

Pre-Feasibility Report for Bus Rapid Transit System for Mumbai

1.0 Introduction:

Mumbai's bus services, BEST, caters to the road based travel demands of the city. It carries around 4.5 million passengers per day, which is about 50% of the total population that uses public transportation, with its fleet of 3400 buses. Though BEST tries its best to meet the demand for its services, it has not been able to exploit its capacity to the optimum. One major reason being BEST has to compete with other traffic for the right of way. Eventually, the bus services operate at sub-optimal levels because of the highly



*Bus Speeds curtailed by other traffic**

congested operating conditions, and are losing passengers to private modes of transport such as cars and 2-wheelers. In order to stem this counter flow, the Government of Maharashtra has decided to introduce Bus Rapid Transit Systems (BRTS) on all major arterials and on the Eastern and Western Express Highways, to start with. Improved operating conditions and better quality of service and ride are expected to wean away a substantial proportion of the commuters who have shifted over to other modes. The worldwide experience shows that BRT in fact results in higher public transport ridership, purely by its merits.



*Bus Speeds curtailed by other traffic**

Given the widely varying nature of Mumbai in the Island and the Suburbs, the nature of the BRT designed and provided will vary in the Island and the Suburbs. Since the availability of land is not much of a constraint in the suburbs, provision of all necessary cross sectional components for a full BRT will not be a problem in the suburbs. However, given the mature and densely developed character of the Island City, the BRT provided may be partial one, since all necessary cross sectional elements may not be available. In the Suburbs too, except on Highways and certain East- West connectors, BRT will be a truncated version. While it is recommended that BRT be provided throughout the City and its suburbs, the character of BRT provided will change from the Suburbs to the Island City.

**Picture credit: Paper on "Pilot Project on Dedicated Bus Lane, Case for Bus Rapid Transit in Mumbai": presentation to the MTSU by the MMRDA, 9th December 2006*

In the suburbs, the BRT will operate along the median. The median is the separation between the 2 directional flows of traffic, and the lanes that run alongside the median are called ***median lanes***. This will be a ***full BRT***, with complete segregation of the BRT lanes from the rest of the traffic, completely grade separated access to the BRT stations, priority signals, and fully redesigned junctions to accord priority to the BRT. The BRT Stations will be in the middle of the carriageway, as shown in the accompanying conceptual sketch, on the median.

In the Island City, due to narrow roads, it will be difficult to reserve 2 lanes next to the median for the BRTS. Moreover, the roads are of limited width, and the properties are abutting the footpaths, with no possibility of widening the roads, and there is continuous access to adjoining properties from the left lane. In this case, it will not be possible to provide the same quality of BRT as is suggested above for the suburbs, as a totally segregated system. The medians are also not wide enough to accommodate a Bus Station, and it will therefore become necessary to use the existing bus stop facilities on the footpaths on either side. The left lane cannot be barred to local traffic as they will need to enter / exit the adjoining properties, and so it will not be possible to restrict this exclusively for the buses. ***It will therefore be necessary to use the 2nd lane from the footpath, for the BRT operations in the Island.*** This lane will be a Dedicated BRT lane, and other forms of traffic will be banned from using it. The buses will then weave left from this lane, exactly as is currently being done, in order to reach the bus stops. The Island BRT will therefore be a sort of truncated version of the Suburban BRT.

While the full BRT can be designed on both the Western and the Eastern Express Highways, the arterial roads in the suburbs and the Island City that are identified as potential routes can also be designed to have this partial or truncated BRT. In cases where the available road width is limited, supplementary or secondary road networks can be identified to accommodate the volumes of personal modes. This is possible even in the Island City, where the road network is more organic in nature.

1.1 Need for BRTS:

BRTS is a relatively low cost and flexible system, which can be introduced in an incremental manner over a period of time. The benefits of BRTS are:

- It moves very large volumes of people rapidly at high speeds in segregated, dedicated road corridors, eliminating delays due to congestion.

Mumbai has heavy traffic loads virtually round the clock in most areas of the city and suburbs. The delays to this volume of commuters because of congestion are tremendous.

1. With higher disposable incomes and longer distances that need to be traveled, people will be willing to pay a higher fare if the system delivers better speed and better comfort than the current buses and trains.
2. Unlike the Metro, BRTS demands dedicated space on the road. In certain areas, the frequency of the buses is so high that they warrant an exclusive lane right away.

3. In the context of Mumbai, BRTS can achieve a modal shift from cars, reducing existing congestion on the roads. This can be achieved through higher speeds of BRT.
4. A preliminary assessment indicates that BRT can be a self- financing proposition on certain corridors.
5. The cost of each bus stop and allied infrastructure will be anything between Rs. 2 to Rs. 4 crore per km for Western Express Highway. We are ignoring the cost of BRTS buses from this figure since they can earn more than the cost of servicing the loans for acquiring the buses in an incremental fashion.

Bus Rapid Transit is not expected to replace the Metro or the Suburban Railway System. These 2 forms of mass transportation have a very clear role to play in the transportation scenario of Mumbai. They serve the long haul movements, carrying much heavier volumes of traffic at a much higher operating speed than that of road based mass transportation. Road based mass transportation caters to the needs of the medium trip length. All these forms of mass transportation are expected to form an hierarchy of mass transportation systems, meeting the desire for movement of the city as a composite whole.

1.2 Core Working Group:

A pre-feasibility study for introducing BRTS was recommended by Shri G. S. Gill, Principal Secretary, Transport, and the following persons were inducted in a “Core Working Group on BRTS”:

- Shri A.K. Jain, I.A.S., Project Manager, MTSU
- Mrs. Bina C. Balakrishnan, Transportation Consultant, MTSU
- Shri Ashok Datar, Chairman, MESN
- Shri R. Ramana, Sr. Transportation Planner, MMRDA
- Shri Shailesh Mehta, Ex. Engineer (Traffic), MCGM
- Shri Victor Solomon, Sr. Traffic Officer (Projects) BEST
- Shri Sudhir Badami

The terms of reference of the Core Working Group were:

- to assess the feasibility of introducing a BRTS in Mumbai
- to identify the corridors on which it is to be introduced
- to identify the elements of the BRTS required for Mumbai, and the possibility of locating them on the selected routes
- to draw up the terms of reference for the consultants to be appointed for the Feasibility Study and the DPR.

The Core Working Group (CWG) was formed on the 19th of January 2007, and the first meeting was held immediately after this. The Pre- Feasibility Report was to be submitted on 6th February 2007. The Group met about twice a week during this period, in order to finalise this report.

Mumbai's road network has 5 clearly defined North- South corridors that channel traffic and commuters from the northern Suburbs to the CBDs in the South, and vice- versa. Of these, the Eastern Express Highway and the Western Express Highway are the most well planned and constructed, with a minimum of 5 lanes in each direction, now being developed into 14-lane carriageways (including service roads) under MUIP. Considering the availability of Right of Way, it was decided to examine these 2 routes to introduce BRTS.

A field visit was also organized on the 25th of January 2007, and the field team traveled the length of the 2 routes, identifying all the stops, the availability of land within the right of way for locating the BRTS Stations, and the existing constraints on the routes.

Of the 2 Highways, the Western Express Highway is currently the main roadway arterial that connects the southern tip of Mumbai with its suburbs as well as the extended suburbs. It is also the more heavily trafficked, having better roadway geometrics, riding quality and better junction controls with linked signals, providing a partial green channel along its length. Starting a BRTS on this route is therefore expected to have greater acceptability, with a larger volume of commuters than on the EEH. It was therefore decided to recommend starting the BRTS as a full fledged service, with segregated bus lanes, pre-ticketing, and single ticket facility and grade separated passenger access to the bus stations, on the Western Express Highway.

The Eastern Express Highway would be started with a Dedicated Bus Lane, operating in the middle lane, and utilizing all the existing stops on the kerb –side of the roads. This Bus Priority Lane is expected to improve the operations of the BEST on this route, before the system can be upgraded to a full BRTS like the one proposed for the WEH.

2.0 Western Express Highway (WEH):

2.1 Type of Lane & Segregation



*Uni-directional BRT**

The experience globally has been that BRTS works efficiently only if it is operated with a continuous network and a dedicated right of way. It was accordingly decided to consider the BRTS operating in the median lanes of the WEH.

On the Western corridor, the BRTS lane should be fully segregated, with 2 lanes being clearly separated out from the rest of the traffic on either side, by installing unmountable kerb-stones, suitably designed. The total width of BRT lanes to be available should be a minimum of 5.5 mtrs, which will provide for overtaking of the buses also, if necessary.

The WEH main carriageway has an average of 5-6 lanes in each direction, with a median of average width 1.5 metres, and 2- lane service roads on either side. It was decided to exploit this available median width to locate the BRTS Stations, and take the additional width required to accommodate a 3.0 meter wide platform at the stations by bulging the carriage way outwards. At the edge of the roadway, this will then need to take away an equivalent width from either the verge where present, or from a part of the footpath.

However, as the calculations below show, this excess width required is on an average only about 40 cms, and can easily be accommodated within the existing Right of Way.

Given an average lane width of 3.3 mtrs,

Width of 2 lanes existing	= 6.6 mts
Width of median	= 1.5 mts
Therefore, width of land available	= 8.1 mts

Minimum width of bus lane required	= 5.5 mts
Width of platform required	= 3.0 mts
Total width of land required	= 8.5 mts
Shortfall	= 0.4 mts

Constraints where existing, were also marked in the field study, with regard to location of storm water drains, etc.

**Picture credits : H.N. Josserand: "Public Transport and Bus Priorities: Main Characteristics and issues": paper presented at the Seminar on "Bus Rapid Transit System for Mumbai", Mumbai, 9th December 2006*



** Provision for Overtaking at BRT Station*

2.2 Type of Buses:

Buses having wide doors of at least 1.50 mts width, without a central bar that permit rapid clearance of commuters is recommended. The platform height can be adjusted to be flush with the floor level of the bus, to affect ease of boarding and alighting. These buses should have their doors on the right side of the vehicle, so that they can be operated in the conventional direction of flow.

The control of the gate operations should be with the driver, so that he maintains control of the passenger movement. It is desirable that these doors are hydraulically operated. The availability of such buses can be obtained from the Airports Authority of India (or MIAL in Mumbai).

2.3 Location of BRTS Stations:

A study of the alignment of the WEH also revealed that the entire length of the section has been provided with grade-separated pedestrian crossings in the form of subways, as well as with flyovers over junctions that handled heavy vehicular traffic. Location of the BRTS Stations therefore become rather constrained, as it is necessary to locate them in such a way that adequate braking distance is obtained after descending from a slope of the flyover, to stop at the last slot of the station. Several of the stops identified during the field visit therefore had to be dropped or combined with other stops, in order to meet with this requirement.

An additional factor that was considered in the selection of the stops was its proximity to the suburban railway stations. These are major catchment points, where commuters transfer to another mode in order to reach their destination.

The names of the locations finally selected for siting the BRTS Stations are as below. The details of the stops with the distance between them and their proximity to the nearest suburban railway station are given in Annexure- 4.

1. Kalanagar
2. Cardinal Gracias: after Kherwadi Flyover

**Picture credits : H.N. Josserand: "Public Transport and Bus Priorities: Main Characteristics and issues": paper presented at the Seminar on "Bus Rapid Transit System for Mumbai", Mumbai, 9th December 2006*

3. New Agripada
4. Milan Subway Stop
5. Hanuman Road
6. Gundavli
7. Ismail Usuf College
8. Vanrai College
9. Virwani Indl Estate
10. Bandongri (Khandivli Police Station)
11. Dattani Park
12. Onkareshwar Park (National Park):

2.4 Facilities to be provided:

All the above stops are to be designed as per the following specifications, and are to accommodate the following facilities:

- Length of BRTS Station: 50 meters, to accommodate 3 bus stops in each direction, and staggered, as shown in the accompanying sketch, each 15 meters long, with 2.5 mtrs gap between each;
- Access is to be permitted between the platforms for the 2 directions of movements, so that passengers can change direction if required.
- Width of BRTS Station: 3.0 mtrs wide, to be fitted over available median width, and the remaining width required to be carved out from the adjoining lanes;
- Wherever possible, considering the availability of land, it is desirable to increase the width of the platforms to 4.0 m.
- Height of platform 1.20 mtrs, or as required to be flush with the floor of the buses.
- All BRT Stations to have grade- separated access, by and large through skywalks only.
- All skywalks should be provided with escalators in the up-direction.
- Where available, all subways will provide through access to pedestrians who do not have a destination in the BRTS station

- Toilet and drinking water facilities are not to be located on the platforms. However, these may be located at some suitable point in the vicinity of the BRT Stations.
- A meter room and power supply will need to be accommodated in the Stations.
- All bus stations are to be provided with Real Time Passenger Information Systems / Bus Arrival Information Systems / Public Address Systems.

2.4.1 Skywalks:

Skywalks are to be provided at each BRT Station, and all Ticketing Counters are to be located on these skywalks, as shown in the schematic diagram. Ticketing is to be provided at two places on the skywalk, for both the directions of movement, to facilitate the commuters and prevent bunching on the skywalks. All Skywalks will also need to have at least one Coupon Validating Machine on them.

The Skywalks are to be provided with escalators in the Up direction, to facilitate access to the stations, as well as to ensure that jaywalking is discouraged. The downward movement can be provided by standard width staircases, which will also provide the emergency exits. Wherever possible, a lift is also to be provided as handicapped access to the facility.

It is desirable to integrate these Skywalks with nearby suburban stations and other catchment areas.

2.5 Bus Routing and Scheduling:

The BEST routes today perform both the feeder/ dispersal as well as the trunk route operations. A BRTS operates most efficiently when it runs as a Trunk Service to another Feeder / Dispersal Service. The existing BEST routes will therefore have to be redesigned into a Trunk and Feeder service, prior to the launch of the BRTS.

It is very essential for BEST to have proper feeder services to the BRTS alignment. They should also examine the possibility of feeding the BRTS through the other routes that run along the highway at different stretches. BEST should either carry out the study in-house or appoint consultants for carrying out the study. However, it should ensure that the study is completed within 6 months. BEST should also examine the possibility of carrying out the study through the MMRDA.

There should also be exclusive BRTS services to the airport such as ‘baggage bus’, with convenient transfer facilities for passengers with luggage. Additionally, instead of having

all the buses terminate at the same point, it would be desirable to have several termini in the northern and the southern ends of the route, so that the catchment area of the BRTS is widened.

The consultants will also have to examine the possibility of extending the BRT into the Island City. However, it is possible that the character of the BRTS would be slightly truncated, depending upon the ground realities. They should examine the possibility of a Dedicated Bus Lane to be provided on all the major arterial roads of the metropolis, being connected with the full BRTS on the Expressways.

2.6 Terminal Facilities:

The fleet of BRT is required to be operated in an optimum manner, with least amount of dead mileage and turn around time. While BEST may not find adequate area to create the terminal facilities at either end of the BRT corridor, the existing terminals such as Bandra West, Dharavi, Rani Laxmi Chowk (Sion), Anik Bus Depot towards the Southern end, and Dahisar Depot, Magathane and Mulund Bus Depots may be suitably utilized for terminal facilities, including staff scheduling / changeover, maintenance and cleaning of the fleet. These can also become additional catchment areas where “Park and Ride” facilities can be encouraged.

2.7 Phase 2 for WEH:

The BRTS as detailed above would only be serving the Suburbs partially, and it is necessary to consider it being extended to the rest of the Suburbs and the Island City. In a citywide BRT system, this should ultimately be connected / integrated with the major suburban stations such as Churchgate, CST, Dadar, Wadala, Bandra, Andheri, Borivilli, Mulund and Thane. The expansion of BRT onto the other major arterial roads and redesigning of the system, suiting the local requirements and constraints, should be handled as Phase 2 of the BRTS. The site constraints in the Island City are very different from that of the suburbs, and therefore the design and operating conditions need to be treated differently. The BRTS in the Island would in fact probably be a partial BRTS, since a large number of the sectional requirements would not be attainable here. Additionally, instead of having a partial BRTS on several roads in the Island, it would be worth considering if an entire road, viz. Senapathy Bapat Marg or Dr. B. Ambedkar Road, could be made over for the exclusive use of BRTS, while the rest of the road network is left for the undisturbed use of cars and other personal modes of transport.

The final objective should be a continuous access to BRT throughout the region, with cross over points being well designed where the character of BRT changes, such as at Mahim, etc

2.8 Scope of Work for the Consultants:

The Scope of Work for the consultants should include the following aspects. The objective will be to get at least one line operational by the 15th of August 2007.

The Consultants will be required to:

- Identify and finalise the limits of the 2 corridors, and explore the possibility of extensions to the same in the next phase, both Southwards into the Island City as well as further Northwards
- Provide the complete engineering design of the routes identified, including;
 - o Identify the ideal locations of the BRTS Stations, in the broad localities identified in this report, keeping in mind the requirement of *minimum stopping distance* required from the ends of the flyover, for the design speed of the BRTS
 - o Design of the geometrics of the BRTS lane, for best possible operating conditions, without sacrificing any aspect of safety
 - o Decide the nature of barriers to be installed for the demarcation of the lanes.
 - o Detailed engineering design of all junctions along both routes
 - o Complete signal designs, and use of Vehicle Actuated Signals for the BRTS lanes
 - o Location and design of all bus stops enroute, within the broad framework given in this Report
 - o Decide what the optimum spacing of the stops enroute should be
 - o Design Bus stops to include all necessary pre-board facilities, such as pre-ticketing, Coupon Validating Machines, if necessary, passenger information systems, Smart Card Readers, etc.
 - o All necessary facilities shall be accommodated within the existing Right of way to the extent possible, and no acquisition of land will be possible
 - o Prepare detailed Cost Estimates and Bid Documents
- Formulate BRT Routing and Scheduling by suitably modifying the existing BEST routes into Trunk and Feeder System, if required
- Design the optimum frequency of the Trunk Services and the Feeder Services
- Give guidelines for integration of BRTS with other forms of transport
- Give the detailed costs of implementing the system, including costs of civil works such as reserved lane, Foot over Bridges, stations, etc; fixed assets, and fleet costs, including cost of additional buses, operating staff and maintenance facilities
- Examine enforcement issues related to the reserved lane
- Verify the availability of additional parking at terminal areas, and other stops, for provision of Park and Ride facility
- Provide ticketing facilities, drinking water fountains, toilets in the vicinity of the terminals, or as shown in the schematic drawings in Annexure- 2

- Examine all other existing proposals for the study areas by other agencies such as MMRDA, MCGM, PWD, MSRDC, etc. and ensure that no conflicts arise regarding proposals

The Area Traffic Control project involves 53 junctions in the 1st phase and 200 in the 2nd phase, within a period of 25 months. These junctions have been designed in detail along with complete geometric designs. The Consultant will examine those that fall within the BRT route and ensure complete synchronization with the MCGM on these.

In order to ensure compliance from the public, the people need to be educated with regard to BRT lane discipline. The consultant will also examine ways to achieve this.

3.0 Eastern Express Highway (EEH):

The Core Working Group decided that BRTS could be introduced on the EEH, after it is successfully launched on the WEH. As a pre-cursor to the BRTS on this route, however, a Dedicated Bus Lane could be carved out of the existing roadway, in order to give priority to buses. This in itself is expected to improve the operating speeds of the buses to a substantial extent. This lane will be the middle lane, as is currently being used by the buses, and the buses will weave to the kerb-side lane in order to access the bus stops that are currently located on the footpaths. These lanes will be marked with a Yellow Unbroken Line, Cat's Eyes as well as Spring Bollards, and will be tidal in nature: - Southbound in the mornings and Northbound in the evenings. This could be expanded into a full BRTS in the next phase.

4.0 Recommendations:

The recommendations of the Core Working Group on BRTS for Mumbai are therefore as under:

1. Introduce BRT on 2 corridors – i.e. the Western Express Highway and the Eastern Express Highway- in the suburbs at the earliest and then extend this to the rest of the city in phases
2. BRT is to be developed as a highly dependable system with very high level of service and frequency
3. Road User Charges should be reviewed with a view to encourage bus travel
4. Parking fees and regulations need to be reviewed in order to create additional space on roads and give priority to buses
5. Develop SATIS so as to optimize on BRT and current BRT operations
6. The Government may also examine the possibility of revising the Notification suitably, to permit BEST to charge a higher fare for a premium service like the BRT
7. Appoint a Consultant for detailed design of the BRT System and preparation of Bid Documents.

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Recommended BRTS Stops on WEH

The following stops are recommended for the BRTS in the section between Daravi Bus Depot and Dahisar Bus Depot.

1. **Kalanagar Stop:** First stop on left on Sion- Bandra Link Road, at 50 mtrs before the junction beneath the Kalanagar flyover. The underbelly of the flyover will also be used to accommodate the bus stop facility, to be located 50 mtrs after the junction. Skywalk access also to be provided to the facility, from Bandra Station. Extension of A. Khanekar skywalk to be considered upto this facility. Enough space on left of flyover to accommodate a bus lane as well as Skywalk foot.

2. Cardinal Gracias: after Kherwadi Flyover

3. New Agripada

4. Milan Subway Stop

5. Hanuman Road

6. Gundavli

7. Ismail Usuf College

8. Vanrai College

9. Virwani Indl Estate

10. Bandongri (Khandivli Police Station)

11. Dattani Park

12. Onkareshwar Park (National Park): At this point the bus does not take the flyover, uses the road at grade, utilizing the space under the flyover for the facility, and then proceeds to the next junction, where they turn right to Dahisar Bus Depot.

This depot should be designed as a terminal to accommodate all facilities for collecting commuters and ticketing. This should be connected to the highway through skywalks.

BRTS route to feed airport also, as well as railway stations. Routes to be designed accordingly, with transfers to be designed for various routes to permit transfers. BRTS routes to be spread out between Dharavi Bus Depot, B/K Complex and Bandra East.

Report of the Field Trip on 25th January 2007

A field trip was organized by the MTSU in order to examine the feasibility of introducing BRTS on the two routes selected – the Eastern Express Highway (EEH) and the Western Express Highway (WEH). The objectives were

- to determine the availability of adequate Right of Way to locate the necessary system facilities of the BRTS
- to verify the existing facilities that could be used towards the BRTS.

The two corridors were traversed in detail, starting at about 11.30 am and concluding at 7.30 pm, and the locations of all the stops en-route as suggested by the BEST studied for all cross sectional components required for the BRT System.

A section wise detailed report is given below.

Present on the Field Trip:

1. Mrs. Bina C. Balakrishnan, Transportation Consultant, MTSU
2. Mr. Shailesh Mehta, Ex. Engineer (Traffic), MCGM
3. Mr.P.D. Vadhavkar, CTM (P & D), BEST
4. Prashant B. Kanthe, Dy. Transportation Planner, MMRDA
5. Mr.B.M. Nair, Traffic Officer, (Planning), BEST
6. Mr.U.M. Mahajan, Sub- Engineer (Traffic), MCGM
7. Mr. S.C. Pathare, Sub-Engineer (Traffic), MCGM
8. Mr. Pankaj Khandke, Sub- Engineer (Traffic), MCGM

Note: All measurements were visually approximated by the team, but are expected to be accurate within a range of +/- 10%

Eastern Express Highway:

BRTS recommended from Dadar Khodadad Circle to Cadbury Junction, Thane.

1. Khodadad Circle:

The buses are expected to start from the Wadala Bus Depot and enter the dedicated lane from under the flyover. The stop on the Western side is recommended by the BEST to be 100 mts from the junction, and the bus stops to be located on the kerb-side, because of the touch down point of the flyover. In this case, the BRT lane should start only from the Ruia College junction. However, we feel we need to explore the possibility of using the underbelly of the flyovers for locating the bus stops in such cases. The BRT lane then can start directly from the junction.

On the Eastern side of the road, the bus stop will need to be located on the kerb-side, since the bus will then have to make a left turn to return to the depot. The BRT lane will therefore have to be terminated at the junction before this- i.e .the Ruia College Jtn.

2. Maheshwari Udyan:

The median is wide enough for the bus stops to be placed in parallel rather than in series, and the footpaths are wide enough for locating the skywalk foot. There are a couple of temples on the Western side that should not be obstructed by the skywalks; they can however, benefit from the skywalk location.

There is a proposal for a flyover at this point, and we will need to get the details from the MSRDC.

3. Sion Hospital

The median lane between Maheshwari Udyan and Sion Hospital is raised because of drainage, and this will need to be taken into account during the BRT lane construction. The median is wide enough – 3.0 m - to accommodate a bus stop, and the footpath is about 3.5 mts on the western side.

4. Everard Nagar:

There is a 3.0 meter wide subway at this location, the median is 1.2- 1.5 meters wide, but there is a service road that can be used

5. Postal Colony:

There is a median of 1.2 mts width, a service lane and a footpath wide enough to accommodate all required facilities

6. Chedda Nagar:

Median 1.2 m wide

Sewer line existing to be considered in design. Existing footpath over sewer line, so unavailable for skywalk. Need to consider locating skywalk closer to the kerb

7. Ramabai Nagar:

Median 2.5 mts wide. Ample land available for all facilities, but there is a sewer line and storm water drains to be considered. In addition, there is a nullah by the side that needs to be considered, and it is felt that the bus stop should be located after the nullah.

8. Kannamwar Nagar:

Existing FOB of 3 mts across the road may be utilized as a skywalk, after proper upgradation. This is a steel structure, so modifications are easy. The stairs provided are 3.0 mts wide. The deck can be extended to locate the ticketing booths if required. There are sewer, storm water drains running alongside this section

9. Navgarh Junction, Mulund:

There is a proposal for a flyover here, in addition to a subway. These proposals are with the MMRDA, and need to be examined before the BRTs stop can be located. If the subway is being constructed, then this needs to be provided with access to the proposed bus stop; alternately, the subway can be replaced by a skywalk, and serve the same purpose.

10. Gyansadan College:

There is an existing FOB here. There is also a temple on the Eastern side that may cause conflict with the land available and required. However, there is a service lane that can be utilized, and the junction geometrics need to be redesigned. The approach bridge is only 2-lane, and this will also need to be widened. Inspection from beneath the bridge showed that there was enough space to widen the bridge with at least another 2 lanes, but there was a large water main running alongside that would need to be considered as a major constraint. In addition, the bridge runs over railway tracks, and any modifications will involve the Railway Authorities also.

11. Louis Wadi:

Median 1.0 mts wide. Buffer strips are well designed on both sides, and service lanes are also provided. There is an FOB also at this point.

12. Cadbury Junction:

Terminal point. The buses will unload and make a U-turn under the bridge to the other side and proceed towards Mumbai. In this case, we can use the underbelly of the flyover to locate the bus stop.

Observations of the EEH:

It is possible to install the necessary infrastructure along the EEH, and operate a BRTS efficiently on this route. The BEST feels there is a need to locate a terminal at this end, but it is possible for the drivers to refresh themselves at the bus stops, which can be provided with necessary facilities.

Western Express Highway:

The buses will originate from Dahisar Bus Depot which can handle conventional buses. The flyovers on this route have ample room beneath them to locate all the bus stops, but in this case, the buses will not be using the flyovers. The assessment has therefore been made from the position that buses should be allowed to use the flyovers.

Should we decide to use the space beneath the flyovers, then these will have to be fed by subways, in which case we need to examine the details of the foundation, the spacing of the footings, etc. to locate the subway. These details will be with the PWD.

There are pedestrian subways along the length of the route. If this is to be used to feed the bus stop, then the roof slab will need to be cut to permit this entry. These aspects will need to be looked into.

Footpaths all along this route are obtained by covering open drains with a slab. It will therefore not be possible to cut into this space for the additional width required at bus stops. Moreover, locating the foot of the skywalk at these points becomes very difficult.

1. Dahisar:

Check post at Dahisar after the depot. Median is only 1.0 m wide, but there is ample width on both sides for locating facilities.

2. National Park Flyover

Stop to be located towards the south of the flyover. Although more passengers will be available at this point, there is inadequate width at this point, and the flyovers are located too close together to get the necessary braking distance and also the length of the bus stops plus the taper.

3. Devi Pada

South of the National park Flyover; the median is only 1.2 m wide, but the road is in cutting, and another flyover starts here.

4. Telephone Exchange, Magathane

Median 1.0 m wide. Land width constraints because of open drains on both sides; unable to find space to locate the feet of the skywalks. However, ample land is available at Thakur Complex further south.

5. BHAD Colony/ Mahendra & Mahendra

Flyover under construction. Enough room for skywalks, but location of bus stop is a problem.

6. Bandongri

Severe constraints, bus stop not possible.

7. Pushpa Park

Heavy commuter concentration, but severe land constraints. Alternative site to be found.

8. Kurar Village

Median 1.0 m wide. The road is in cutting on one side. There is a service road on Eastern side that can be merged to get the necessary width. However, it may not be possible to get all the necessary geometrics in place.

9. Dindoshi

Existing subway, land width constraints

10. Virwani Industrial Estate

Land available on the Eastern side. Median is only 1.0 m wide. The bus stops can be arranged in parallel instead of in series, and skywalks can also be located here. Possible location for BRTS stop.

11. Vanrai Colony

Land available on both sides, Subway in place currently. Bus stop to be on top of subway. Use of subway to be mooted.

12. Ismail Usuf College

Recommend location to be shifted further southwards. There is a subway at Shankarwadi, however.

13. Gundawli

Another subway, with a low rise bridge. As usual, all the footpaths are on storm water drains.

14. Hanuman Road

Median 1.5 m wide. Subway present. Landwidth constraints.

15. Centaur Hotel, Santa Cruz

Median 1.5 m wide. Proposed flyover at this location. Landwidth constraints

16. New Agripada

Median 1.5 m wide. Pedestrian subway. Footpath over drains, service roads existing on both sides.

17. Cardinal Gracias School

Median 1.5 m wide. Land available from part of footpath for required width. Possible location of bus stop.

18. Kherwadi Junction

Same as above – possible location

19. Kalanaga

Eastern side stop to be on left kerb, as buses will now turn left to Dharavi depot.
Possible to locate bus stops and skywalks here also

20. T- Junction

This and the next stop are en-route to the depot, and the bus may as well carry passengers until the end point. However, there will be no reserved lane in this section, and stops will be on the kerb-side, as for the normal feeder service.

21. Peolia Jtn

As above.

22. Dharavi Bus depot:

This is a large, well equipped depot, and the terminal point for the BRTS buses.

Observations on Western Express Highway

The WEH has subways constructed at various places along its length as well as flyovers at close proximity to each other. In addition, although the row is fairly clear of all encroachments, the road is in cutting along several parts, and in many sections, the road is partly on embankment. Curving the road outwards in order to meet the geometric requirements will need to be made carefully. Additionally, since almost all of the footpath width is obtained on the top of drain covers, cutting or shifting this will need careful handling.

A detailed study will need to be made of the WEH, and more detailed designs made, to design this route for BRTS. Bus stops can be designed differently, and can be placed in parallel rather than in series, to make use of available road width.



Initial Economic Analysis*

a simplified model for initial working- W.Expressway

parameters	current reg diesel	BRTS diesel ac bus	BRTS bus CNG non ac	
bus capacity incl standees	71	150	150	est , to be confirmed
investment in a new bus- rs	1,500,000	4,500,000	4,500,000	
type of bus	single	double	double	
km/trip- Dahisar to Bandra East	24	24	24	
avg gr speed- km/hr incl turnaround	14	25	25	assumed
no of hours of working by bus	18	18	18	
no of hrs/trip in one direction	1.71	0.96	0.96	
no of trips /working day - rounded	10	18	18	
no of km /day per bus	240	432	432	
av load factor % (6hrs)	65	90	90	assumed
peak hour load factor%(12 hrs)	100	120	120	
av distance per ticket -km	8	8	8	
no of passengers per avg trip	46	135	135	
no of passengers /working day	462	2430	2430	
av price per ticket	6	10	10	&
ticket sales - rs per day	2769	24300	24300	
no of pasengers per trip - 25 km	138.45	405	405	
passengers/day	1385	7290	7290	
peak hour load factor%	100	120	120	
service frequency per hour	n a	60	60	
peak hr/peak direction passengers		10800	10800	
passenger rev per bus per day	8307	72900	72900	figures to be verified
km/litre-kg	3.3	1.4	2.2	
fuel cost /litre	36	36	22	
cost/km - rs	10.91	25.71	10.00	
cost/pasenger km	0.24	0.19	0.07	
price of ticket for 10 km	6	10	10	*
rev frm ticket per pass km	0.75	1.25	1.25	
conrib/pass km (rev- fuel	0.51	1.06	1.18	

cost)				
tot contrib per bus per day	4267	77239	85725	
tot contrib/ bus/year - 330 days	1,407,983	25,488,964	28,289,250	
.- interest & depr/bus/yr @ 25%	375,000	1,125,000	1,125,000	
.-employee cost per bus/yr #	1,754,645	1,754,645	1,754,645	# employee cost in
.=surplus per bus per year (to cover oth ovhs and net profit)	-721,662	22,609,320	25,409,605	05-06 - Rs. 595 cr

ten employees per bus with cost to company of Rs. 173000 in 2005-06 . This cost is higher than the interest and depr cost even on an expensive double bus . BEST has been aiming at higher earnings from short distance travellers with higher per mile fare. But BRTS supported by higher speeds and productivity has to think differently. net surplus will be much less for BRTS - under both diesel ac and CNG versions due to the cost of feeder operation . It is suggested that investment in road infra should be financed thru taxing of cars . The cost of bus stops and ancillaries , physical segregation could be Rs. 4 cr /km

**Analysis contributed by Shri Ashok Datar, Chairman, MESN*

Annexure-4**List of Stops identified, with details of proximity to suburban stations**

Location of BRTS station on Western Express Highway (Survey on 25/01/2007)

Sr. No.	Destinations		Distance (Kms)	Nearest Rly. Station	Distance from Rly. Station to BRTS Station
	From	To			
1	Dharavi	Pivla Bunglow	0.5	Sion	1.7
2	Pivla Bunglow	Dharavi 'T' Junction	0.4	Sion	1.7
3	Dharavi 'T' Junction	Kala Nagar	0.9	Sion	1.9
4	Kala Nagar	Kherwadi Junction	0.8	Bandra	0.6
5	Kherwadi Junction	Cardinal Gracias School	0.9	Bandra	1.5
6	Cardinal Gracias School	New Agripada	2.0	Santacruz	1.9
7	New Agripada	Centaur Hotel	1.4	Santacruz	0.7
8	Centaur Hotel	Hanuman Road	1.3	Vile Parle	1.1
9	Hanuman Road	Gundavli	2.2	Vile Parle	1.5
10	Gundavli	Shankarwadi	0.8	Andheri	2.6
11	Shankarwadi	Ismail Yusuf College	0.5	Jogeshwari	2.0
12	Ismail Yusuf College	Vanrai Colony	2.3	Jogeshwari	1.3
13	Vanrai Colony	Virwani Indl. Estate	1.8	Goregaon	2.7
14	Virwani Indl. Estate	Gen.A.K.Vaidya Marg Junction	0.7	Goregaon	1.4
15	Gen.A.K.Vaidya Marg Junction	BHAD Colony	3.6	Goregaon	2.1
16	BHAD Colony	Dattani park	0.7	Kandivili	1.9
17	Dattani park	Magathane Tel. Exchange	0.6	Kandivili	2.5
18	Magathane Tel. Exchange	Omkareshwar Mandir	1.7	Borivili	2.6
19	Omkareshwar Mandir	Ovripada	1.3	Borivili	0.9
20	Ovripada	Dahisar Check Naka	1.9	Borivili	2.0
21	Dahisar Check Naka	---		Dahisar	1.8
	Total Distance		26.3		

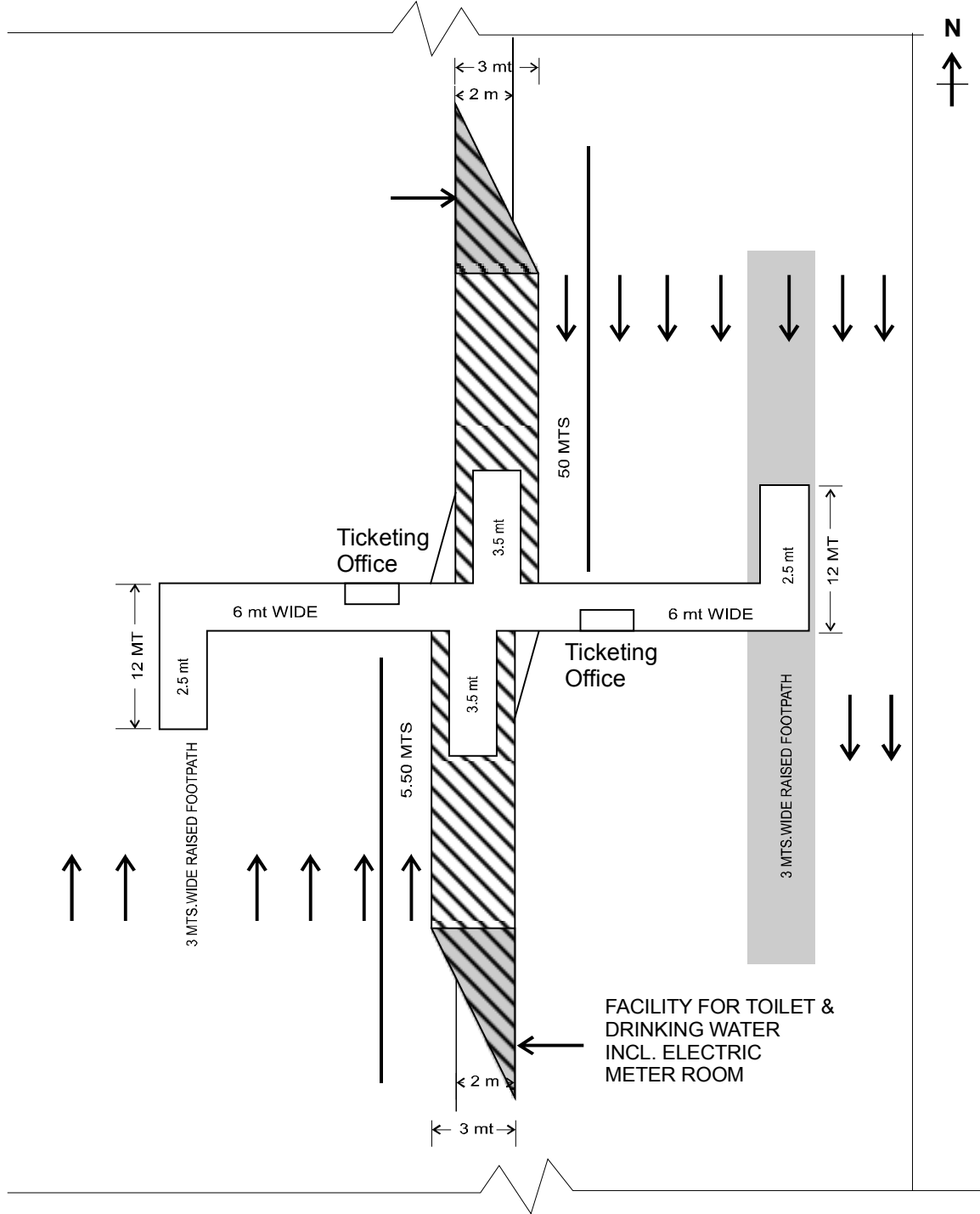
Location of BRTS station on Eastern Express Highway (Survey on 25/01/2007)

Sr. No.	Destinations		Distance (Kms)	Nearest Rly.Stn	Distance from Rly. Stn To BRTS Stn
	From	To			
1	Wadala Depot	Dadar	0.8	Dadar	1.1
2	Dadar	Maheshwari Udyan	1.4	Dadar	0.6
3	Maheshwari Udyan	Sion Hospital	1.0	Matunga	0.5
4	Sion Hospital	Everard Nagar	2.4	Sion	1.4
5	Everard Nagar	Postal Colony	2.4	Sion	1.5
6	Postal Colony	Chheda Nagar	1.4	Kurla	1.8
7	Chheda Nagar	Ramabai Nagar	1.7	Kurla	4.0
8	Ramabai Nagar	Kannamwar Nagar	4.8	Ghatkopar	4.4
9	Kannamwar Nagar	Navghar Road	6.2	Vikhroli	2.8
10	Navghar Road	Dnyansadhana college	2.0	Mulund	0.6
11	Dnyansadhana college	Louiswadi	1.7	Thane	2.5
12	Louiswadi	Cadbury Junction	1.3	Thane	3.0
13	Cadbury Junction	---		Thane	3.5
			27.1		

Annexure -5

Schematic Layout of Proposed BRT Stations

LAYOUT SKETCH OF TYPICAL 'BRTS STATION'



Annexure 6

Estimate of Cost of Typical BRT Station with Skywalk

Item	No.	L in m	W in m	Area in sqm	Block Rate Rs./ Sqm	Block Cost Rs.	
Bus Station with Roof	1	100.00	3.00	300.00	3000/-	9,00,000	
Skywalk Deck	1	50.00	6.00	300.00			
Landing	4	12.00	2.50	120.00			
				420.00	10,000/-	42,00,000	
Ancillary Units: Toilet blocks, Drinking Water Fountain, Electric Meter Room, Display facilities, etc							
						Lump sum	10,00,000
						Total	61,00,000
Add 15% for price variation							9,00,000
						Total Cost*	70,00,000

The estimated cost of construction of a BRT Station with Skywalk and conventional staircase access is approximately Rs. 70,00,000 /-.

*This does not include the cost of escalators