposed trains operation plan are :

- Running of services for 19 hours of the day (5 AM to Midnight) with a station dwell time of 30 seconds,
- Make up time of 5 -10% with 8 -12% coasting.
- Scheduled speed for these corridors has been assumed as 34 Kmph

The Capacity of each coach and trains is given below:

4 Car Train: 1038 Passengers (@ 6 persons per sqm of standee area)
6 Car Train: 1580 Passengers (@ 6 persons per sqm of standee area)

No. of coaches required

The no. of coaches required in the year 2011, 2016, 2026 are also given below. These includes operation and maintenance reserve.

Table 0.7.1

Coach Requirement

Corridor	Year	Headway (min)	No. of Rakes	Rake Consist	No. of Coaches
Washermanpet - Chennai Central - Airport	2011	4.5	23	4 car	92
	2016	3.5	30	4 car	120
	2026	3.5	30	6 car	180
Chennai Fort-Anna Nagar-St. Thomas Mount	2011	4.5	23	4 car	92
	2016	3	34	4 car	136
	2026	3	34	6 car	204

Total 184 coaches (92 coaches for Corridor 1 & 92 coaches for Corridor 2) are required in the year 2011.

0.8 POWER SUPPLY ARRANGEMENTS

Power Supply System

Power supply is required for operation of Metro system for running of trains, station services (e.g. lighting, lifts, escalators, tunnel ventilation system, signaling & telecom, fire fighting etc) and workshops, depots & other maintenance infrastructure within premises of metro system. The major component of power supply is traction requirements for elevated sections and auxiliary requirements for Underground section.

The power requirements of a metro system are determined by peak-hour demands of power for traction and auxiliary applications. Broad estimation of auxiliary and traction power demand is made based on the following assumptions:-

(i) Specific energy consumption of rolling stock – 70KWh/1000 GTKM
(ii) Regeneration by rolling stock – 20%.
(iii) Elevated/at –grade station load – initially 200KW, which will increase to 300 KW inclusive of Property Development loads in the year 2026.
(iv) Underground Station load – initially 2000 kW, which will increase to 2500 kW in the year 2026.
(v) Depot auxiliary load – initially 2000KW, which will increase to 2500 KW in the year 2026.

Keeping in view of the train operation plan and demand of auxiliary and traction power, power requirements projected for the year 2011, 2016 and 2026 are summarized in **table 0.8.1** below :-

Table 0.8.1
Power Demand Estimation (MVA)

	Year

Corridor		2011	2016	2026.
Corridor – 1 Washerman Pet – Chennai Central – Airport. [22.34km & 18 Stns. (11 U/G)].	Traction Auxiliary **Total**	10.3 31.4 **41.7**	13.2 32.1 **45.3**	18.9 39.7 **58.7**
Corridor – 2 Chennai Fort – Anna Nagar – St. Thomas Mount. [22.48 kms & 19 Stns.].	Traction Auxiliary **Total**	10.4 7.2 **17.6**	15.0 8.6 **23.6**	21.7 10.1 **31.8**

Table 0.8.2
Sources of Power Supply

Corridor	Grid sub-station (with Input voltage)	Location of RSS of Metro Authority	Approx. length of cables
Corridor – I Washerman Pet – Chennai Central – Airport.	GMR Vasavi (230 / 110kV)	Jail Complex (110 / 33 kV).	2km. 110kV (Double Circuit cables).
	Guindy Grid Sub Station (230 / 110 kV).	Adiyar **(110 / 33 kV)**	2km. 110kV **(Double Circuit cables).**
Corridor – II Chennai Fort – Anna Nagar – St. Thomas Mount.	Koyambedu Grid Sub station (230/ 110 kV).	Koyambedu Depot (110 / 33 kV)	1 km. 110 kV (Double Circuit Cables).

Auxiliary Supply Arrangements for Stations & Depot

Auxiliary sub-stations (ASS) are envisaged to be provided at each station. A separate ASS is required at each depot. The ASS will be located at mezzanine or platform level inside a room. Wherever TSS is required, ASS & TSS will be housed together inside a room. The auxiliary load requirements have been assessed at 300 kW for elevated/at-grade stations. Accordingly, two dry type cast resin transformers (33/0.415kV) of 400kVA capacity are proposed to be installed at the stations (one transformer as standby). Both the Depot ASSs will also be provided with 2x2500 kVA auxiliary transformers. For Underground station, the auxiliary load requirements have been assessed at 2500 kW, accordingly, three dry type cast resin transformers (33/0.415kV) of 1600kVA

capacity are proposed to be installed at the stations (with one transformer as standby).
Initially, 1x2.5MW transformer-rectifier set shall be provided in each TSS with space provisions for an additional set to be accommodated in future as and when train composition is increased to 6 coaches beyond 3 minutes headway. Self-cooled, cast resin dry type rectifier-transformer is proposed, which is suitable for indoor application. From the traction sub-stations, 750V dc cables will be laid up to third rail and return current cables will be connected to running rails.

Supervisory Control and Data Acquisition (SCADA) System

The entire system of power supply (receiving, traction & auxiliary supply) shall be monitored and controlled from a centralized Operation Control Centre (OCC) through SCADA system. Modern SCADA system with intelligent remote terminal units (RTUs) shall be provided. Optical fiber provided for telecommunications will be used as communication carrier for SCADA system.

Energy Saving Measures

Energy charges of any metro system constitute a substantial portion of its operation & maintenance (O & M) costs. Therefore, it is imperative to incorporate energy saving measures in the system design itself. The auxiliary power consumption of metros is generally more than the traction energy consumed by train movement during initial years of operation. Subsequently, traction power consumption increases with increase in train frequency/composition in order to cater more traffic. Following energy saving measures are recommended :

(i) Lightweight and Modern rolling stock with 3-phase VVVF drive
(ii) Regenerative braking
(iii) Effective use of natural light at stations and sectioning of load
(iv) Machine-room less type lifts
(v) Energy efficient, auto sensor escalators with 3-phase VVVF drive
(vi) Energy efficient electrical equipment (e.g. transformers, motors, light fittings etc)
(vii) SCADA system for energy and power factor control.

0.9 VENTILATION AND AIR-CONDITIONING SYSTEM

The proposed alignment has an underground section of about 14.25 km. This would include 11 underground stations the Ventilation and Air-conditioning (VAC) system requirements for the underground sections of the proposed Chennai Metro alignment. It includes the following:

- Station Air-conditioning System
- Ventilation System for station plant rooms (ancillary spaces)
- Station Smoke Management System
- Tunnel Ventilation System

VAC system design parameters are assumed in the present report.

(1) Outside ambient conditions:

This is based upon ASHRAE recommended design conditions for 2% and 1% criteria, as under

	2% Criteria	**1% Criteria**
Summer :	36.0 DB, 25.2 WB	37.0 DB, 25.2 WB
Monsoon :	31.4 DB, 27.5 WB	32.0 DB, 27.9 WB

- For Chennai Metro Underground Corridor it is suggested to use 2% criteria, which is defined as the conditions, when the DB or WB temperatures are likely to exceed for only 2% of the total time.

(2) Inside design conditions:

Platform areas	-	27 deg. C at 55 % RH
Concourse	-	28 deg. C at 60% RH

(3) Tunnel design conditions

Normal conditions	–	Max. DB 40 deg. C
Congested conditions	--	Max. DB 45 deg. C

(4) Minimum fresh air - 10 % or 18 cmh / person (in station public areas).

0.10 ENVIRONMENTAL IMPACT ASSESSMENT

Provision for environmental impacts of this METRO corridor has been made to cover various protection works, additional compensatory measures, compensation for loss of trees, compensatory afforestation and fencing, monitoring of water quality, air/noise pollution during construction, establishment of Environmental Division. The cost for Environment Management plan has been included in the project cost.