

Transmittal

CS Transmittal No. 2090

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Project No./Contract No.: M544.1
Task No./Title:
Project Phase:

Date: October 18, 2012

Subject: Draft Professional Services Scope for Rail Simulation of Phases 1+2 Service Integration Plan

Reference:

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<input type="checkbox"/> other	Draft Rail Simulation Scope			

Item No.	Copies	Description	Rev. No.	Date
1	1	Draft Rail Simulation Scope for Systems / Operations Capacity Analysis	1a	10-18-12

If enclosures are not as noted, kindly notify us at once.

Remarks: The enclosures present responses the draft scope for a Central Subway Rail Simulation. The scope directs a rail simulation that fulfills the FTA's June 2011 Spot Report and follow on recommendations conveyed in 2 meetings with the SFMTA in July 2011. The simulation purpose and results, as finalized and transmitted in Transmittal # 1759 to the FTA in September 2011, are presented on the first page under the "Scope Summary".



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cc: Eric Stassevitch, Central Subway
CS File No. M544.1.5.0420.a

San Francisco Municipal Transportation Agency
San Francisco, California 94103

Third Street Light Rail Phases 1+2

Systems / Operations Capacity Analysis

For Use by Construction Procurement, Transit Operations and Traffic Start Up Planning

Rail Simulation Scope of Professional Services for Review and Cost Estimate

Third Street Light Rail Program

Phase 2 Central Subway Project

Draft update to Revision 1a

June 2012

T-Third Phase 1 + 2 Service Integration Plan
Scope of Systems / Operations Simulation Services

DRAFT

T-Third Phase 1 + 2 Service Integration Plan
Scope of Systems / Operations Simulation Services

Scope Summary

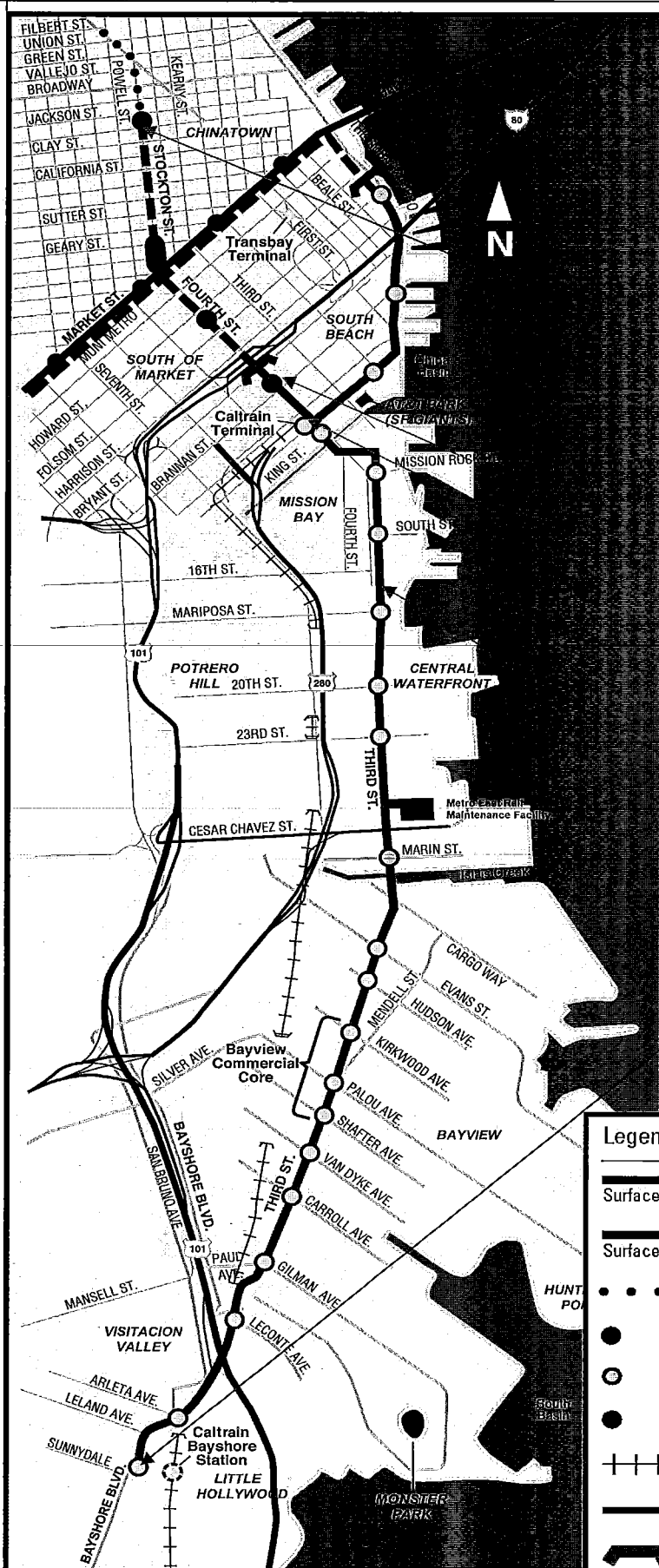
The San Francisco Municipal Transportation Agency (SFMTA) seeks to obtain Rail Systems / Operations Capacity Analysis Services to test and assess the Phase 1 + Phase 2 Central Subway Project (Project) Service Integration Plan. The Phase 2 Project consists of a 1.7-mile extension, along 4th and Stockton streets, from the existing Third Street Light Rail Station at 4th and King streets to a new terminus in Chinatown at Stockton and Jackson streets. At this time, final design is completed and construction has begun. Revenue service is expected to begin at the end of 2018.

The Federal Transit Administration's July 2011 final review of the SFMTA T-Third Phase 1 + 2 Service Integration Plan resulted in a written agreement that the SFMTA will provide a rail simulation of the 2018 Service Integration Plan (SIP). The simulation, to be led by Agency team of Transit Operations and CS implementation staff, will provide the Agency with a capacity planning resource to:

- a) assess the design of the surface track signal and timing on all approaches to the 4th and King intersection, the new 4th and King diamond interlocking links and interface with the approaching track signal system;
- b) prepare the operations procedures that will integrate the 4th and King diamond connection of CS Phase 1 and Phase 2;
- c) confirm and guide the turnaround timing procedures at Chinatown in terms of timing and travel through the cross over, the possible use of platform operators to reverse direction and other steps that may be options to achieve the required headway capacity at the terminus, and,
- d) use the above, (a-c) to develop the CS Phase 1 + 2 Start Up Plan with SFMTA Transit Operations staff.

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T- Line Phases and Service Areas

Phase 1 T- Third

- 4th and King to Bayshore Station
- 18 T-Third surface stations

Phase 2 Central Subway

- 4th and King to Chinatown Station
- 1 surface station
- 3 subway stations

Terminus #1 Double cross over with tail track Chinatown Station - Jackson St.

Surface track double cross over #5 turnout with 200' Radius - Bluxome St.

Double track, right angle diamond crossing on 4th /King Streets linked to a separate, adjacent crossover interlocking on the King Street median approach used by the N line.

Terminus #2 single-track Mission Bay turn around loop at 19th to 18th Street on Illinois, signaled one crossover on main line to loop.

Terminus #3 Double cross over with tail track Sunnysdale Ave. & Bayshore Blvd. for long line service from Chinatown Station.

Legend

		Existing T Third Alignment (Phase 1)
		Surface
		Subway
		Central Subway Alignment (Phase 2)
		Surface
		Subway
		Central Subway North Beach Tunnel Extension
		Central Subway Stations
		T Third Stations
		BART and Muni Metro Stations
		Caltrain
		BART
		Surface to Subway Portal

Third Street Light Rail Program

Phase 2 Central Subway Project

1 Introduction

The Federal Transit Administration's July 2011 final review of the SFMTA T-Third Phase 1 + 2 Service Integration Plan resulted in a written agreement that the SFMTA will provide a rail simulation of the Central Subway's (CS) 2018 Service Integration Plan.

The simulation will provide the Project with capacity planning resource to: a) assess the design of the surface track signal and timing on all approaches to the 4th and King intersection, the new 4th and King diamond interlocking links and interface with the approaching track signal system; b) prepare the operations procedures that will integrate the 4th and King diamond connection of Phase 1 and Phase 2; c) confirm and guide the turn around timing procedures at Chinatown in terms of timing and travel through the cross over, the possible use of platform operators to reverse direction and other steps that may be options to achieve the required headway capacity at the terminus, and to, d) use all of the above inputs described in items a-c above to develop the Phase 1 + 2 Start Up Plan with SFMTA Transit Operations staff.

The verification shall use a Rail Simulation Application to confirm that the planned T-Third Phase 1 + Phase 2 headways provide sufficient levels service and capacity. The simulation will be used to demonstrate to SFMTA Operations that the CS planned service and infrastructure under construction between the Chinatown terminus and the diamond and signal interlocking at 4th and King Streets will perform as expected to fulfill the 2018 Service Plan. The results will be incorporated in a revised update of the T-Third Phase 1 + 2 Service Integration Plan approved by SFMTA Operations.

The performance of the 4th and King Street interlocking will be assessed to verify the capacity and throughput of three different light rail routes that cross and connect (T, N, E) at the diamonds: the T-Third Phase 1 + 2, the N-Judah and the E-Embarcadero Streetcar line. The simulation will verify the interlocking capacity of the signal programming and timing that control vehicle movements, speeds and volumes.

The key reasons for reduced transit delay at the intersection of 4th and King Street, with the Central Subway are as follows:

T-Third Phase 1 + 2 Service Integration Plan

Scope of Systems / Operations Simulation Services

Drawing on the SYSTRA report and its conclusions (pg 37), submitted April 2010, the next simulation will focus on the 4th/King Street train and traffic signal interlocking capacity and verify the proposed street traffic and train operating plans. The expanded and revised signal system at the new diamonds will determine the minimum headways and maximum throughput, and, will be modeled in detail using the Rail Simulation Application which has appropriate signal modeling capability.¹

The report preparation and results of the simulations will assist SFMTA traffic and transit operations staff to determine and establish that the intersection design and operation will achieve the approved Service Plan AM and PM peak level of service. The SFMTA's review of the simulation results with the selected provider will consider if modifications to the intersection and adjustments to the service plan are needed to achieve the service capacity needed and to avoid poor performance and overcrowding.

Based on the report requirements by SFMTA to achieve the above verification the reporting form may include operational statistics, run times, delay times, and speed performance, stringlines, video simulation, written text. The SFMTA Central Subway Project Management team will finalize this scope in 2012 at the completion of final design to set the schedule and the number of simulations that will be used to achieve the goals outlined here.

The final scope and costs of the simulation report shall contain a subsection that presents summary highlights, key topics and guidance for reuse of the simulation report by the construction contractor, and if helpful, the intersection designer. That is, the completed simulation report shall confirm that the database is provided in a format and with sufficient information that would allow the SFMTA to further use it to a) test proposed changes to the operating plan, or, b) to test infrastructure changes; or, c) to identify what sustainable service could be operated during rehabilitation the interlocking; or, d) traction power load flow analysis; or, e) the effects of changing passenger volumes on dwell and travel times.

Finally, for start of the Phase 1 + 2 service integration, the simulation report shall be prepared with a subsection that presents summary highlights, key topics and guidance for reuse of the simulation report by SFMTA acceptance inspectors for testing and for SFMTA O&M training as part of the initial testing and start-up process.

¹ The Consultant shall document these steps to build on and draw from the SYSTRA simulation and analysis:

- a) Incorporate changes to the operating plan, and infrastructure design that are now described in the T-Third Phase 1 + 2 Service Integration Plan and CS 2012 Final Design Report.
- b) Address that this work avoids duplication of effort from the SYSTRA's simulation report where possible.
- c) Confirm the new model equivalency to SYSTRA's RAILSIM for producing accurate modeling of train movements, train signal systems, load flow, etc.
- d) Confirm that the new simulation will accurately model the street traffic signal effect on train movements between the portal and King Street and the capacity of the 4th/King Streets intersection to support train operations. Specifically, the simulation report shall exactly document the traffic signal complexity at the diamond intersection and address if the works needs to be supplemented by a separate traffic simulation such as VISSIM to capture the complexity.

T-Third Phase 1 + 2 Service Integration Plan
Scope of Systems / Operations Simulation Services

1.1 T-Third Phase 1 + 2 Network Simulation Analysis by SYSTRA

The 2010 operations/capacity simulation defined the limits of operations for the T-Third line from the Ferry Portal of the Muni Metro service to the Sunnydale terminus near Bayshore; also, the N-Judah line between the Ferry Portal and that line's 4th/King Street Station terminus; and, the Central Subway service between 4th/King Street and Chinatown Station. SYSTRA released a technical memorandum: *Muni Central Subway Network Simulation Analysis*, dated April 5, 2010. The SYSTRA report concluded that the "headway intended in the service plan can barely be sustained at the intersection of 4th and King Streets." The report also indicated that the recovery time provided in the operating plan was insufficient to provide reliable service.

The recommendations were:

- a) Complete AM pull-outs from MME earlier to reduce congestion at 4th and King
- b) Increase recovery time at terminals and permit double berthing at 4th/Berry Station to move trains through 4th and King more quickly – two trains in the same signal cycle.
- c) Retain the current pull-out schedule but increase T-Third headways without double berthing at 4th/Berry

Coincidentally to the Systra report concerns, the SFMTA committed to capital improvements to redesign and reconstruct the King Street interlock physical plant where the cross over to approach the King Street terminus and the switch for turning movements by the Phase 1 T-line are located to closely together. The results of this redesign are expected to achieve improved performance for all light rail movements and shall be incorporated into the performance assessment of the 4th and King interlocking. The improvements are being carried out independent of the simulation in this scope. However, the scope here may result in additional improvements at the same time as the King Street interlocking improvements are constructed.

The proposed T-Third service integration plan was also revised after the SYSTRA report in April, 2010 as described below.²

² Changes to the Service Integration Plan include removing a "Tripper" service that operated only between Chinatown and 4th Street/King St. Station. The headways of the Mission Bay Loop and the service between Chinatown and Sunnydale were also adjusted based on the final New Starts ridership forecast released in July, 2010. The Embarcadero Line between Fisherman's Wharf and 4th/King Street via the 4th Street diamond interlocking was also added.

T-Third Phase 1 + 2 Service Integration Plan
Scope of Systems / Operations Simulation Services

1.2 Service Integration Plan:

The *Third Street Light Rail Phases 1+2, 2018-2030 Service Integration Plan for Operations, Fleet, and Financial Planning*, Revision 1a, dated June, 2012 describes service to accommodate ridership demands and integrate the Central Subway Phase 2 with Phase 1.

Key Phase 1 + 2 Service Integration Plan elements include:

- a. Establishing at the 2018 start-up the completed T-Third Phase 1 + 2 6.8 mile service route between Chinatown and Sunnydale for revenue service.
- b. Establishing in 2018 the T-Third 2.9 mile service route between Chinatown and the Mission Bay Loop (MBL) for revenue service.

The combined service frequency will result in trains arriving and departing Chinatown station every 3 minutes 45 seconds.

The MBL is critical to achieving the ridership and service plan by increasing train frequency through the turning of trains to serve the maximum loads north of the MBL. The segment between Mission Bay and Market Street is the most densely used segment of the overall route with 90% of T-Line the peak hour travel demand will be between the MBL and Chinatown.

The combined service frequency of the service to Sunnydale and the MBL line will result in trains arriving and departing Chinatown station every 3 minutes 45 seconds. In 2018 the MBL route alone is estimated to serve 14,000 average weekday boardings growing to 22,000 boardings by 2030. The combined MBL and Bayshore routes together are expected to serve 64,600 daily boardings in 2030.³

- c. Discontinuing, at the 2018 startup, the interim MBL N-Judah service and current K/T hybrid lines that will be replaced with the T-Line stand-alone combination of the Central Subway and the existing T line.

Rerouting The N-Judah service back from the Mission Bay Loop terminus route to serving just the 4th/King Street terminus route via the Market Street Muni Metro subway.

³ Note that as background, the SFMTA will implement extending the N-Judah service route from the 4th/King Street terminus to the Mission Bay Loop in the 2016 time period to provide interim supplemental service to the T-Third corridor.

T-Third Phase 1 + 2 Service Integration Plan
Scope of Systems / Operations Simulation Services

The following table summarizes ridership and service plan information.

T-Third Phase 1 + 2 Service Integration Plan Ridership and Service Summary

Service Description	Current (1)	Forecast	
		2019	2030
1. Overall Muni Transit Daily Boardings w/o CS	673,196	847,328	901,430
2. Overall Muni Transit Daily Boardings with CS	-	856,393	917,576
3. Overall New Muni Transit Boardings Difference with CS	-	9,065	16,146
4. Overall T Line Phase 1 Daily Boardings Today Bayshore – Berry Street	13,000	-	-
5. T Line Daily Boardings for just those on the CTS – MBL service (2)	-	-	21,930
6. T Line Daily Boardings for just those on the CTS – Bayshore service (3)	-	-	42,690
7. Overall T Line Daily Boardings with CS (Line 5 + 6 above)	-	43,521	64,620
8. T Line Daily Boardings for the CS Phase 2 4-station segment only	-	-	35,100
9. CTS – MBL service / CTS – Bayshore service combined frequency (4)	9 min	3.75 min.	2.5 min.
10. T-Line LRVs per Train Set for Mission Bay and Bayshore service routes	1 car	2 cars	2 cars

Notes:

- 1) Source of current SFMTA ridership <http://www.sfmta.com/cms/rfact/documents/SFFactSheet201111-29-2011.pdf>
- 2) The CTS – MBL service and boardings are for trains that will operate between Chinatown and Mission Bay Loop.
- 3) The CTS – Bayshore service and boardings are for trains that will operate between Chinatown and the Bayshore terminus. The Daily Boardings for the CS 4-station segment only are those passengers who are boarding between CTS and 4th and King who are on both the CTS – MBL and the CTS – Bayshore trains.
- 4) The current T-Line service is combined with the K-Line in the Muni Metro Market Street subway with all inbound subway trains called a T and outbound trains a K. This hybrid 6-mile route serves more than 32,000 daily boardings between the Sunnysdale T-Line Terminus and Balboa Park K-Line Terminus. Approximately half of these riders are projected to be unique to the T-Line at the 2018 start up.

The current T-Line peak period scheduled frequency is 9 minutes in the PM and 10 minutes in the AM three hour window. Actual frequency currently varies between 12 and 20 minutes. Source of scheduled service: <http://www.sfmta.com/cms/mroutes/WeekdayFrequencyGuide.htm>

- d. Finally, including the E-Embarcadero service that will operate from Fisherman's Wharf to 4th and King Street terminus at Caltrain.

This route is expected to be underway in the 2018 Baseline, at the 2018 Start-up, and the 2030 service periods.

2. Service Simulation Routes⁴

The proposed limits of the simulated system and the three primary routes are:

- a. Existing N Line Embarcadero. Simulation of current light rail operations between the 2nd and King street Station to the 4th and King Street that is the currently T and N-Line route.

This route captures the N and E line plus trains entering and leaving service via MME.

For this route's background current revenue schedule see the "511" transit information for the T-Third at the following web site

<http://transit.511.org/schedules/index.aspx#m1=S&m2=rail&routeid=43865&cid=SF> under the header **KT - Muni (SFMTA) Ingleside/Third Street**.

Note that the Ferry Portal is outside of the proposed limits of the simulation but is along this route. The Ferry Portal provides some reference to the expected operations on the CS alignment at the Hwy 80 portal with trains entering and leaving the portal transitioning between the Automatic Train Control System and manual operations.

- b. Existing T Line Third Street. Simulation of current light rail operations between 4th and King Street station south to the T-Third 20th Street Station. This route captures the Mission Bay Loop turn back operation.

The MBL operation has southbound trains turning back via crossing the T-Third northbound track to access the loop. The MBL is a single track in street running return to Third Street via a layover stop on Illinois Street.

Modeling from 4th and King Street to 20th Street Station is also the point to capture T-Third trains arriving and going to Sunnydale.

This route capture trains traveling to and from the Muni Metro East Maintenance facility (MME) at 25th Street that also cross the 20th street simulation limit line. Northbound trains from MME will be introduced at 20th Street with an appropriate delay for travel time from the MME yard.

- c. Future Phase 2. Simulation of future light rail operations between/through the 4th and King Street intersection and the Chinatown station platform.

This route will capture the 2,000 feet of surface operations, the portal transition, subway service at three stations and the CTS turn arounds via the crossover, tail track and platforms. The current estimated travel time from CTS to 4th and King Streets is 8 minutes.

⁴ The proposed simulation limits in this scope do not capture the entire T-Third line to Sunnydale. For this scope the simulation is expected to generate appropriate treatment of trains entering the simulation with variability, as well as with accompanying information demonstrating that the run times on this segment and turning movements/times at Sunnydale are adequate for the cycle times used in the Service Integration Plan.

3. Scope of Work

Central Subway Systems Consultant will provide professional engineering services in the form of operations simulation and analysis. These services will consist of modeling train service as described in Section 1.2 and Section 2 (Routes) above and described in full in the *Third Street Light Rail Phases 1+2, 2018-2030 Service Integration Plan for Operations, Fleet, and Financial Planning*, Revision 1a, dated June 2012. Proposed operations on all existing and planned mainline track and signal conditions and interlockings will be incorporated. The analysis shall not include yard capacity or operations.

Operations of MME related revenue train movements will be captured by trains leaving or entering the simulation limits at 20th Street just south of the MBL.

A primary focus is the 4th/King interlocking peak north/south - east/west traffic flow and capacity. The operating plan should be tested by simulation to verify that the planned headways and peak throughput can be reliably and consistently achieved and demonstrate these conditions can be expected:

- Spacing (block) and headway between successive trains on a common track between the Embarcadero and the 4th and King street interlocking and terminus achieve throughput,
- Delays caused by track switching during revenue movements through the diamond are not significant especially during the AM peak period movements to start and decrease service prior to and after the peak periods as trains move between revenue service and MME. This potential delay is a subject of the simulation results.
- The overall 4th and King interlocking plants, integrate new 4th Street CS surface signals and integrate all of the above service with the intersection traffic signals. The new 4th and King interlocking programming and signals are expected to allow:
 - Parallel train movements to proceed simultaneously through the intersection,
 - Two intersecting lines can simultaneously request traffic signal pre-emption, and both be served during the same signal cycle in a sequence of train movement; and
 - More opportunities to grant a pre-emption request will be included in the intersection signal program.

A second focus is the Chinatown Station timing and travel through the cross over, the reversal of direction by the operators and boarding times to consistently achieve the proposed headway at the terminus operations.

The first step will be to collect and database the engineering data describing the existing system (This data includes track alignment, grades and curvatures, train consist and performance, signal system data, etc.). A Base Case simulation will be developed to

T-Third Phase 1 + 2 Service Integration Plan

Scope of Systems / Operations Simulation Services

represent existing infrastructure and train operations. Once development of the Base Case is complete, the model will be verified against the raw data, to eliminate coding errors. Train operations on the Base Case model will be validated against existing operating data.

Following validation, the Base Case simulation will be modified by adding the Project. Simulations will be run to test the ability of the proposed infrastructure to accommodate the proposed operating schedules.

Central Subway Systems Consultant will report the results of these simulations in the form of operational statistics (run times, delay times, and speed performance) and stringlines, as well as written text, to assist in the interpretation of the data.

4. Task breakdown

- 1.0 Data Collection – Data needed to model the existing system, as well as proposed extensions and improvements will be largely prepared and provided to the consultant by the SFMTA.

The primary source of documentation is the sections of the *CS Design Criteria Compilation* updated February 6, 2012 listed below:

- 1.1 Section 4 defines ~~operating and maintenance~~ requirements for the design of the Central Subway as they affect the facilities and systems required to meet the operational needs.
- 1.2 Section 6 outlines the general physical characteristics, performance, and operational the existing fleet of LRV2 vehicles that will be operated in the Central Subway
- 1.3 Section 7 presents the design criteria for the project track geometry and clearances.
- 1.4 Section 8 presents the design criteria for the project trackwork, including track related elements, and trackwork details.
- 1.5 Section 10 presents the design criteria for the design of traffic controls implemented in the construction of the project.
- 1.6 Section 18 presents general guidelines for the design of the train control and signaling system in areas where exclusive right-of-way provides higher speed operations or in areas where surface street operations include operations through interlockings.
- 1.7 CS Drawings CTS to 4th and King
- 1.8 Vertical and horizontal alignment
- 1.9 Station locations and platform lengths
- 1.10 Interlocking configurations
- 1.11 MR-1141 Third Street Light Rail Transit Project, Mission Bay, King Street to 22nd Street Drawings, dated September 26, 2001.
- 1.12 Signal and IJ locations.

T-Third Phase 1 + 2 Service Integration Plan
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- 1.13 Route priorities at interlockings that may not be indicated on the signal drawings.
- 1.14 Safe braking criteria
- 1.15 Normal service braking rates
- 1.16 Allowable speed data.
- 1.17 Operators manuals and/or rulebooks
- 1.18 Operating plans.
- 1.19 Schedules and headways for all services operating in the area to be modeled, including the N-Judah, and T-Third St. Long and Short line service, and the E-Embarcadero line which is expected to be operating between Fisherman's Wharf and 4th/King Street Station by 2018.
- 1.20 Detailed information of all non-revenue moves in the modeled area and when they occur.
- 1.21 "San Francisco LRV-2 Project," prepared by General Electric Transportation Systems, dated February 26, 1992
- 1.22 "SF Muni LRV2 Technical Specifications," January 6, 1992 Conformed Version

2.0 Base Case Development – Using the data collected in Task 1, Central Subway Systems Consultant will construct a simulation database using the Rail Simulation Application for the existing infrastructure and operations.

The model of the existing network will include:

- 2.1 T-Third Street line between 20th Street and 4th and King Streets existing schedules, train operations and train configurations.
- 2.2 N-Judah Line between Ferry Portal and storage tracks located southwest of 5th and King Streets intersection existing schedules, train operations and train configurations.
- 2.3 The network will then be verified vs. the source documentation to ensure accurate entry.

3.0 Base Case Validation – Central Subway Systems Consultant engineers will use runtimes and other simulation output to validate the Base Case simulation against the operational data provided in the "Technical Memorandum, Muni Central Subway Network Simulation Analysis", produced by SYSTRA and dated April 5, 2010.

4.0 Future Case Development – The Base Case database will be revised to include:

- 4.1 Mission Bay Loop.
- 4.2 Central Subway from 4th and King Streets to the proposed storage tracks north of the intersection of Jackson and Stockton Streets.
- 4.3 Proposed train operations and schedules through the modeled area based on planned headways and service.
 - 4.3.1 T- Line service between the Chinatown Station and the MBL turn around. A proposed service schedule will be proposed based on the simulation of the distance, alignment features, train performance, the expected headways and hours of service.

T-Third Phase 1 + 2 Service Integration Plan
Scope of Systems / Operations Simulation Services

- 4.3.2 T-Line service to Sunnydale terminus. A proposed service schedule will be based on the simulation as noted for the MBL service.
 - 4.3.3 N-Judah service to the King Street terminus based on a schedule provided by the SFMTA.
 - 4.3.4 E-Embarcadero service to King Street terminus based on a schedule provided by the SFMTA.
- 5.0 Evaluate Future Case. The Future Case simulation will produce the above four services, run and evaluate the combination for operational instability and capacity chokepoints. The results shall be compared to the previous SYSTRA simulation and analysis. Findings will be presented to the client and a set of preliminary suggestions for mitigating operational and capacity issues will be presented for consideration.
- Mitigation measures to be considered will include infrastructure and interlocking configuration modifications, and operating/schedule adjustments.
- 6.0 Future Case revisions and evaluation – The Future case will be revised based on feedback from the CS Project staff and Transit Operations. The Revised Future Case will be evaluated with comparison to the original Future Case. Up to three Revised Future Cases will be developed and evaluated.
- 7.0 Final Report – Central Subway Systems Consultant will report the results of these evaluations in the form of operational statistics and stringlines, as well as written text, to assist in the interpretation of the data.
- 8.0 Meetings and Trips – Central Subway Systems Consultant engineers from the Oakland or San Francisco office will attend meetings as necessary. Central Subway Systems Consultant will also attend meetings via conference call and internet.

5. Assumptions

- 1.0 The simulation files previously created by SYSTRA will not be available and will need to be re-coded in Rail Simulation Application for this project.
- 2.0 SFMTA will provide all data listed under task 1 unless it already resides in the Central Subway Systems Consultant offices or the Project office.
- 3.0 Observed runtimes, dwell times, turn times, traffic light signal delays provided in the “Technical Memorandum, SFTMA Central Subway Network Simulation Analysis” by SYSTRA, dated April 5, 2010 are valid and can be applied in the development of the Central Subway Systems Consultant simulation.
- 4.0 Dwell randomization parameters developed by SYSTRA and provided in the “Technical Memorandum, Muni Central Subway Network Simulation Analysis” by SYSTRA, dated April 5, 2010 are valid and can be applied in the development of the Central Subway Systems Consultant simulation.

T-Third Phase 1 + 2 Service Integration Plan
Scope of Systems / Operations Simulation Services

- 5.0 Collection of new data and development of randomization parameters listed in assumptions 3 and 4 is not included under this scope.
- 6.0 Schedule of completion based on NTP.
- 7.0 Up to 3 alternatives will be analyzed as described in Task 6.
- 8.0 T-Third service, and T-Long service, will be introduced and removed from the simulation at Marin Street Station.
- 9.0 N-Judah service will enter and exit the simulation at the 2nd and King Street
- 10.0 E-Embarcadero service will enter and exit the simulation at Folsom Station.

6. Deliverables

- 1.0 Memo of Base Case Validation Results from the results of Task 3.0.
- 2.0 Memo of Preliminary Evaluation of Future Case from the results of Task 5.0
- 3.0 *Final report* on the results of Task 6; This report will detail performance of the proposed schedules and infrastructure configuration. Train delays and locations will be identified and these sources of delay will be incorporated into specific recommendations of refinements that are needed in the scheduling, operations and operating practices, procedures, vehicle, equipment, track and signal systems or signal programming to improve operations.

7. Schedule:

Task 1.0 - Data Collection	30 days
	23 days are concurrent w/ Task 2.0
Task 2.0 - Base Case Development	30 days
Task 3.0 - Base Case Validation	14 days
Task 4.0 - Future Case Development	21 days
Task 5.0 - Evaluate Future Case	21 days
Task 6.0 - Future Case Revisions and Evaluation	60 days
Task 7.0 - Final Report	14 days
Task 8.0 - Meetings and Field Trips	X meetings, X days total

T-Third Phase 1 + 2 Service Integration Plan
Scope of Systems / Operations Simulation Services

8. Cost breakdown:

- 1.0 Data Collection – Data needed to model the existing system, as well as proposed extensions and improvements include the following:
- 2.0 Base Case Development
- 3.0 Base Case Validation
- 4.0 Future Case Development
- 5.0 Evaluate Future Case.
- 6.0 Future Case revisions and evaluation
- 7.0 Final Report.

9. Scope Appendices

T-Third Phase 1 + 2 Service Integration Plan
CS Design Criteria Compilation updated February 6, 2012

Section 4 operating and maintenance requirements

Section 6 physical characteristics, performance of LRV2 vehicles.

Section 7 track geometry and clearances.

Section 8 track work and track work details

Section 10 traffic controls implemented in the construction of the project.

Section 18 train control and signaling system including operations through interlockings.

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