



CALIFORNIA
High-Speed Rail Authority

Operations and Maintenance Cost Model Documentation

DRAFT 2014 BUSINESS PLAN

Section 5: Operations and Maintenance

California High-Speed Rail System



DRAFT 2014 BUSINESS PLAN
TECHNICAL SUPPORTING DOCUMENT

Operations and Maintenance Cost Model Documentation

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Acronyms

Authority	California High Speed Rail Authority
B2B	Bay to Basin
BCA	Benefit Cost Analysis
BI	Bogie Inspection
BLET	Brotherhood of Locomotive Engineers and Trainmen
BLS	Bureau of Labor Statistics
BMF	Basic Maintenance of Infrastructure Facility
CDL	Commercial Driver's License
CEC	California Energy Commission
CEO	Chief Executive Officer
CHSR	California High-Speed Rail System
CHSTP	California High Speed Train Project
ConOps	Concept of Operations
CPI	Consumer Price Index
CPUC	California Public Utilities Commission
CWR	Continuous Welded Rail
DDOC	Deputy Director—Operations Control
DOC	Director—Operations Control
DOT IG	Department of Transportation Inspector General
EIC	Employee in Charge
FB	Flatbed
FELA	Federal Employers Liability Act
FGA	Facility Gang Addition
FRA	Federal Railroad Administration
G&A	General and Administrative (Costs/Staff)
HMF	Heavy Maintenance Facility
HMFA	Heavy Maintenance Facility Addition
HSIPR	High Speed Intercity Passenger Rail
IOS	Initial Operating Segment
ISU	Initial System Unit
IT	Information Technology
KWH	Kilowatt hour
LADWP	Los Angeles Department of Water and Power
LAUS	Los Angeles Union Station
LGV	Lignes à Grande Vitesse
LIRR	Long Island Railroad
MOE	Maintenance of Equipment



MoE	Maintenance of Equipment
MOI	Maintenance of Infrastructure
Mol	Maintenance of Infrastructure
MoW	Maintenance of Way
O&M	Operations and Maintenance
OBA	On-Board Attendants
OCC	Operations Control Center
OGI	Overhaul General Inspection
OHC	Overhead Catenary
P1B	Phase 1 Blended
RCC	Regional Control Center
RER	Réseau Express Régional
RPS	Renewable Portfolio Standards
RUIA	Railroad Unemployment Insurance Act
SFMTA	San Francisco Municipal Transportation Agency
SFV	San Fernando Valley
SJ	San Jose
SNCF	Société Nationale des Chemins de fer Français
TCF	Terminal Control Facility
TM	Technical Memorandum
TSMF	Trainset Maintenance Facility
UIC	Union Internationale des Chemins de fer or International Union of Railways
UTA	Utah Transit Authority
VPO	Vice President of Operations
VTA	Santa Clara Valley Transportation Authority
WMATA	Washington Metropolitan Area Transit Authority



1 Introduction

The California High-Speed Rail Authority (Authority) is responsible for developing and implementing California's high-speed rail system. The system will consist of over 800 miles of track and up to 24 stations. Electrically-powered trains will travel speeds of up to 220 miles per hour, with a travel time of less than 2 hours and 40 minutes between San Francisco and Los Angeles. Initial service will serve San Francisco to Los Angeles via the Central Valley; service will then be added to Sacramento and San Diego. The system will also be integrated with existing rail systems to enhance rail service and improve efficiency. Funding will be provided by a mix of federal, state, and private sources and the project will be a partnership between the public and private sectors.

This Technical Memo documents the assumptions and inputs for the California High-Speed Rail System (CHSR) Operating and Maintenance (O&M) Cost Model. The model is designed to test the system's ability to meet the requirements of Proposition 1A to operate without a subsidy. The model is based on the current level of available system detail and assumptions surrounding the operations of the system.

The DOT Inspector General's *HSIPR Best Practices: Operating Costs Estimation* report (DOT IG Report) serves as a guiding document for many of the cost categories, where it is applicable.¹ The DOT IG Report lays out general parameters for estimates in the preliminary, intermediate, final, and commercial closeout stage of program development. However, as described in the report, programs rarely fall in just one of these categories and will usually overlap between several of these categories. In that context, large parts of the model are best interpreted as an intermediate stage forecast, with some portions still in their preliminary stage, and some portions further advanced towards the final stage.

Although the O&M model uses the DOT IG Report as a guiding document, it does not attempt to follow every estimating method in the report as there are project-specific elements that do not fall neatly into all of the methods laid out by the DOT IG. Instead, the model aims to achieve the same intended *outcomes* as the guidance in the DOT IG Report (such as accounting for all of the appropriate categories, using best practices, etc.).

The model includes the following categories of operations and maintenance costs: train operations, dispatching, maintenance of equipment, maintenance of infrastructure, station operations and train/station cleaning, police and security, commercial, and general and administrative (G&A). Each section summarizes assumptions for headcounts, tours, personnel wages, material and tool costs, and other expenses around which conceptual operating strategies are developed. The model also includes high and low cost scenarios based on changes in assumptions from the medium (base) scenario for a less efficient and a more efficient (private sector) operation. The model does not attempt to optimize the operations to reduce costs but provides an achievable operating scenario that could be further improved upon by a private operator.

The upgrades to the O&M model from the previous version have been designed to increase the detail and flexibility of the model to allow for more precise estimating, easier validation, and faster scenario testing. The assumptions and inputs in this document are largely based on a compilation of railroad operations requirements and various reference documents.

¹ US Department of Transportation Office of Inspector General. *HSIPR Best Practices: Operating Costs Estimation*. US Department of Transportation, June 2011. 14 Nov. 2012. <<http://www.oig.dot.gov/sites/dot/files/OIG-HSR-Best-Practice-Operating-Cost-Report.pdf>>.



2 Purpose of the Model

The O&M cost model aims to test different operating scenarios, ridership, service, commercial, and procurement options. Specifically, the model tests whether these different scenarios would be in compliance with Proposition 1A as to the system's ability to operate without an operating subsidy. For this purpose, the results of this model should be compared with the revenue forecasts for each year. The model will also provide estimates of the total employees that will be needed to run the system and will create inputs for the Benefit-Cost Analysis (BCA). Finally, the model will be used to validate the results of the top-down model that was used as part of the 2012 Revised Business Plan.



3 Universal Assumptions

The model aims to present a realistic feasible scenario for operation of the high-speed rail system. The scenario aims to be technically sound based on conventional rail practice in the US and applicable adjustments for high-speed rail service from around the world. For the medium (base) cost scenario, the following assumptions are applicable across all categories of costs/personnel:

1. The model assumes the phasing as proposed in the 2012 Revised Business Plan as follows:

Table 1. System Implementation Phasing from the 2012 Revised Business Plan

Step	End Points	Anticipated Opening Year
Initial Operating Segment (IOS)	San Fernando Valley to Merced	2022
Bay to Basin (B2B)	San Fernando Valley to San Jose and Merced	2027
Phase 1 Blended (P1B)	Los Angeles to San Francisco	2029

2. The length of the system, the stations that are assumed to be operating, and other assumptions are based on the information used in the development of the 2012 Revised Business Plan.
3. Fringe rates are applicable to all positions except those that are contracted.
4. Fringe rates, as extracted from the Brotherhood of Locomotive Engineers and Trainmen (BLET) document on fringe rates, with the addition of costs for the Federal Employers Liability Act (FELA)², are as follows:
 - \$18,742 for the health, vision, dental, and retiree health plans
 - 5.55% of wage up to \$16,380 for RUIA
 - 12.1% of wage up to \$89,900 for Railroad Retirement Tier 2
 - 6.2% of wage up to \$110,100 for Railroad Retirement Tier 1
 - 7.45% with no limit (1.45% for Medicare and 6% for FELA)
5. Employees are not paid overtime. It is acknowledged that this is not the most efficient way to operate and that a private operator will improve their labor costs by using overtime for short additional labor needs instead of using higher levels of personnel as currently assumed in the model.
6. One frontline supervisor is assumed for every 10 non-contracted positions.
7. General and administrative (G&A) personnel are assumed to be an additional 10% of the total workforce (including frontline supervisors).
8. Frontline supervisors earn 10% more than each category's highest wage.

² Brotherhood of Locomotive Engineers and Trainmen. *Fringe Benefits 2012*. Dec. 2011. 13 Nov. 2012. <http://www.ble-t.org/Fringe_Benefits_2012.pdf>.

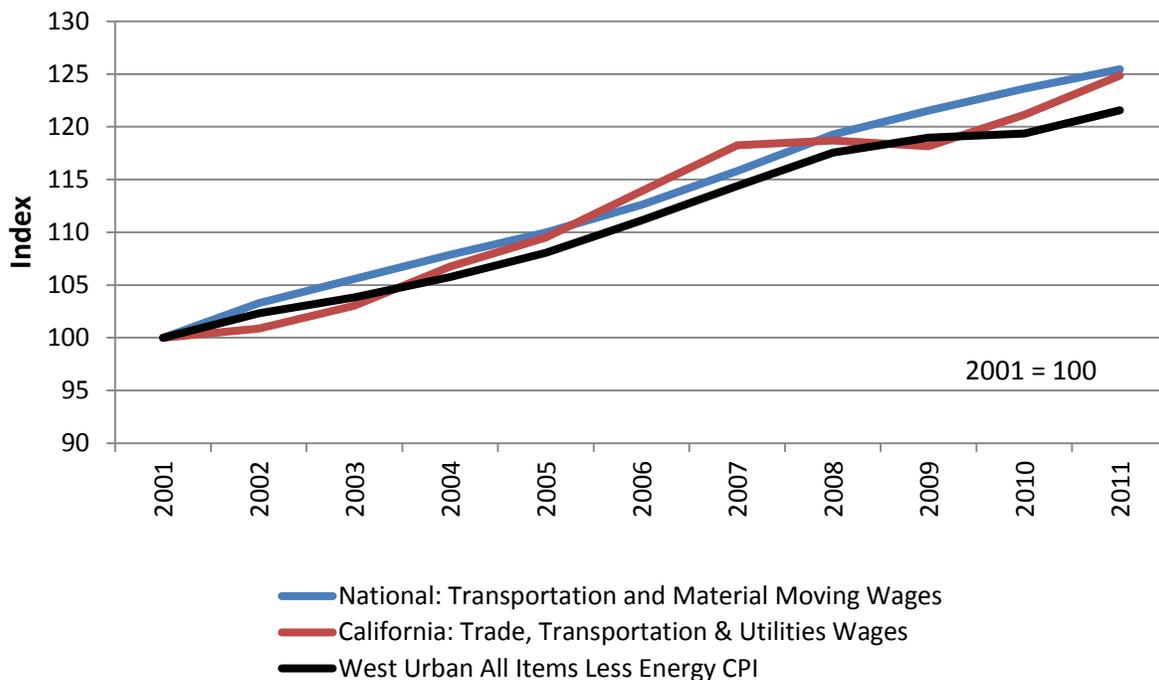


9. Of the 365 days in the year, employees will be unavailable to work on some days. For positions that need to be covered 7 days per week, the unavailability is assumed to be 141 days out of 365 days per year. Unavailable time includes 104 days for weekends, 15 days (average) for vacation, 10 days for sickness, 8 holidays, and 4 days for training or other absences. For positions that are only needed 5 days per week, the unavailability is assumed to be 29 out of 252 days (which excludes the weekends and holidays). Whether employees fall under each type of availability calculation is described in each section for each type of employee.
10. To account for unavailability, each regular crew assignment is multiplied by a factor of 1.63 (365 days per year/224 days per year = 1.63) for 7-days per week crews and 1.13 (253 days per year/224 available days per year = 1.13) for 5-days per week crews. These factors are described in this documentation as the “availability calculation”.
11. Generally, the availability calculation applies to non-contract positions. The availability assumption is not applicable to contractors and management and administrative staff.
12. The same number of trains, and therefore the same number of crews, will operate every day. Crews will work a 40-hour workweek, with relief days covered by separate crews.
13. Wages were gathered from existing railroad and transit properties across the country and adjusted for regional wage differences between California and the original sources (see Appendix 2—Wages).
14. A 0.267 percent per year real inflation rate is applied to wages based on historic differences in the rate of increase of the wages in the California Trade, Transportation, and Utilities sector and CPI. Figure 1 shows the difference in CPI growth relative to national and California wages in representative categories for the transportation industry. The growth in California transportation wages above CPI over the 10-year period is equivalent to the 0.267 percent.³

³ Bureau of Labor Statistics. Wage and CPI indexes. Accessed February 2013.



Figure 1. Changes in wages relative to changes in CPI from 2001 to 2011



15. The costs for shared facilities (i.e. the Caltrain corridor and others) have been fully accounted for in the model pending agreements that would allow some of these costs to be shifted to other operators. Future agreements may result in reduced costs but there is no established basis for a distribution of costs for shared facilities at this time so all costs necessary to run the system are included and assumed to be borne by the Authority or its contractors.

16. The results were escalated from 2012 \$ (as presented here) to 2013 \$ (as presented in the Draft 2014 Business Plan) using the increase in CPI from the average of the 3rd quarter of 2012 to the 3rd quarter of 2013. This amounted to an escalation rate of 1.23 percent.

The following sections describe in detail the assumptions and estimation methods for various elements of the system.



4 Train Operations Cost

The Train Operations portion of the model consists of personnel and costs directly involved in the operation of train service.

4.1 Related Personnel

For the purpose of the O&M Model, personnel in the calculation of train operations cost are considered to be on-board train crews consisting of train engineers, conductors, assistant conductors, and on-board attendants (OBA), roustabout crews, protect crews, and drill crews.

4.2 Assumptions and Model Inputs for Train Operations Personnel

4.2.1 Primary Drivers

Many factors that may not move in a strictly linear fashion affect operating headcount growth as a start-up operation matures. For the purposes of this model, the following assumptions pertaining to the categories of operating personnel are made to allow order of magnitude comparison of costs when operating conditions change:

1. The primary driver affecting escalation of on-board personnel headcount is assumed to be the total number of runs that trains make each day and the efficiency of the crews. It is assumed that each crew will be able to cover one round trip per day (two legs) and crew changes will be used, where necessary, to maintain this efficiency.
2. Protect crews will operate to fill in when originally planned personnel cannot make their runs because of delays, sickness, emergencies, or any other reason that causes them to be absent.
3. Roustabout crews will operate from the maintenance facilities to respond to breakdowns or other problems on trains and provide replacement rolling stock, move broken trains to the maintenance facilities, and perform other tasks to ensure smooth operations.
4. Drill crews will be based at each yard and maintenance facility to move equipment around as necessary.

4.2.2 General Assumptions

The following describes the specific assumptions that have been made:

1. The number of OBAs will increase if on-board refreshment services are added. It is assumed that no on-board refreshment service will be provided under any of the phases. However, one OBA will be on board trains without food service to respond to passenger needs and assist the core train crew in case of an emergency. An extra OBA will be added if on-board services are added.
2. Double consist trainsets will have the same number of transportation crew members as single trainsets. However, the number of OBAs will double.
3. It is assumed that crews will start and finish at the same location, whether crews are operating a train or deadheading.



4. It is assumed that road crews will make non-revenue trips to position equipment at outlying terminals for AM service, cycle trains to maintenance facilities, deadhead to their start locations, and for other reasons. It is assumed that non-revenue deadhead trips will not exceed one hour.

4.2.3 Personnel Headcount

1. The following on-board personnel are assumed for each type of crew:
 - For a single-consist train: 1 train engineer, 1 conductor, 1 assistant conductor, and 1 on-board attendant if there is no food service and 2 on-board attendants if there is food service (Table 2).
 - For a double-consist train: 1 train engineer, 1 conductor, 1 assistant conductor, and 2 on-board attendants if there is no food service and 4 on-board attendants if there is food service (Table 3).
 - Protect crews consist of 1 train engineer, 1 conductor, and 1 assistant conductor (Table 4).
 - Roustabout crews consist of 1 train engineer, 1 conductor, and 1 assistant conductor (Table 4).
 - Drill crews consist of 1 train engineer, 1 conductor (Table 4).
2. The following other assumptions are applied to these crews:
 - The number of **Protect Crews** assumes 2 tours per day with crews stationed at each system terminal (Level A Station).
 - **Roustabouts** are assumed to be on for 2 tours per day and they will be based at each maintenance facility of Level III or higher.
 - The number of **Drill Crews** and how many tours they are on is based on the maintenance facilities and yards that are in operation at any given point. Each Level V facility (HMF) is assumed to have 1 drill crew for 3 tours per day while each other facility and yard is assumed to have 1 drill crew for 2 tours per day.

Table 2 through Table 4 summarize the information discussed above for each type of on-board crew:

Table 2. Headcount per Revenue Single-Consist Train

Position	Without On-Board Services	With On-Board Services
Train Engineer	1	1
Conductor	1	1
Assistant Conductor	1	1
On-Board Attendant	1	2
Total	4	5



Table 3. Headcount per Revenue Double-Consist Train

Position	Without On-Board Services	With On-Board Services
Train Engineer	1	1
Conductor	1	1
Assistant Conductor	1	1
On-Board Attendant	2	4
Total	5	7

Table 4. Headcount per Protect Crew, Roustabout Crew, and Drill Crew

Position	Protect Crew	Roustabout Crew	Drill Crew
Train Engineer	1	1	1
Conductor	1	1	1
Assistant Conductor	1	1	0
Total	3	3	2

4.2.4 Wages

Table 5 summarizes wages for Train Operations.

Table 5. On-board Staff Wages

On-board Staff	Salary	Availability?
Train Engineer	\$71,005	Yes, 7-day
Conductor	\$68,528	Yes, 7-day
Assistant Conductor	\$54,164	Yes, 7-day
On-board Attendant (OBA)	\$40,831	Yes, 7-day

4.3 Energy Costs

Energy costs are based on the usage of energy for the movement of trains, usage at maintenance facilities, and related to stations. The Authority has committed to using 100% renewable energy so the price for energy is based on the cost of renewables.

4.3.1 Energy Cost Calculation

The cost of renewable energy has been estimated using the California Public Utilities Commission's *Renewable Portfolio Standard Quarterly Report* from the fourth quarter of 2012. The renewable energy cost from the report is less than \$0.09 per kWh for contracts approved in 2012.⁴ The model assumes a cost of \$0.09 per kWh. The 2012 cost is lower than previous years as more renewable energy has been

⁴ California Public Utilities Commission. *Renewable Portfolio Standard Quarterly Report*. 4th Quarter 2012. 5 June 2013. <http://www.cpuc.ca.gov/NR/rdonlyres/4F902F57-78BA-4A5F-BDFA-C9CAF48A2500/0/2012_Q3_Q4RPSReportFINAL.pdf>.



created under the program. In discussions with the California Energy Commission (CEC), officials stated that their forecasts for the future expected prices to stabilize as the market has approached equilibrium. Thus, no further real growth or reduction is expected beyond inflation.

4.3.2 Energy Usage

Based on energy use simulation modeling, rolling stock energy consumption at the pantograph is assumed to be 41.5 kWh per trainset mile during IOS and Bay to Basin and 43.0 kWh per trainset mile during Phase 1 Blended.⁵ Energy losses during transmission and distribution are assumed to be part of the energy cost.

4.4 Uniforms, Vehicles, and Supplies

4.4.1 Uniforms

Each member of the on-board crew will require a uniform. The uniform allowance is based on the uniform costs from the SFMTA Operating Budget for FY 2013-2014.⁶ Uniform costs are estimated at \$280 per employee per year. This does not apply to frontline employees or management.

4.4.2 Vehicles

On-board employees will require a small number of non-rail vehicles for supervisors to respond to incidents and get between crew bases in occasions when rail service is not an option. The vehicle fleet will consist of 1 car at each terminal and 4 cars at the HMF. The vehicles are priced based on the wet rate of \$28,752 per car per year based on Metrolink's rate for Std. 4WD Ext. Cab Pick Ups as a representative vehicle cost.

4.4.3 Supplies and cell phones

Frontline personnel will incur office supply costs and will require cell phones. The office supplies are assumed to be \$393 per year per frontline employee based on the SFMTA Operating Budget for FY 2013-2014.⁷ The cell phone allowance is estimated at \$650 per year per frontline employee based on the U.S. General Services Administration Cost Per Person Model.⁸

4.4.4 Travel

Based on the assumption that each employee would do a daily roundtrip and return to their home bases, and the additional staff added to allow for that, it is assumed that on-board personnel will not incur travel costs or have to stay overnight between runs. Some efficiency could potentially be gained by reducing the staffing level and allowing some employees to incur overtime and travel costs.

⁵ Specific Energy Consumption for Electric Traction—CHSTP. *Technical Memo*. November 20th, 2012.

⁶ SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.

⁷ SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.

⁸ U.S. General Services Administration. *Cost Per Person Model V2.0*. 14 October, 2013.

<http://www.gsa.gov/portal/content/105134>



5 Dispatching and Control Costs

The Dispatching and Control portion of the O&M model consists of the personnel and costs directly related to directing and controlling train operations.

5.1 Related Personnel

Dispatching and control personnel include dispatchers (both train and power) and various operations controllers such as the rolling stock operations controllers, infrastructure operations controllers, public information controllers, yardmasters, and so forth. These functions are further described in the ConOps but the O&M model estimates the costs for generic “dispatcher” positions that would encompass all of these functions.

5.2 Assumptions and Model Inputs

5.2.1 Primary Drivers

For the purposes of this model, the following assumptions pertaining to the dispatching and control personnel are made to allow order of magnitude comparison of costs when operating conditions change:

1. The primary driver of increases in the control center personnel headcount is assumed to be the phase of operations (as indicative of the length of the system and complexity of the operation).
2. It is assumed that each section of track that includes significant blended operations where high-speed rail trains interline with conventional rail will have its own Regional Control Center (RCC) to manage that section of track. However, this excludes interlined operations in approaches to stations as those will be dispatched by a combination of the Operations Control Center (OCC) and the Terminal Control Facility (TCF) at those stations.
3. TCF personnel are driven by the stations’ role as a temporary or permanent system terminal.
4. The previously assumed southern RCC has been removed from Phase 1 Blended based on the assumption that service into LAUS will be over exclusive high-speed rail track with no interlined service. In lieu of this facility, an additional dispatcher and other personnel (if needed) will be added to the OCC. The northern RCC will remain to support blended operations on the Caltrain Corridor. The southern RCC may be added at a later date if service is initiated south of Los Angeles in a blended fashion and the costs will be included in the model at that point.

5.2.2 Personnel Headcount

Train dispatching consists of four sets of functions: the OCC, the RCC, the TCFs, and the Yard Dispatchers. The OCC staffing is based on the phase of operation. RCCs are added whenever new blended operations come online. TCF staffing depends on the stations that are on the system. Finally, the yard dispatching is needed for each yard and maintenance facility.



The following is the staffing for the OCC under different phases of the system for each of 3 tours:

Table 6. OCC Headcount per Tour by System Length

Position	IOS	B2B	P1B
Director Operations Control (DOC)	1	1	1
Deputy DOC	1	1	1
Train Dispatcher	5	9	10
Total	7	11	12

The RCCs that are in charge of each section of blended operations are in operation for 2 tours per day and are assumed to have the following staff:

Table 7. RCC Headcount per Tour

Position	RCC Staffing
Director Operations Control (DOC)	1
Deputy DOC	1
Train Dispatcher	9
Total	11

The TCF staffing is dependent on the level of the station (Level A, B, or C) as described in Table 8. The TCFs are staffed while trains are in operations, which is 2 tours per day. Additionally, the Level A Station TCFs are minimally staffed for 1 tour per day when trains are not running (i.e. at night). Level C stations have no TCF staffing. The TCF staffing is as follows:

Table 8. TCF Headcount per Tour by Terminal Type

Position	Level B Stations	Level A Stations (during train operations)	Level A Stations (not during train operations)
Deputy DOC	1	1	1
Train Dispatcher	2	6	1
Total	3	7	2

Each maintenance facility is assumed to have 2 train dispatchers for yard dispatch duties (these would be yardmasters and facility dispatchers). Yard dispatchers are assumed to be on for 3 tours per day at the HMF and 2 tours per day at each of the other facilities. In the IOS, the southern maintenance facility would not include any dispatching duties.



5.2.3 Wages

Table 9. Dispatcher position wages

Employee(s)	Salary/ Contract Cost	Availability Applicable?	Source/Notes
OCC and RCC			
Director Operations Control (DOC)	\$106,005	Yes, 7-day	
Deputy DOC	\$92,153	Yes, 7-day	Midpoint of dispatcher and DOC
Train Dispatcher	\$78,300	Yes, 7-day	
TCF			
Deputy DOC	\$92,153	Yes, 7-day	Midpoint of dispatcher and DOC
Train Dispatcher	\$78,300	Yes, 7-day	
Yard			
Train Dispatcher	\$78,300	Yes, 7-day	

5.3 Vehicles and Supplies

5.3.1 Vehicles

Dispatchers will require a small number of non-rail vehicles for supervisors to respond to incidents and get between locations in occasions when rail service is not an option. The vehicle fleet will consist of 2 cars at the OCC. The vehicles are priced based on the wet rate of \$28,752 per car per year based on Metrolink's rate for Std. 4WD Ext. Cab Pick Ups as a representative vehicle cost.

5.3.2 Supplies and cell phones

All dispatch personnel including frontline will incur office supply costs and the frontline personnel will require cell phones. The office supplies are assumed to be \$393 per year per dispatch employee based on the SFMTA Operating Budget for FY 2013-2014.⁹ The cell phone allowance is estimated at \$650 per year per frontline employee based on the U.S. General Services Administration Cost Per Person Model.¹⁰

⁹ SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.

¹⁰ U.S. General Services Administration. *Cost Per Person Model V2.0*. 14 October, 2013.

<http://www.gsa.gov/portal/content/105134>



6 Maintenance of Equipment Costs

The Maintenance of Equipment portion of the model consists of personnel and other costs required to maintain trains. The model assumes a warranty period for major work that will be handled by the rolling stock manufacturer of three years (with two of those years before revenue train operations starts).

6.1 Related Personnel

Personnel in the rolling stock maintenance department are divided into the following categories:

1. Rolling Stock Maintenance Technicians
2. Rolling Stock Maintenance Supervisors
3. Mechanical Technicians
4. Electrical Technicians
5. Laborers
6. Storehouse Employees

6.2 Assumptions and Model Inputs

6.2.1 Inspections

1. Regulatory inspections are guided by the Code of Federal Regulations (CFR).
2. Each maintenance facility will perform regulatory inspections. Each team that will be doing routine maintenance will each consist of 13 people as follows:
 - 1 Supervisor
 - 7 Technicians
 - 2 Laborers
 - 3 Storehouse employees
3. The number of teams and tours at each facility depends on the amount of maintenance anticipated to take place there. The following number of tours and teams is assumed for each facility (note that for the number of teams listed is over *all* of the planned tours and the tours are generally listed for information purposes only):

Table 10. Maintenance Facility Regulatory Inspection Staffing

Teams and Tours at Maintenance Facilities	IOS	B2B	Phase 1 Blended
HMF	3 teams over 3 tours	3 teams over 3 tours	3 teams over 3 tours
Palmdale	2 teams over 2 tours	3 teams over 3 tours	4 teams over 3 tours
Gilroy	N/A	2 teams over 2 tours	2 teams over 2 tours
San Francisco	N/A	N/A	3 teams over 3 tours



4. Assumptions for occurrence of inspections:
 - Daily, every 48 hours, 182.5 inspections per year per trainset
 - Monthly, every 30 days, 12.167 inspections per year per trainset
 - 92 days, 4 inspections per year per trainset
5. Material costs for these inspections¹¹:
 - Daily, \$500 per inspection
 - Monthly, \$2,230 per inspection
 - 92 days, \$500 per inspection

6.2.2 Overhauls

1. Bogey inspections and overhaul generation inspections are driven by the mileage of the trainsets.
2. Overhauls occur only at HMF and once they start additional personnel are added beyond the requirements of the regulatory inspections. For each 600,000 miles that a trainset covers, a Bogey Inspection (BI) needs to be performed. Once Bogey Inspections begin, the following staff need to be added at the HMF:
 - 6 Supervisors
 - 37 mechanical technicians
 - 17 electrical technicians
 - 8 laborers
 - 10 storehouse employees
3. Wheel change outs will occur, on average, at every third BI or every 1.8 million miles and are added to the basic cost for that BI.
4. In addition, for every 1.2 million miles, each trainset needs to have an overhaul general inspection (OGI). Once these starts, the following personnel need to be added at the HMF (on top of the personnel hired for the BIs):
 - 4 Supervisors
 - 20 mechanical technicians
 - 16 electrical technicians
5. Materials for overhauls include:
 - Bogie/truck inspections(BI) cost \$127,000 per inspection¹²
 - Overhaul General Inspection (OGI) cost \$880,000 per inspection¹³
 - Wheel change outs cost \$150,000 per trainset.¹⁴

¹¹ Costs based on the Taiwan High Speed Rail Corporation Model of Maintenance Practices

¹² Costs based on the Taiwan High Speed Rail Corporation overhaul records

¹³ Ibid.

¹⁴ Ibid.



6.2.3 Wages

Table 11 summarizes the wages for Rolling Stock maintenance personnel.

Table 11. Rolling Stock and Building/Yard Maintenance Wages

Employee(s)	Salary/Contract Cost	Availability Applicable?
MOE Supervisors	\$74,964	7-day for inspections, 5-day for overhauls
MOE Technicians (including electrical and mechanical technicians)	\$59,233	7-day for inspections, 5-day for overhauls
Storehouse Employees	\$42,919	7-day for inspections, 5-day for overhauls
Laborers	\$47,845	7-day for inspections, 5-day for overhauls

6.3 Utilities

6.3.1 Energy Usage

Maintenance facility energy usage is estimated at 27 kWh per square foot based on the average of VTA's Guadalupe Facility (25 kWh per square foot) and UTA's Jordan River Facility (29 kWh per square foot).¹⁵

6.3.2 Water and Sewer

Maintenance facility water and sewer costs are estimated at \$0.176 per year per square foot and \$0.161 per year per square foot, respectively. These are based on the SFMTA Operating Budget for FY 2013-2014.¹⁶

6.3.3 Facility Size

The number and level of maintenance facilities that are planned for the system drive some of the MOE staffing needs and their size drives the energy usage. The levels of maintenance facilities explain the set of functions that they are able to perform. Typically, a facility will be able to perform functions up to a certain level (and including all lower level functions). The functions are described in the Concept of Operations (ConOps) as follows¹⁷:

1. Level 1: In-Service Monitoring
2. Level 2: Examination
3. Level 3: Periodic Inspections
4. Level 4: Overhauls
5. Level 5: Modifications and Major Repair

¹⁵ VTA Guadalupe Facility energy consumption provided by VTA on 26 Nov. 2012. UTA Jordan River Facility energy consumption provided by UTA on 27 Nov. 2012.

¹⁶ SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>

¹⁷ *Concept of Operations*. CHSTP. May 4th, 2012.



The facilities that are planned at each stage of the program are as follows:

Table 12. Maintenance Facilities and Levels by Phase

Facility	IOS	B2B	Phase 1 Blended
Level 5: HMF	On	On	On
Level 3: Palmdale	On	On	On
Level 2: Gilroy	Off	On	On
Level 3: San Francisco	Off	Off	On

The facilities have the following buildings and sizes, which are used to calculate the approximate energy consumption for these facilities:

Table 13. Heavy Maintenance Facility Buildings and Sizes

Heavy Maintenance Facility Building Function	Size (square feet)
Support & Administration Building	283,800
Maintenance Building	101,900
Wheel True Building	54,600
Maintenance of Way Building	40,050
Car Wash Building	58,200
Paint & Body Shop Building	54,600
Service & Inspection Building	134,650
Total (square feet)	727,800

Table 14. Non-HMF Maintenance Facility Buildings and Sizes

Maintenance Facility Buildings and Sizes	Sizes (square feet)	Locations		
		San Francisco	Gilroy	San Fernando
Support & Administration Building	127,960	X	X	X
Maintenance Building	45,935	X	X	X
Wheel True Building	24,610	X		X
Maintenance of Way Building	18,050	X	X	X
Car Wash Building	26,250	X		X
Paint & Body Shop Building	24,610			
Service & Inspection Building	60,700	X	X	X
Total (square feet)		303,505	252,645	303,505



6.4 Uniforms, Vehicles, Tools, Supplies, and IT/Software

6.4.1 Uniforms

Each member of the MoE staff will require a uniform. The uniform allowance is based on the uniform costs from the SFMTA Operating Budget for FY 2013-2014.¹⁸ Uniform costs are estimated at \$280 per employee per year. This does not apply to frontline employees or management.

6.4.2 Vehicles

MoE personnel will require a small number of non-rail vehicles to move people and materials between various locations in the facilities and between facilities. The vehicle fleet will consist of 2 cars for each maintenance facility and 4 cars at the HMF. The vehicles are priced based on the wet rate of \$28,752 per car per year based on Metrolink's rate for Std. 4WD Ext. Cab Pick Ups as a representative vehicle cost. Additionally, there will be 2 flatbed stake trucks at each maintenance facility and 4 flatbed stake trucks at the HMF. The flatbed stake trucks are priced at the Metrolink wet rate of \$38,940.

6.4.3 Tools

Consistent with the maintenance of infrastructure assumptions below, tools and other consumables are assumed to be five percent of the total labor cost.

6.4.4 Supplies and cell phones

Frontline personnel will incur office supply costs and will require cell phones. The office supplies are assumed to be \$393 per year per frontline employee based on the SFMTA Operating Budget for FY 2013-2014.¹⁹ The cell phone allowance is estimated at \$650 per year per frontline employee based on the U.S. General Services Administration Cost Per Person Model.²⁰

6.4.5 Information Technology / Software

Each maintenance of equipment facility will require some IT/software functionality. Based on the GSA per person cost model, the IT costs are estimated at \$5,000 per user profile. It is assumed that each maintenance facility will have 10 user profiles.

6.5 Cost Rationalization for BI and OGI Inspections

The average number of miles travelled by each trainset is assumed to be the total trainset miles for that year divided by the number of trainsets in the fleet at that time. However, if each trainset's actual usage is assumed to be the system wide average then the BI and OGI costs would have very large swings between years as each batch of trainsets all get the work done together. This would be an unrealistic scenario as actual operating practice would plan the overhauls and operations in a way that would have roughly the same amount of work to be done each year by running some trainsets more than others.

¹⁸ SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.

¹⁹ SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.

²⁰ U.S. General Services Administration. *Cost Per Person Model V2.0*. 14 October, 2013.

<http://www.gsa.gov/portal/content/105134>



It would be impractical to attempt to plan the equipment manipulation to this level of detail at this time. Instead, the model assumes that the operations will successfully rationalize the BI and OGI schedules. The model uses a 7-year rolling average for all but the first and last three years of the model after the end of the warranty period.

For the first three years, the model calculates the total expected expenditure in the first half of the model timeframe and compares it to the costs not included in the rolling averages. The difference is then allocated to the first three years assuming a ramp-up with $1/6$ of the difference in the first year, $1/3$ in the second year, and $1/2$ in the third year. For the last three years of the model, the difference between the total expenditure and the rolling average total is split evenly between the last three years.

This method creates a more accurate and realistic cost profile while maintaining the total costs over the model's estimating period. For a simplified example of how the rationalization is applied please see Appendix 3 MOE Cost Rationalization Example.



7 Maintenance of Infrastructure

The Maintenance of Infrastructure portion of the model includes the personnel, materials, tools, and equipment required to maintain the tracks and other infrastructure. It is assumed that most MOI activities will occur during one tour at night and that daytime MOI staffing will be aimed at maintenance that does not negatively impact train service and responding to unscheduled outages as they occur.

7.1 Related Operating Personnel

Personnel for the maintenance of infrastructure are divided into the following units:

1. MOI Facility Units
2. System Units
3. Specialty Units, including HMF Addition Unit, Crane/Tractor Unit, Facility Gang Addition Units

7.2 Assumptions and Model Inputs

7.2.1 Duties and Responsibilities of MOI Units

The description and duties and responsibilities of the MOI units are as follows:

1. **Basic MOI Facility**—A work force / equipment component providing Maintenance and Inspection functions. A Basic MOI Facility component will be added for each new line segment placed into service. It is assumed that the new line segment will be 100-150 route miles (proposed line segments which do not fall within these limits will require special consideration). This component includes work force and equipment to address responsibilities in the Track (including visual track inspection), Structures, Signal, Communications, Overhead Catenary System (OCS), Electric Traction (ET), and Utilities areas. It does not include track surfacing and alignment responsibilities which will be provided by a system work force.
2. **Initial System Unit**—a work force / equipment component, not attached to a specific facility, which has system-wide (or major line segment responsibility in an expanded system) responsibility for machine vision inspection, track replacement, alignment, surfacing and rail grinding, as well as, catenary repair, replacement and tensioning. The Initial System Unit will be augmented by the local MOI Facility Unit as required.
3. **HMF Addition**—a work force / equipment component work, added to a Basic MOI Facility component to maintain the yard track, switches, signals, and structures at the Heavy Maintenance Facility where major rolling stock repair, overhaul, and storage takes place.
4. **Crane/Tractor Unit**—Two specialty pieces of equipment, a Kirow Crane and a Tractor Low Boy with Flat Bed Trailer with operators expected to be added to the system concurrently but will work as needed and not necessarily in concert.
5. **2nd System Unit**—a work force / equipment component, not attached to a specific facility, which will share system-wide responsibility with the Initial System Unit, for track replacement, alignment, and surfacing. The 2nd System unit will be added when the Gilroy / San Jose segment is added to the original route from Merced to San Fernando Valley (if the planned



phasing is changed, the deployment of the 2nd System Unit will have to be reviewed). The Rail Grinder and OCS Gangs included with the Initial System Unit are not duplicated in the 2nd System Unit but the Kirow Crane and Tractor Low Boy with Flat Bed Trailer Unit (listed above) are planned to be added in conjunction with the 2nd System Unit. The 2nd System Unit will be augmented by the local MOI Facility Gang as required.

6. **Facility Gang Addition**—a work force / equipment component, added to a Basic MOI Facility component, work to provide additional support due to the challenges presented in certain locations. This component will be added for each Level 3 MOE facility (and for the Level 2 facility presently planned for Gilroy due to the number of trains expected to use that facility), system extension from San Fernando Valley to Los Angeles and from San Jose to San Francisco, and when service through the Tehachapi Mountains begins. When the system expands beyond the Phase 1 Blended system (into Phase 2), further analysis will be required to identify other challenges requiring FGAs.

7.2.2 Phasing of Units

1. It is envisioned that a Basic MOI Facility (BMF) will be commissioned when one segment of the system is in operation for construction, equipment testing, or other purpose. Additional BMFs are required as each segment of 100 - 150 route miles is added. An Initial System Unit (ISU) is required when two line segments are in operation.
2. The HMF Addition (HMFA), and Facility Gang Additions (FGA) will be added as those components of the system are brought online.
3. The 2nd System Unit will be added when the Gilroy / San Jose segment is added to the original route from Merced to San Fernando Valley (if the planned phasing is changed, the deployment of the 2nd System Unit will have to be reviewed).
4. The Crane /Tractor Unit will be added at the same time as the 2nd System Unit.
5. The following gangs are anticipated for each phase at this time:

Table 15. Number of MOI Gangs by Phase (as currently planned)

	IOS	Bay to Basin	Phase 1 Blended
Basic MOI Facility	3	4	5
Initial System Unit	1	1	1
Second System Unit	0	1	1
HMF Addition	1	1	1
Crane/Tractor Unit	0	1	1
Facility Gang Additions	2	3	6



7.2.3 Personnel Headcount

The following personnel are needed for the maintenance of infrastructure with each team working one tour per day. Descriptions of each staff position are summarized in Appendix 3. Assignments listed as “Day” will have coverage seven (7) days each week. Assignments listed as “Night” will be covered five (5) days. Each team will be managed by supervisory staff specialized in the area of responsibility for each team. Manpower is assigned as follows:

Table 16. MOI Staffing Levels by Facility/Addition

Labor	Basic MOI Facility		Initial System Unit		HMF Addition		Crane / Tractor Unit (B2B)		Second System Unit (B2B)		Facility Gang Addition *	
	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day
Track												
Foreman	1	1			1							1
Inspector	1				1							1
Asst. Inspector	1											
Operator	2	1			1		2					1
Laborer	2	1			1							1
Mechanic	1	1										
Truck Driver	1											
Welder	1											
Welder Helper	1											
Surfacing												
Foreman			1							1		
Asst. Foreman			1							1		
Inspector			1							1		
Operator			5							5		
Mechanic			1							1		
Truck Driver			1							1		
Rail Grinding												
Operator			1									
Technician			2									
Laborer			1									
Condensed Track Insp.												
Operator			1									
Technician			2									
Laborer			1									
Work Train												
Train engineer			1									
Conductor			1									

** This component will be added for each Level 3 MOE facility, system extension from SFV to LA and from SJ to SF, and when service through the Tehachapi Mountains begins.*



Labor	Basic MOI Facility		Initial System Unit		HMF Addition		Crane / Tractor Unit (B2B)		Second System Unit (B2B)		Facility Gang Addition *	
	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day
RR Structures												
Foreman	1											
Inspector	1											1
Operator	1											
Laborer	2											
Truck Driver	1											
ROW Structures												
Foreman	1											
Inspector	1											
Operator	1											
Laborer	1											
Truck Driver	1											
Signal												
Foreman	1	1			1							
Operator	1	1										
Systems Engineer	1											
Signal Engineer	1	1										
Signal Inspector	1											
Signal Maintainer	3	1			1							1
Communications												
Foreman	1											
Operator	1											
Comm. Engineer	1	1										
Comm. Technician	1											
Comm. Inspector	2	1										
Overhead Cat. System												
Foreman	1	1							1			
Asst. Foreman									1			
Inspector	1											1
Operator	2	1							3			
Laborer	2	1							4			
Truck Driver	1								1			
Lead Wireman	1								2			
Electrician (Hi Volt.)	1	1							2			



Labor	Basic MOI Facility		Initial System Unit		HMF Addition		Crane / Tractor Unit (B2B)		Second System Unit (B2B)		Facility Gang Addition *	
	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day	Night 5-day	Day 7-day
Electric Transmission/ Substations												
Foreman	1											
Inspector	1											1
Operator	1											
Laborer	1											
Stations / Wayside												
Foreman	1	1			1							
Operator	1	1										
Laborer	1	1			1							
Truck Driver	1											
Electrician	1	1			1							
Plumber	1	1			1							
TOTAL	56	19	19	0	10	0	2	0	24	0	8	0

In addition to the 10% of staff for front line management, another 10% cumulative (of front line staff and personnel in the field) is added for general administration and overhead staff and is part of the G&A staff described in the General Administration and Executive Management section.

7.2.4 Materials and Other Costs

1. Based on the UIC's International Benchmarking of Track Cost, materials for MOI are estimated as 15% of the total MOI labor cost.²¹
2. An additional 5% of the total labor cost (including frontline management) is assumed for miscellaneous tools, uniforms, and so forth.
3. Stations and other buildings are assumed to be maintained by the same maintenance teams as the infrastructure and their maintenance material costs are assumed to be the same percentage of the total costs.

7.2.5 Maintenance Vehicles

1. The MOI teams will also need to have both rubber tired and on-track vehicles. All vehicles are assumed to be leased with their costs based on Metrolink's actual wet costs for similar equipment where available. Where no data on the cost of leasing the vehicle was available, the annual wet lease cost is assumed to be 1/5th of the estimated purchase price. The cost for

²¹ International Union of Railways (UIC). *International Benchmarking of Track Cost*. 2001. 13 Nov. 2012. <http://www.urema.org/files/library/2001_Conference_Proceedings/00026.pdf>.



vehicle leasing/maintenance (wet rates) and the number of vehicles of each type needed are described in the following tables:

Table 17. MOI Equipment Assigned to Manpower Units

Equipment	Basic MOI Facility	Initial System Unit	HMF Addition	Crane/Tractor Unit (B2B)	Second System Unit (B2B)	Facility Gang Addition*
Track						
Hi-Rail Power Unit (Brandt Truck or Equiv.)	1					
1 Ton 4WD HR Crew Truck	1		1			
3/4 Ton 4WD HR Inspection	1					1
2 1/2 Ton HR Boom Truck	1					
2 1/2 Ton HR Welders Truck	1					
4WD Ext. Cab Pick Up	1					2
1 Ton Stake Bed Truck	1		1			
966 CAT (or equiv.) End Loaders	1					
Extended Reach Fork Lift	1					
Mechanics Truck (specialized)	1					
Fuel Lube Truck	1					
Speed Swings	1					
4WD HR Backhoes	1					
2.5 Ton HR Swivel Bed Dump Truck	1					
Field Induction Welding Truck HR (specialized)	1					
Rail Heaters (rail mounted)	2					
Ballast Cars	3					
Flat Cars	2					
Truck Mntd. Hydra. Rail Puller	2					
2 1/2 Ton HR Water Trucks (fire suppression and dust control)	1					
Portable Rail Train / Dollies	1					
Tie Exchangers		1			1	
2 ½ Ton, Hi-Rail Weed Spray Vehicle		1			1	
Surfacing						
1 Ton 4WD HR Crew Truck		1			1	
4WD Ext. Cab Pick Up		1			1	
Mechanics Truck (specialized)		1			1	
Production Multi. Tamper		1			1	
Dynamic Track Stabilizer		1			1	



Equipment	Basic MOI Facility	Initial System Unit	HMF Addition	Crane/ Tractor Unit (B2B)	Second System Unit (B2B)	Facility Gang Addition*
Ballast Regulator		1			1	
Tractor w/Low Boy & FB Trailer				1		
Kirow Crane				1		
Rail Grinding						
4WD Ext. Cab Pick Up		1				
Rail Grinder		1				
2 1/2 Ton HR Vacuum Truck		1				
Condensed Track Insp.						
Comprehensive Insp. Train		1				
Work Train						
Work Locomotive		1				
RR Structures						
1 Ton 4WD HR Crew Truck	1					
3/4 Ton 4WD HR Inspection	1					
2 1/2 Ton 4WD HR Bridge Inspection Boom Truck	1					
Hydraulic, Self Propelled Rail Lifts	1					
ROW Structures						
4WD Ext. Cab Pick Up	1					
Signal						
1 Ton 4WD HR Crew Truck	1					
3/4 Ton 4WD HR Inspection	1					1
2 1/2 Ton HR Boom Truck	1					
4WD Ext. Cab Pick Up	2		1			
3/4 Ton HR 4WD Maintainer / Wireman Truck (specialized)	4					
1 Ton Stake Bed Truck	1		1			
Communications						
2 1/2 Ton HR Boom Truck	1					
4WD Ext. Cab Pick Up	2					
Overhead Cat. System						
1 Ton 4WD HR Crew Truck	1				1	
4WD Ext. Cab Pick Up	1				1	
3/4 Ton HR 4WD Maintainer / Wireman Truck (specialized)	1				1	
OCS Equipped Wire Cars/Reel Trailer	1					
2 Piece Wire Stringing Unit					1	



Equipment	Basic MOI Facility	Initial System Unit	HMF Addition	Crane/Tractor Unit (B2B)	Second System Unit (B2B)	Facility Gang Addition*
Electric Transmission/ Substations						
1 Ton 4WD HR Crew Truck	1					
2 1/2 Ton HR Boom Truck	1					
4WD Ext. Cab Pick Up	2					
3/4 Ton HR 4WD Maintainer / Wireman Truck (specialized)	1					
Stations / Wayside						
2 1/2 Ton HR Boom Truck	1					
4WD Ext. Cab Pick Up	4		1			
TOTAL	56	11	5	2	10	4

Table 18. MOI Equipment Leasing Costs

Rubber Tire MOI Equipment	Monthly Lease Rate (Metrolink 2012 Base)	Unit Purchase Cost (Estimated)	Yearly Unit Cost/Rate
Hi-Rail Power Unit (specialized Brandt Truck or equiv.)		\$2,500,000	\$500,000
1 Ton 4WD, Hi-Rail Crew Trucks	\$3,245		\$38,940
3/4 Ton 4WD, Hi-Rail Inspection Vehicles	\$3,245		\$38,940
2 ½ Ton, Hi-Rail Boom Trucks (specialized)	\$9,418		\$113,016
2 ½ Ton, 4WD, Hi-Rail Bridge Inspection Boom Trucks (specialized)	\$12,245		\$146,936
2 ½ Ton, Hi-Rail Welders Trucks (specialized)	\$4,369		\$52,432
Std. 4WD Ext. Cab Pick Ups	\$2,396		\$28,752
3/4 Ton Hi-Rail, 4WD Maintainer/Wireman Trucks (specialized)	\$4,217		\$50,606
1 Ton, Stake Bed Trucks	\$3,245		\$38,940
966 CAT (or equivalent) End Loaders	\$11,464		\$137,568
Extended Reach Fork Lifts	\$3,840		\$46,080
Mechanic's Trucks (specialized)	\$4,217		\$50,606
Fuel Lube Truck	\$8,096		\$97,152
Speed Swings	\$3,840		\$46,080
FWD, Hi-Rail Backhoes	\$4,103		\$49,236
Production Multiple Tamper	\$20,822		\$249,864
Dynamic Track Stabilizer	\$32,358		\$388,296
Ballast Regulator	\$8,793		\$105,516
OHC Equipped Wire Cars/Reel Trailer		\$1,800,000	\$360,000
2 ½ Ton, Hi-Rail Swivel Bed Dump Truck	\$5,292		\$63,504
Field Induction Welding Truck, Hi-Rail, (specialized)		\$700,000	\$140,000



Rubber Tire MOI Equipment	Monthly Lease Rate (Metrolink 2012 Base)	Unit Purchase Cost (Estimated)	Yearly Unit Cost/Rate
Ballast Cars		\$10,000	\$2,000
Flat Work Cars		\$10,000	\$2,000
Tractor with Low Boy and Flat Bed Trailer		\$600,000	\$120,000
Rail Heaters (rail mounted)	\$7,816		\$93,792
Truck Mounted Hydraulic Rail Pullers		\$10,000	\$2,000
Portable Rail Train/Dollies	\$11,339		\$136,068
Hydraulic, Self Propelled Rail Lifts		\$8,000	\$1,600
Tie Exchangers		\$800,000	\$160,000
Work Locomotive Unit		\$2,000,000	\$400,000
Rail Grinder		\$2,500,000	\$500,000
Revenue Vehicle Mounted (Vehicle Truck Interaction Equipped)		\$200,000	\$40,000
2 ½ Ton, Hi-Rail Vacuum Truck		\$300,000	\$60,000
2 ½ Ton, Hi-Rail Water Trucks (fire suppression / dust control)	\$3,947		\$47,364
2 ½ Ton, Hi-Rail Weed Spray Vehicle	\$3,947		\$47,364
Comprehensive Inspection Train (Track/Cat./Signal)		\$25,000,000	\$5,000,000
Kirow Crane		\$2,500,000	\$500,000
Two Piece Wire Stringing Unit		\$7,500,000	\$1,500,000

7.2.6 Wages

Table 19 summarizes wages for Maintenance of Infrastructure personnel. Note that some positions are not listed specifically under the Signal, Communications, and OCS teams if they are already listed under the Track, Surfacing, Rail Grinding and Inspection, Structures, Stations/Wayside, and Electric Transmission/Substation Teams, in which case their wages are assumed to be the same.

Table 19. MOI Wages

Position	Salary	Availability Applies?
Track		
Foreman	\$67,890	5-day for night crew, 7-day for daytime protect crews
Inspector	\$63,624	5-day for night crew, 7-day for daytime protect crews
Asst. Inspector	\$61,073	5-day for night crew, 7-day for daytime protect crews
Operator	\$48,843	5-day for night crew, 7-day for daytime protect crews
Laborer	\$47,845	5-day for night crew, 7-day for daytime protect crews
Mechanic	\$56,940	5-day for night crew, 7-day for daytime protect crews
Truck Driver	\$47,835	5-day for night crew, 7-day for daytime protect crews
Welder	\$55,883	5-day for night crew, 7-day for daytime protect crews
Welder Helper	\$47,445	5-day for night crew, 7-day for daytime protect crews



Position	Salary	Availability Applies?
Surfacing		
Foreman	\$67,890	5-day for night crew, 7-day for daytime protect crews
Asst. Foreman	\$65,169	5-day for night crew, 7-day for daytime protect crews
Inspector	\$63,624	5-day for night crew, 7-day for daytime protect crews
Operator	\$48,843	5-day for night crew, 7-day for daytime protect crews
Mechanic	\$56,940	5-day for night crew, 7-day for daytime protect crews
Truck Driver	\$47,835	5-day for night crew, 7-day for daytime protect crews
Rail Grinding		
Operator	\$48,843	5-day for night crew, 7-day for daytime protect crews
Technician	\$61,047	5-day for night crew, 7-day for daytime protect crews
Laborer	\$47,845	5-day for night crew, 7-day for daytime protect crews
Condensed Track Insp.		
Operator	\$48,843	5-day for night crew, 7-day for daytime protect crews
Technician	\$61,047	5-day for night crew, 7-day for daytime protect crews
Laborer	\$47,845	5-day for night crew, 7-day for daytime protect crews
Work Train		
Train engineer	\$71,005	5-day for night crew, 7-day for daytime protect crews
Conductor	\$68,528	5-day for night crew, 7-day for daytime protect crews
RR Structures		
Foreman	\$67,890	5-day for night crew, 7-day for daytime protect crews
Inspector	\$63,624	5-day for night crew, 7-day for daytime protect crews
Operator	\$48,843	5-day for night crew, 7-day for daytime protect crews
Laborer	\$47,845	5-day for night crew, 7-day for daytime protect crews
Truck Driver	\$47,835	5-day for night crew, 7-day for daytime protect crews
ROW Structures		
Foreman	\$67,890	5-day for night crew, 7-day for daytime protect crews
Inspector	\$63,624	5-day for night crew, 7-day for daytime protect crews
Operator	\$48,843	5-day for night crew, 7-day for daytime protect crews
Laborer	\$47,845	5-day for night crew, 7-day for daytime protect crews
Truck Driver	\$47,835	5-day for night crew, 7-day for daytime protect crews
Signal		
Foreman	\$76,096	5-day for night crew, 7-day for daytime protect crews
Operator	\$48,843	5-day for night crew, 7-day for daytime protect crews
Systems Engineer	\$66,877	5-day for night crew, 7-day for daytime protect crews
Signal Engineer	\$53,982	5-day for night crew, 7-day for daytime protect crews
Signal Inspector	\$67,176	5-day for night crew, 7-day for daytime protect crews
Signal Maintainer	\$65,111	5-day for night crew, 7-day for daytime protect crews



Position	Salary	Availability Applies?
Communications		
Foreman	\$76,096	5-day for night crew, 7-day for daytime protect crews
Operator	\$48,843	5-day for night crew, 7-day for daytime protect crews
Comm. Engineer	\$71,285	5-day for night crew, 7-day for daytime protect crews
Comm. Technician	\$58,610	5-day for night crew, 7-day for daytime protect crews
Comm. Inspector	\$65,356	5-day for night crew, 7-day for daytime protect crews
Overhead Cat. System		
Foreman	\$76,096	5-day for night crew, 7-day for daytime protect crews
Asst. Foreman	\$70,352	5-day for night crew, 7-day for daytime protect crews
Inspector	\$67,176	5-day for night crew, 7-day for daytime protect crews
Operator	\$48,843	5-day for night crew, 7-day for daytime protect crews
Laborer	\$47,845	5-day for night crew, 7-day for daytime protect crews
Truck Driver	\$47,835	5-day for night crew, 7-day for daytime protect crews
Lead Wireman	\$49,583	5-day for night crew, 7-day for daytime protect crews
Electrician (Hi Volt.)	\$59,414	5-day for night crew, 7-day for daytime protect crews
Electric Transmission/ Substations		
Foreman	\$76,096	5-day for night crew, 7-day for daytime protect crews
Inspector	\$67,176	5-day for night crew, 7-day for daytime protect crews
Operator	\$48,843	5-day for night crew, 7-day for daytime protect crews
Laborer	\$47,845	5-day for night crew, 7-day for daytime protect crews
Stations / Wayside		
Foreman	\$67,890	5-day for night crew, 7-day for daytime protect crews
Operator	\$48,843	5-day for night crew, 7-day for daytime protect crews
Laborer	\$47,845	5-day for night crew, 7-day for daytime protect crews
Truck Driver	\$47,835	5-day for night crew, 7-day for daytime protect crews
Electrician	\$59,031	5-day for night crew, 7-day for daytime protect crews
Plumber	\$57,525	5-day for night crew, 7-day for daytime protect crews

7.3 Uniforms, Supplies, and IT/Software

7.3.1 Uniforms

Each member of the MoI staff will require a uniform. The uniform allowance is based on the uniform costs from the SFMTA Operating Budget for FY 2013-2014.²² Uniform costs are estimated at \$280 per employee per year. This does not apply to frontline employees or management.

²² SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.
<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.



7.3.2 Supplies and cell phones

Frontline personnel will incur office supply costs and will require cell phones. The office supplies are assumed to be \$393 per year per frontline employee based on the SFMTA Operating Budget for FY 2013-2014.²³ The cell phone allowance is estimated at \$650 per year per frontline employee based on the U.S. General Services Administration Cost Per Person Model.²⁴

7.3.3 Information Technology / Software

Each maintenance of equipment facility will require some IT/software functionality. Based on the GSA per person cost model, the IT costs are estimated at \$5,000 per user profile. It is assumed that each maintenance facility will have 10 user profiles.

7.4 Low Service Level Adjustments

During years when the service levels are relatively low (mostly during the first few years of operation), maintenance needs are anticipated to be somewhat lower, allowing for lower levels of staffing. While regulatory inspections and maintenance will still be required, fewer unexpected incidents are anticipated and fewer major maintenance issues are likely to be faced. Additionally, with lower service levels, acceptable response times to issues would be somewhat higher than during full service. To account for this, the following changes from the base assumptions are assumed for years when there are fewer than 50 total runs (25 roundtrips) per day:

1. One systemwide daytime protect crew is assumed (instead of one at each maintenance base)
2. One fewer maintenance base is assumed to be in operation, replaced by one *additional* Facility Gang Addition to provide flex maintenance coverage

²³ SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.

²⁴ U.S. General Services Administration. *Cost Per Person Model V2.0*. 14 October, 2013.

<http://www.gsa.gov/portal/content/105134>



8 Station Operations and Train and Station Cleaning

The Station Operations portion of the model consists of personnel and costs directly involved in the operation of passenger stations, including cleaning as well as police and security costs. Costs for train cleaning at stations as well as in yards are also included in this section.

8.1 Related Personnel

Station personnel include terminal managers, station managers, ticket agents, passenger assistance representatives, facility maintenance managers, station cleaners and so forth. In addition, the cost for police and security (including security at maintenance facilities) and the cost of personnel for cleaning train cars are included in this section.

8.2 Assumptions and Model Inputs

The following assumptions apply to station operation and cleaning, train cleaning staff, station energy usage, and police and security functions.

8.2.1 Station Operations and Cleaning

8.2.1.1 Primary Drivers

1. The primary driver effecting escalation of station personnel headcount is assumed to be the number of stations in the system and station ridership in each phase.
2. Stations fall under the following classifications:

Table 20. Station levels and descriptions

Level	Description	Stations
Level A	Final system configuration terminals	Los Angeles Union Station San Francisco Transbay Transit Center
Level B	Stations that serve as terminals under some phases of development or other major stations that are not Level A stations.	Merced San Jose San Fernando Valley (in IOS and B2B and)
Level C	Intermediate stations that never serve as system terminals	All Other Stations (including San Fernando Valley in P1B)

8.2.1.2 General Assumptions

1. Station personnel consists of an agent/station manager, a building systems manager, ticket clerks, and customer service representatives. The station staffing is driven by the role of the stations on the system. Level A and Level B stations have more staffing than Level C stations. Level B stations maintain their staffing levels even after they are no longer terminals on the system because they still maintain a prominent role on the system.
2. Each station is assumed to be staffed for customer operations utilizing 2 tours per day. Stations may be open for customer operations for up to 18 hours. The tours of the station personnel will be staggered in order provide the required coverage. In stations that have TCF capabilities, station staffing is in addition to TCF staffing except for the Building Systems Manager position,



which is shared between the TCF and the station staffing for Level A stations. For Level B Stations, the Building Systems Manager is assumed to be on for 1 tour per day in the IOS and 2 tours per day in the other phases.

- All stations that have passengers going through them will also require personnel to clean them. The level of staffing for station cleaning will depend on the level of the stations. Part-time cleaning positions are assumed to be half-time positions (4 hours per day).

8.2.1.3 Personnel Headcount

Table 21. Level C Station Headcount per Tour

Position	Headcount
Agent/Station Manager	1
Ticket Clerk	3
Total	4

Table 22. Level B Station Headcount per Tour by Phase (system length)

Position	IOS	B2B	P1B
Agent/Station Manager	1	1	1
Ticket Clerk	3	5	5
Total	4	6	6

Table 23. Level A Station Headcount per Tour

Position	Headcount
Agent/Station Manager	1
Ticket Clerk	6
Total	7

Table 24. Station Cleaning Staff by Station Level

Station Level	Number of Cleaning Crew Tours	Staff per Tour	Total Staff
Level A	2	8	16
Level B	2	5	10
Level C	1	2 (part-time)	1



8.2.2 Train Cleaning Staff

8.2.2.1 Primary Drivers

1. Trains going from revenue service to revenue service will generally be cleaned in the stations where they are being turned.
2. Trains going from revenue service to deadhead or from deadhead to revenue service will be cleaned at the maintenance facilities.

8.2.2.2 Personnel Headcount

Stations that have trains that terminate there and start a new revenue run there will have the following train cleaning staffing.

1. Station-based Train Cleaning Teams will consist of 10 people. However, these teams can be split into half-teams when necessary.
2. The number of teams that will be used to clean trains will be one team per 15 trains being turned from revenue to revenue service in that station rounded to the nearest half-team with no cleaning staff if three or fewer trains will be turned.
3. For example, with two trains being turned in a station²⁵, no cleaning teams will be required, with 10 trains being turned, there will be one full team, and with 20 trains being turned there will be one full team and one half team.
4. Yard Train Cleaning Teams will consist of 12 people and will work in conjunction with the yard maintenance teams.
5. The number of cleaning teams and tours at each facility depends on the amount of maintenance anticipated to take place there (that is based on the number of trainsets expected to be there). The following number of tours and teams is assumed for each facility (note that for the number of teams listed is over *all* of the planned tours and the tours are generally listed for information purposes only):

Table 25. Maintenance Yard Cleaning Staffing Tour

Teams and Tours at Maintenance Facilities	IOS	B2B	Phase 1 Blended
HMF	3 teams over 3 tours	3 teams over 3 tours	3 teams over 3 tours
Palmdale	2 teams over 2 tours	3 teams over 3 tours	4 teams over 3 tours
Gilroy	N/A	2 teams over 2 tours	2 teams over 2 tours
San Francisco	N/A	N/A	3 teams over 3 tours

²⁵ It is assumed that in cases where there is no cleaning staff at a station, the on-board staff and/or the station staff will do basic cleaning before returning the train to revenue service and a more thorough cleaning will be performed at the yard.



8.2.3 Wages

Table 26 summarizes the wages Station, Cleaning and Police and Security personnel.

Table 26. Station Administration and Station and Train Cleaning Wages

Employee(s)	Salary/Contract Cost	Availability Applicable?	Source/Notes
Station Administration			
Agent/Station Manager	\$66,225	Yes, 7-day	
Ticket Clerk	\$49,147	Yes, 7-day	
Station and Train Cleaning			
Trainset and Station cleaning	\$36,616	Yes, 7-day	

8.2.4 Utilities

8.2.4.1 Energy Usage

Table 27 summarizes the total building area of each station as they are planned at this point. These stations are generally in their conceptual levels of design and will continue to change as the design advances through coordination with local municipalities and agencies. These figures are used to calculate the total energy costs for stations. Station utility costs are estimated at 14.3 kWh per square foot based on the Energy Information Agency's average for retail buildings.²⁶

Table 27. Station Building Areas (subject to change as design advances)²⁷

Station	Total Building Area (square feet)
San Francisco Transbay (inc Caltrain)	640,000
Merced	131,400
Millbrae	125,000
San Jose	294,000
Gilroy	136,600
Fresno	168,800
Kings/Tulare	145,200
Bakersfield	140,200
Palmdale	163,200
San Fernando Valley	192,200
LA Union Station	427,200

²⁶ Energy Information Agency. *Commercial Building Energy Consumption Survey*. 2003.

http://www.eia.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html Accessed 10 Dec. 2012.

²⁷ The model includes the ability to add the other stations under consideration for the system including infill stations such as Mid-Peninsula, San Francisco 4th and King, Burbank, Norwalk/Santa Fe, Anaheim, and Phase 2 stations but all of those stations are currently turned off.



8.2.4.2 Water and Sewer

Station water and sewer costs are estimated at \$0.176 per year per square foot and \$0.161 per year per square foot, respectively. These are based on the SFMTA Operating Budget for FY 2013-2014.²⁸

8.3 Uniforms, Vehicles, Tools, Supplies, and IT/Software

8.3.1 Uniforms

Each member of the station staff will require a uniform. The uniform allowance is based on the uniform costs from the SFMTA Operating Budget for FY 2013-2014.²⁹ Uniform costs are estimated at \$280 per employee per year. This does not apply to frontline employees or management.

8.3.2 Vehicles

Station personnel will require a small number of non-rail vehicles to move supervisors and other personnel around, as necessary. The vehicle fleet will consist of 1 car at each terminal. The cars are priced based on the wet rate of \$28,752 per car per year based on Metrolink's rate for Std. 4WD Ext. Cab Pick Ups as a representative vehicle cost. Additionally, there will be 1 flatbed stake truck at the HMF. The flatbed stake trucks are priced at the Metrolink wet rate of \$38,940.

8.3.3 Supplies and cell phones

Frontline personnel will incur office supply costs and will require cell phones. The office supplies are assumed to be \$393 per year per frontline employee based on the SFMTA Operating Budget for FY 2013-2014.³⁰ The cell phone allowance is estimated at \$650 per year per frontline employee based on the U.S. General Services Administration Cost Per Person Model.³¹ Cleaning personnel will require cleaning supplies. The cleaning supplies are priced at \$71 per year per employee based on the SFMTA Operating Budget for FY 2013-2014.

8.3.4 Information Technology / Software

Each station will require some IT/software functionality. Based on the GSA per person cost model, the IT costs are estimated at \$5,000 per user profile. It is assumed that each station will have two user profiles and each terminal will have 4 user profiles.

²⁸ SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>

²⁹ SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.

³⁰ SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.

³¹ U.S. General Services Administration. *Cost Per Person Model V2.0*. 14 October, 2013.

<http://www.gsa.gov/portal/content/105134>

SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.



9 Police and Security Positions

This section provides the position titles, assumptions, and headcount analysis for police and security functions.

9.1 Primary Drivers

1. The planned number of facilities and passenger stations for each segment, and the total route miles of the system.
2. The planned size and function of the stations (Level A, B, or C).
3. Supervisory requirements for a workforce of various sizes.

9.2 General Assumptions

1. Personnel are divided into two categories:
 - A **Sworn Police Officer** is a trained law enforcement officer provided by a local jurisdiction. Each station will have three sworn officers to cover all necessary functions. Level A stations will have an additional three sworn officers. The sworn officer will be responsible for policing their station and patrolling the right-of-way. Other duties aside from normal policing include parking lot patrols, fare evasion detection, receiving criminal complaints from patrons, crowd control, and patron assistance (as necessary).
 - An **Unsworn Officer or Security Guard** is a trained security person in the employ of a certified security firm/contractor. Unsworn officers will be positioned at each station, equipment maintenance facility, and maintenance of infrastructure base. The Level A stations will have 12 total unsworn officers, Level B and C stations will have 7.5 total unsworn officer FTEs, and maintenance facilities and MOI bases will have 6 unsworn officers.
2. The positions identified above are assumed that they will be personnel under law enforcement agreements with local jurisdictions for the police function and under security service agreements with private security firms for the security function. However, for current modeling purposes, the costs are estimated consistent with the rest of the model as non-contracted positions but using the appropriate rates from those organizations.
3. Command staff will consist of “frontline supervisors” (Sergeants) and management staff (Lieutenants, etc.). Frontline supervisors will be assigned as 10% of the positions needed. Management of the police and security functions will fall in the 10% of management and administration staff that is assumed.
4. Security guards and sworn police officers are assumed to work 40-hour weeks.
5. Many separate contracts will need to be negotiated for each station and for security under each phase.



9.3 Personnel Headcount

The following assumptions are applied to police and security staff:

Table 28. Baseline Assumptions: Police and Security Positions

Facility Types	Police Positions (Total FTEs)	Security Positions (Total FTEs)
Maintenance Facility / MOI Base	0	6
Level B and C Stations	3	7.5
Level A Stations	6	12

9.4 Equipment, Vehicles, Supplies, Disposables

The police and security functions will require significant amounts of equipment for their operations. The equipment needs and drivers are as follows:

Table 29. Police and Security Equipment, Vehicles, and Disposable Supplies, Fuels, etc.

Equipment	Driver	Annual Cost
Equipment		
Personal equipment (e.g. uniforms, guns, handcuffs, etc.)	Sworn officers including command staff (frontline and G&A)	\$2,000 / officer
Personal equipment	Unsworn officers including command staff	\$1,000 / officer
Vehicles		
Police Vehicles (2 per station)	Level A stations	\$7,714 / car (amortized cost)
Police Vehicles (1 per station)	Level B and C stations	\$7,714 / car (amortized cost)
ATVs (1 per station)	Level A stations	\$3,000 / ATV (amortized cost)
Disposables		
Car fuel and disposables	Cars	\$20,000 / car
ATV fuel and disposables	ATVs	\$5,000 / ATV
Supplies for each Officer (flares, gloves, etc.)	Sworn Police Officers	\$1,000 / officer



10 Commercial Costs and Functions

10.1 Marketing and Distribution

10.1.1 Marketing and Advertising

Marketing and advertising costs are based on the number of people that the advertising campaign is trying to reach and the number of impressions that will be required for the campaign to have an impact. People generally need to see an advertisement more than once for them to be influenced by it. This concept is called the effective frequency of the advertising and it generally ranges from three to five, depending on the campaign, product, target audience, etc.³² For purposes of the estimate produced here, five will be considered the effective frequency. It is assumed that there will be three campaigns per year, each with five as their effective frequency (for a yearly frequency of 15 for all campaigns).

When the operator of the system will design their advertising campaign, they will target specific market segments and populations. However, it is premature at this point for the plans to go into that level of detail. Instead, the model assumes that the campaign will reach every person in a select number of counties in California. For purposes of the model, it is assumed that no advertising will take place in other states. The counties that will be targeted by each phase are as follows:

Table 30. Counties to be targeted by the advertising campaign for each phase

County	IOS	B2B	Phase 1 Blended
Alameda	Yes	Yes	Yes
Alpine			
Amador			Yes
Butte			
Calaveras			Yes
Colusa			
Contra Costa	Yes	Yes	Yes
Del Norte			
El Dorado			
Fresno	Yes	Yes	Yes
Glenn			
Humboldt			
Imperial			
Inyo			
Kern	Yes	Yes	Yes
Kings	Yes	Yes	Yes
Lake			
Lassen			
Los Angeles	Yes	Yes	Yes
Madera	Yes	Yes	Yes
Marin		Yes	Yes
Mariposa	Yes	Yes	Yes
Mendocino			

³² Professional Advertising. Advertising Planning. <http://www.myprofessionaladvertising.com/Advertising%20Planning.htm>. Accessed 11.7.12.



County	IOS	B2B	Phase 1 Blended
Merced	Yes	Yes	Yes
Modoc			
Mono			
Monterey		Yes	Yes
Napa		Yes	Yes
Nevada			
Orange	Yes	Yes	Yes
Placer			
Plumas			
Riverside	Yes	Yes	Yes
Sacramento			Yes
San Benito	Yes	Yes	Yes
San Bernardino	Yes	Yes	Yes
San Diego			Yes
San Francisco	Yes	Yes	Yes
San Joaquin		Yes	Yes
San Luis Obispo			Yes
San Mateo	Yes	Yes	Yes
Santa Barbara			Yes
Santa Clara	Yes	Yes	Yes
Santa Cruz		Yes	Yes
Shasta			
Sierra			
Siskiyou			
Solano		Yes	Yes
Sonoma			
Stanislaus	Yes	Yes	Yes
Sutter			
Tehama			
Trinity			
Tulare	Yes	Yes	Yes
Tuolumne			Yes
Ventura	Yes	Yes	Yes
Yolo			
Yuba			

The populations of those counties in future years are listed in County Population Projections. To calculate the cost of the advertising, the number of impressions needs to be multiplied by the cost per impression. Costs for media purchases and impressions vary by the media type to be used. It is expected that the high-speed rail system would advertise on some combination of television, online, print, radio, and outdoor media.

According to eMarketer's Online Brand Management Report, the costs for these various media types vary significantly. Since it is too early to create an advertising plan by media type, it assumed that the advertising cost will be equal to the highest cost in eMarketer's data, which is \$10.25 (in 2008 dollars)



per 1,000 impressions for broadcast television.³³ Escalated to 2012 dollars using CPI escalation yields a cost of \$10.77 per 1,000 impressions. Since the actual mix of media purchases is unknown at this time, the highest cost was assumed as the worst case scenario. Similarly, the number of impressions and the demographics to be reached are also taken as worst case options to avoid underestimating of costs.

10.2 Distribution and Credit Card Sales

Distribution costs include those costs that will be incurred to sell tickets and operate other customer-centered functions such as call centers. For purposes of the model, the main distribution costs that have been included are the costs associated with operating a call center and website and credit card fees on ticket sales.

The website is assumed to be able to generate advertising revenue and be cost neutral. The call center costs are estimated as a top-down commission on a portion of the sales. Based on SNCF's experience, 2 percent of ticket purchases are assumed to be through call centers in all but the first two years. For the first two years, it is assumed that the call center purchase percentage will be 4 percent to account for people getting used to the service. The rest of the sales are assumed to take place over the internet and in stations.

Call centers have two costs: for sales and for information. It is assumed 1/3 of the calls will be for information only and 2/3 will be for ticket purchases. To cover the total cost of all of the calls, it is assumed that a 15 percent commission will be applied to the sales conducted through the call center. Thus the cost of the center will be 0.6 percent of sales in the first two years and 0.3 percent of sales thereafter.

Credit card sales costs are calculated as a percentage of total revenue generated. As the rates charged by individual credit card companies vary by transaction type and amount, it would not be practical to model each type. Instead, a general percentage is used based on Amtrak's testimony in front of the Subcommittee on Financial Services and General Government of the Senate Committee on Appropriations on Amtrak's experience with credit card sales.³⁴ According to the testimony, 90 percent of Amtrak's ticket sales were purchased with credit cards and the average credit card fee cost was 2.27 percent of the ticket revenue. The model assumes that the credit card fees for the system will be similar to Amtrak's at 2.27 percent but that 100 percent of the transactions will be with credit cards to account for continued expansion of credit card use in coming years.³⁵

³³ Geoffrey Ramsey. *Online Brand Management: Connecting the Dots*. eMarketer.

http://www.emarketer.com/docs/emarketer_online_brand_measurement_report.pdf. Accessed: 11.7.12.

³⁴ *Statement of Janet Langenderfer Senior Director, Credit Cards National Railroad Passenger Corporation*, 111th Cong. (2010) (testimony of Janet Langenderfer). <http://www.amtrak.com/ccurl/798/198/2010-06-16%20Langenderfer%20Sen%20Approps.0.pdf> Accessed 11.13.12.

³⁵ It is acknowledged that even in future years there will likely be some small percentage of transactions that will be paid for with cash. However, to avoid underestimating potential costs by assuming a smaller than necessary percentage of credit card sales, 100 percent of sales was used.



10.3 Bus Costs

10.3.1 Cost per Mile

The cost of dedicated feeder coach service was estimated from a review of data and discussions with contract operators. In a recent study by Caltrans, rural intercity bus operations in the state were found to have costs per revenue service mile ranging from \$1.25 to \$3.62 (in 2007 \$) with a weighted average of \$2.60 per mile and with very light density service accounting for the upper end of the cost spectrum.³⁶ Discussion with one intercity coach industry executive produced an estimate of around \$65-\$75 per revenue service hour, including the supply of coaches, operation, and establishment / operation of depot and maintenance facilities for a more intense service as would be needed to meet high-speed rail trains.³⁷ Additionally, data from Amtrak's Thruway service showed costs ranging from \$1.99 to \$4.07 (in 2012 \$) per revenue service mile for the various routes with a weighted average cost of \$3.16 per mile. The data from Caltrans' rural intercity bus service study and from Amtrak's Thruway buses is shown in Amtrak Thruway and Rural Intercity Bus Costs.

The model uses \$3.16 per mile as the cost for connecting bus service as the Amtrak Thruway buses are more representative of the service that would be provided than the rural intercity bus routes. However, the rural intercity routes provide a good cross-check on the value for bus costs and the Amtrak Thruway weighted average falls in the higher part of the range for those routes.

10.3.2 Bus Miles

The number of bus miles is determined by the number of riders at each station that use the bus connections for station access. This is dependent on the service plan for the system as well as connecting bus services that are expected to be offered. Deadhead miles are added to the revenue miles to reach a bus miles total. Caltrans Division of Rail provided the deadhead percentage for a representative medium-distance bus route (Sacramento to Reno and Sparks, NV) of 7.4%.³⁸ This percentage is assumed to be applicable to the planned bus connections to the high-speed rail system and is applied uniformly for each year.

10.4 Operator Profit

It is currently assumed that operator profit will be calculated and evaluated separately. As such, it is not currently included in the model.

10.5 Tax Liability

It is currently assumed that tax liabilities will be calculated and evaluated separately. As such, it is not currently included in the model.

³⁶ KFH Group, "California Statewide Rural Intercity Bus Study, Final Draft", Caltrans Division of Mass Transportation, 2007, table 3-9, online at <http://www.dot.ca.gov/hq/MassTrans/Docs-Pdfs/5311/Bus-Study/Chapter-3.pdf>.

³⁷ Conversations with Stanley G. Feinsod, Chairman of the Board, MacDonald Transit Associates and Fullington Auto Bus Company, and business development advisor to RATP Dev USA.

³⁸ Data provided by Caltrans Division of Rail on 11/16/12.



11 General Administration and Executive Management

The executive and corporate organization is comprised of senior level personnel and experienced support staff who lead and direct the organization at the command and policy level. The organization's chief executive (CEO, President, or Executive Director) chairs this group whose members oversee the major departments and their functions. The positions described in this section are illustrative of the major functions that comprise management. However, the number of personnel required to fill these functions is calculated as a percentage of the total personnel employed at the system.

11.1 Related Personnel

The Executive and Corporate Organization is comprised of several organizational levels. The top of the organization consists of the *Chief Executive Officer(CEO)*—the top officer of the organization. The CEO reports to a senior board of appointed individuals and is responsible for the highest level of decision-making and policy setting.

The executive/corporate functions of a railroad organization immediately below the CEO are generally divided into the following areas of responsibility and are represented by the titles which accompany them. The examples below illustrate management positions typically used in other organizations:

1. The *Senior Vice President of Operations* is responsible for the railroad's primary operating functions: the operation of trains and transportation of customers, the maintenance and repair of the rolling stock, the maintenance and repair of the infrastructure, the selling of tickets and the customer services provided in the passenger station. These areas are directed and managed by department heads, reporting to the VPO.
2. The *Vice President of Safety* is responsible for corporate safety policies and procedures, for directing regulatory requirements and managing safety data and reporting, and overseeing the effectiveness of the departmental safety programs.
3. The *General Counsel* is responsible for representing the railroad in general legal matters and litigation as determined by the General Counsel. It is commonly related to corporate law, liability and claims, contracts, labor law, insurance, and so forth.
4. The *Vice President of Finance* is responsible for the development of the budget, payroll, general accounting, accounts payable, revenue accounting, and pertinent financial policies and procedures for the organization. It manages financial forecasting and reporting, bookkeeping, and other corporate finance responsibilities as necessary.
5. The *Vice President of Human Resources* is responsible for developing and managing the primary HR policies and procedures, functions of recruiting and hiring, personnel administration and records management, diversity management, and benefits administration
6. The *Vice President/Director of Labor Relations* is responsible for preparing and managing labor agreements for conducting labor negotiations, managing disputes, and providing direction to departments that are affected by labor contracts and practices. This area is often included in the Human Resources section.



7. The *Director of Contracts* directs and manages the development of contracts for material and services needed by the organization.
8. The *Vice President of Planning* is responsible for a range of corporate planning functions to include capital program infrastructure and fleet procurement plans, strategic (long term) investment and planning, and may include train service planning.
9. The *Vice President of Systems and Information Technology* is responsible for developing the corporate strategy, policies, and procedures on information systems based upon the technology needs of the organization. It directs the purchase, development, installation, and maintenance of the information systems.
10. The *Vice President/Director of Public Affairs/Marketing* directs the corporate communication strategy and manages communications with the media, with the public, with offices at all government levels. It represents the organization in public venues and develops policies and procedures for the management of information at the railroad.
11. Other positions, including Internal Auditing, may be elevated to the corporate level as a way to maintain direct linkage to the chief executive and preserve the priority of the function.

These sections or departments are most often structured in the senior staff level of the railroad. Their position in the structure depends upon the “corporate organization” philosophy and thus not assured of this positioning. They are included here for the purpose of creating an illustrative structure and establishing a placeholder for the functions required at this level.

11.2 Assumptions and Model Inputs

The following assumptions are made concerning the executive and corporate level of the organization:

1. The total headcount for management and administration of the system is assumed to be 10 percent of the organization below this level.
2. Executive positions are estimated to comprise 5 percent of this subtotal and are assumed to be compensated at senior executive rates.
3. Senior manager positions below executives are estimated to comprise 10 percent of the subtotal and are assumed to be compensated at a rate 25 percent below executive rates.
4. Mid-managers are estimated to comprise 25 percent of the subtotal and are assumed to be compensated at a manager’s/supervisor’s rate.
5. Administration and other lower level corporate staff are estimated to comprise 60 percent of the subtotal and will be compensated accordingly.
6. The allocation of positions with the G&A staffing is based on a comparison with other railroad properties in the U.S. and high-speed rail systems abroad.



11.3 Wages

Table 31 summarizes wages for executive and corporate personnel.

Table 31. Executive and Corporate Wages

Employee (s)	Salary	Availability Applies?
Executives	\$200,000	No
Senior Management	\$150,000	No
Mid-Level Managers	\$100,000	No
Admin/Lower Level Corporate Staff	\$50,000	No

11.4 Vehicles, Tools, Supplies, IT/Software, and Travel

11.4.1 Vehicles

G&A personnel will require a small number of non-rail vehicles to personnel around, as necessary. The vehicle fleet will consist of 8 cars in the IOS, 12 cars in B2B, and 16 cars in Phase 1 Blended. The cars are priced based on the wet rate of \$28,752 per car per year based on Metrolink's rate for Std. 4WD Ext. Cab Pick Ups as a representative vehicle cost.

11.4.2 Supplies and cell phones

All G&A personnel will incur office supply costs and the managers will require cell phones. The office supplies are assumed to be \$393 per year per G&A employee based on the SFMTA Operating Budget for FY 2013-2014.³⁹ The cell phone allowance is estimated at \$650 per year per manager (G&A employees at the mid-management level or higher) based on the U.S. General Services Administration Cost Per Person Model.⁴⁰

11.4.3 Information Technology / Software

Each G&A employee will require IT/software functionality. Based on the GSA per person cost model, the IT costs are estimated at \$5,000 per user profile. It is assumed that each G&A employee will have a user profile.

11.4.4 Travel

It is assumed that the managers would incur some amount of travel expenses per year. With most in-state trips being done via the high-speed rail system, most of the travel cost would be out-of-state travel. The costs are estimated at \$1,000 per year for mid-managers, \$3,000 per year for senior managers, and \$10,000 per year for executive managers.

³⁹ SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.

⁴⁰ U.S. General Services Administration. *Cost Per Person Model V2.0*. 14 October, 2013.

<http://www.gsa.gov/portal/content/105134>

SFMTA. *SFMTA Operating Budget for FY 2013-2014*. 14 October, 2013.

<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>.



12 Insurance

Insurance costs were estimated at \$25 million per year in the 2012 Business Plan. This estimate was created based on review of current insurance costs for commuter rail agencies across the country. To further evaluate the system's potential purchased and self-insurance costs, the Authority began work with an insurance consultant to produce estimates for liability, property, and business interruption insurance. However, the consultant was unable to come up with a reasonable way to model the impacts of the high-speed rail system's enhanced safety features on the anticipated insurance costs. The Authority continues to investigate the potential insurance costs for the system but without high-speed rail precedents in the U.S., there are few reliable examples to use.

While the analysis of insurance costs continues, the Authority has doubled its insurance cost estimate for Phase 1 Blended to \$50 million per year and has assumed a cost of \$40 million per year for Bay to Basin and \$25 million per year for the IOS.



13 Contingency

The model contains two sets of contingencies: unallocated contingency to account for unknown unknowns that may arise in the operations and maintenance of the system and allocated contingency to account for known risks, uncertainties, and unknowns associated with individual cost categories. The contingency percentages that were applied followed the guidance from the DOT IG's Report for systems at intermediate stages of development (of 20-40 percent total contingency) and the UIC's recommendation that contingencies for the O&M model should be similar to those used in the capital cost model.

13.1 Unallocated Contingency

Unallocated contingency was set at 5 percent of costs before contingency. This is the same as the unallocated contingency applied in the capital cost estimates and is deemed sufficient to account for unknown unknowns and unexpected costs that may come up.

13.2 Allocated Contingency

Allocated contingency percentages were applied to account for risk and uncertainty associated with individual elements in the model based on the team's evaluation of the quality and reliability of information that is being used. To create the allocated contingency percentages, each team member provided an evaluation of 1 to 5 of the reliability of each of the elements (with 1 being low reliability/confidence and 5 being high reliability/confidence). Additionally, each team member provided the reasons for their confidence or lack of confidence in the estimate.

These ratings were averaged between the team members and a contingency percentage was assigned so that total contingency fell in the range recommended by the DOT IG. The minimum allocated contingency (for a rating of 5) was 15 percent and the maximum (for a rating of 1) was 35 percent.⁴¹ The ratings and allocated contingency percentages are presented in Table 32, the full table of ratings from each team member and reasons for their confidence/lack thereof are presented in Allocated Contingency Risk/Uncertainty Ratings and Percentages. The overall contingency levels ranged from 21 percent to 30 percent, consistent with the capital cost estimates and with the expectations in the DOT IG report for a system moving through the intermediate stage of design.

Table 32. Allocated contingency percentages by cost category

Cost Category	Average Team Confidence Rating	Allocated Contingency Percentage (%)
Labor		
Maintenance of Equipment	4.00	20.00
Maintenance of Infrastructure	3.50	22.50
On-board staff (including roustabouts, drill crews, and protect crews)	3.75	21.25
Dispatching	4.75	16.25

⁴¹ The range of allocated contingencies is 15 to 35 percent because there is 5 percent unallocated contingency leading to a total contingency of 20 to 40 percent, as recommended by DOT IG.



Cost Category	Average Team Confidence Rating	Allocated Contingency Percentage (%)
Train Cleaning and Station Maintenance Staff	4.25	18.75
Stations	3.50	22.50
Police and Security	4.33	18.33
G&A	3.75	21.25
Materials, Tools, and Other Direct Costs		
MOI Materials (including stations)	3.50	22.50
MOI Tools, Uniforms, etc.	3.88	20.63
MOI Vehicles	3.00	25.00
Vehicles besides MOI and Police and Security	3.67	21.67
Police and Security Vehicles	4.00	20.00
Police and Security Equipment	4.00	20.00
Station Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4.33	18.33
On-board Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4.33	18.33
Dispatch Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4.33	18.33
MOI Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4.33	18.33
MOE Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4.33	18.33
G&A Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4.33	18.33
MOE Tools, Uniforms, etc.	3.88	20.63
MOE Regulatory Inspections	3.75	21.25
MOE General Overhauls and Bogey Inspections	3.50	22.50
Utilities		
Train Operations Energy	4.13	19.38
Stations and Maintenance Facilities Energy	3.50	22.50
Station and Maintenance Facility Water and Sewer	3.17	24.17
Other Costs		
Bus Costs	3.38	23.13
Advertising	3.67	21.67
Credit Card Sales	4.00	20.00
Distribution (Call Center)	3.67	21.67
Insurance	4.33	18.33



14 Operations Startup and Commissioning

14.1 Rolling Stock Procurement

Table 33 below describes a possible delivery schedule for rolling stock. It is based on three considerations: an April 29, 2009 memorandum titled CHSTP Trainset Procurement which finds that based on outreach to potential vendors it is reasonable to assume delivery of up to 10 train sets in one year; the Service Plans for IOS, B2B and Phase 1 Blended; and, the rate of ridership growth projected in the 2012 Business Plan.⁴² This delivery schedule may be modified at the time of purchase based on vendor input and capital considerations.

Table 33. Potential Rolling Stock Delivery Schedule

Delivered and accepted by	System Development Step	Additional	Total
2022	IOS	-	15*
2023	IOS	7	22
2024	IOS	7	29
2025	IOS	7	36
2026	IOS	7	43
2027	B2B	7	50
2028	B2B	4	54
2029	Phase 1 Blended	4	58
2030	Phase 1 Blended	4	62
2031	Phase 1 Blended	4	66
2032	Phase 1 Blended	4	70
2033	Phase 1 Blended	2	72

*The initial 15 Trainsets would be delivered over a two year period but would start revenue service at the same time.

14.2 Testing and Commissioning

Testing and commissioning costs are currently not addressed in the model because the model only looks at operating costs after the start of revenue service. Testing and commissioning costs are accounted for in the capital cost estimate.

⁴² CHSTP Train Procurement. PMT Memo. April 29, 2009.



15 Monte Carlo Risk Analysis

Monte Carlo simulations rely on repeated random sampling from a range of variable inputs to determine the probability of different cost, schedule, revenue or other outcomes.

In a traditional, 'bottom-up', analysis, point estimates, e.g., how long a planned activity in a schedule is expected to take, are replaced with a range of possible durations so that instead of '45 days' the activity may take between 40 and 60 days. The possibility of unplanned activities or unexpected costs (risks) may also be included as inputs. The algorithm takes this information and simulates a possible outcome given the underlying schedule or cost estimate and uncertainty/risk. By doing this thousands of times, the program can determine the probability of a particular outcome and answer questions such as how likely it is that a project will finish on time or on budget.

In a top-down analysis, the algorithm works much the same way and is used for the same purposes, but instead of individual schedule activities or costs, it uses actual outcomes from similar projects to determine the probability of certain outcomes, e.g. that, a particular revenue projection will be met or costs will be below a certain target.

Monte Carlo simulations are part of a broad class of computational algorithms that rely on repeated random sampling to determine the range of possible outcomes along with the probability of those outcomes. Monte Carlo simulations are used in a variety of ways on this program to determine possible cost, schedule or revenue outcomes when uncertainty and risk are incorporated into the underlying models. In moving toward a risk-based approach to O&M cost estimating, the Authority performed both a top-down, or reference class analysis, and a bottom-up analysis evaluating specific risk/uncertainty factors.

The most common way Monte Carlo methods are used on this program and others is as part of a 'bottom-up' analysis, replacing point-estimates with probability distributions and incorporating risks into the baseline cost estimate, schedule or revenue projection to calculate possible cost, schedule, revenue or other outcomes. Single values or point estimates for inputs such as activity durations or line item costs are replaced with probability distributions or ranges of possible cost or durations to account for the inherent uncertainty surrounding any particular point-estimate. To this may be added risk 'events' that may or may not happen according to the assigned probability of occurrence, each having a defined impact range such as days of delay or additional costs. The algorithm selects ('samples') a value from the range that has been given to that input, records it, goes on to the next activity or line-item, selects a value from its distribution, records it, and so on down the line for every input to the model. When it runs into a risk, it will 'roll the dice' to determine if the risk has 'happened' on this particular run and if so, select from the range of possible impacts to determine its effect, just as with other inputs. If the risk has a high probability of occurring, then on most runs the risk will 'happen' and will impact the final result. If it is low, then on most runs it will not. In other words, the dice are loaded based on what initial probability was assigned to the risk.

Once it has sampled from every input distribution and risk, completing one run or iteration, it calculates the result—in the case of a cost estimate, simply adding up all the different



individual amounts for each line-item and risk event that happened on that particular iteration—simulating one possible outcome. Then the algorithm goes back and does it again to get another possible outcome. The algorithm will repeat this process thousands of times depending on how complicated the underlying model and inputs are until it is ‘satisfied’ that a full range of possible outcomes and associated probabilities has been determined. These probabilities—how likely a particular cost, completion date or revenue projection is—are a key differentiator between the results of Monte Carlo simulation techniques and the results of traditional ‘What-if’ or scenario analysis which typically do not provide any guidance as to how likely (or not) a particular outcome is.

As a precursor to the bottom up analysis, the Authority analyzed the underlying cost model to perform a sensitivity analysis on both opportunities—potential cost savings—and threats—conditions or situations that may lead to a higher than expected costs. By varying individual parameters within the cost model one at a time, the Authority was able to quantify the cost impact, positive or negative, on the overall estimate. See Figure 2 and Figure 3 for the opportunity and threat factors and their quantification.

Figure 2. Bottom Up Monte Carlo Analysis Opportunities

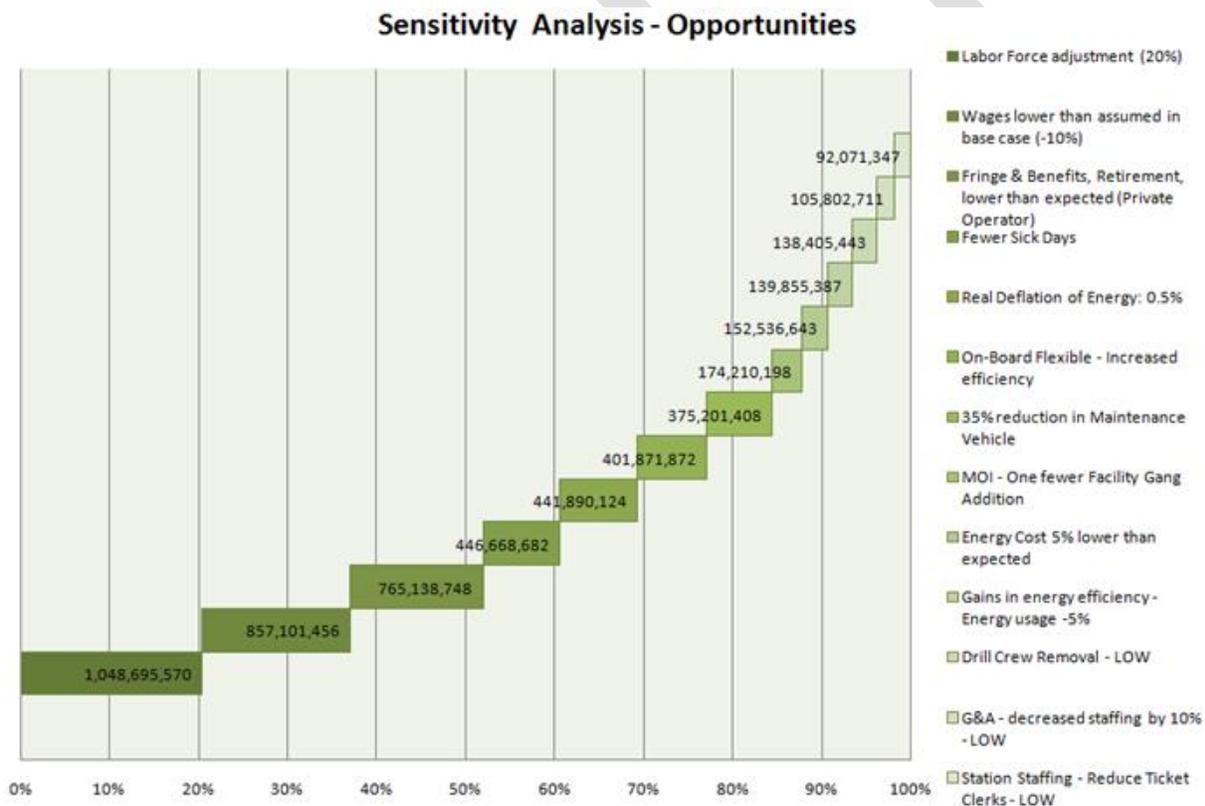
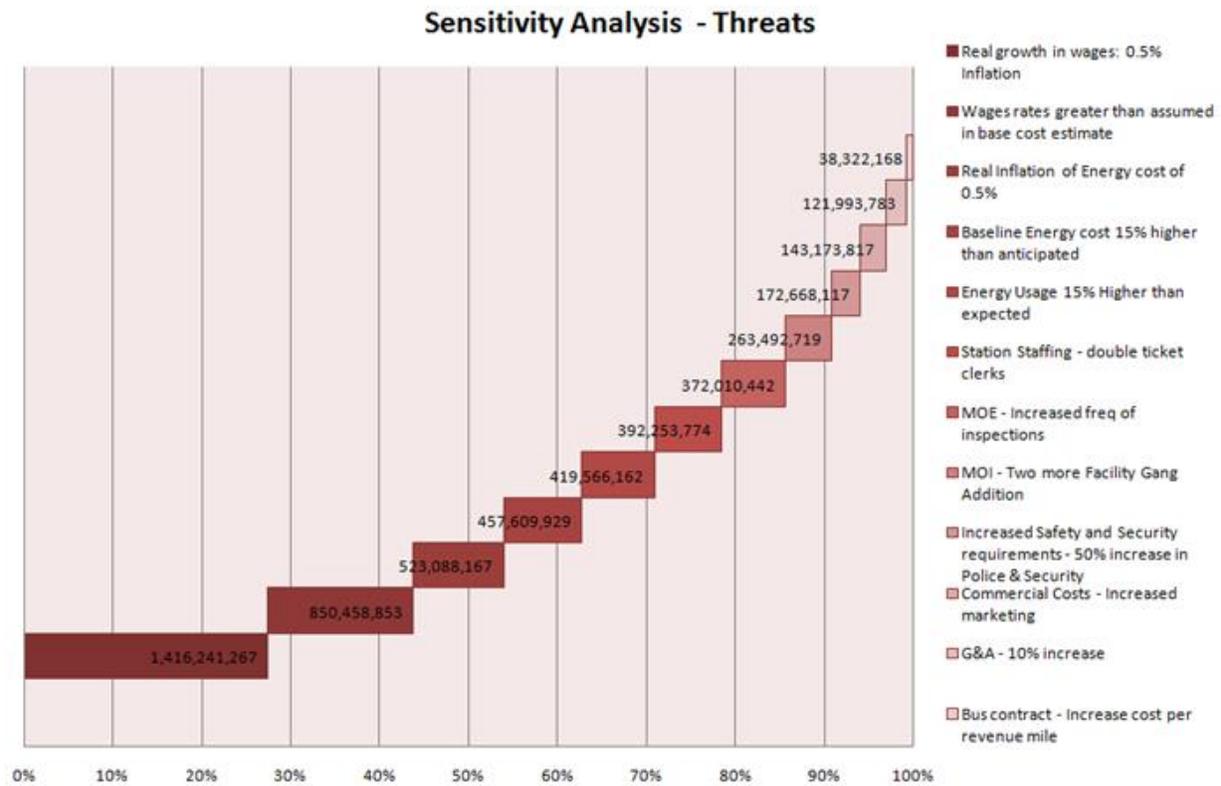


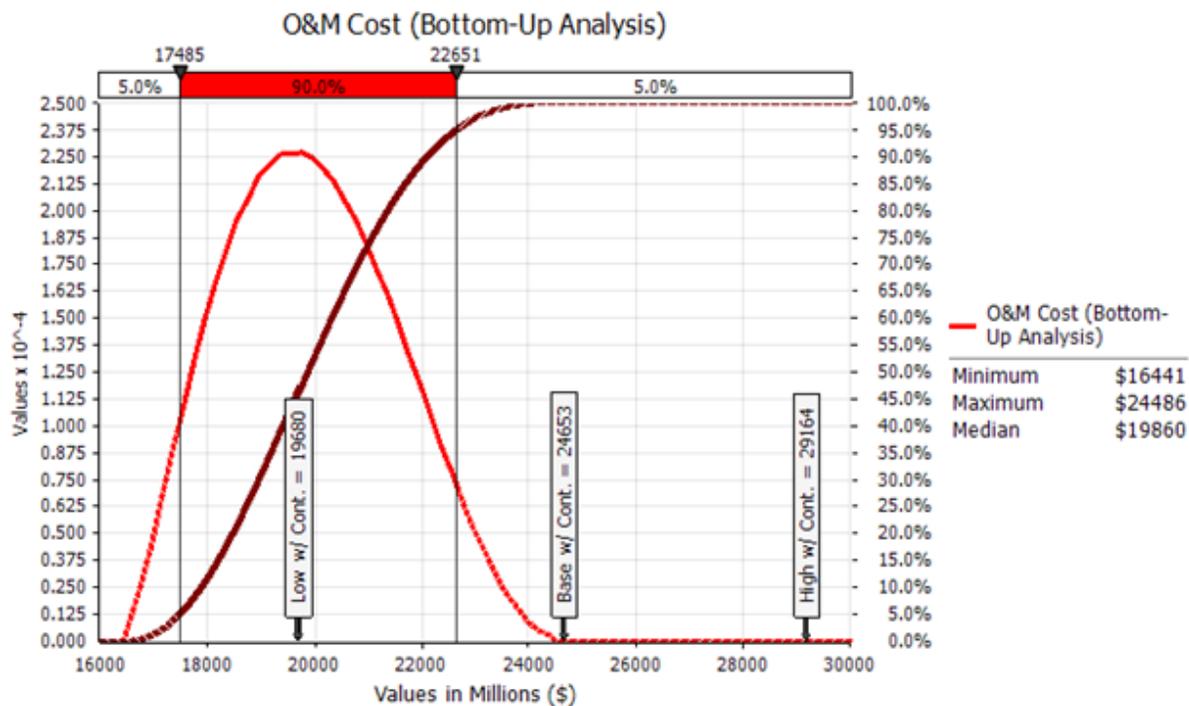
Figure 3. Bottom Up Monte Carlo Analysis Threats



Using these factors in conjunction with the baseline estimates, the Authority parameterized a risk exposure curve to perform a Monte Carlo analysis on an earlier version of the O&M estimate to determine the probability of individual cost outcomes. See Figure 4 below.



Figure 4. Monte Carlo Analysis Results Illustration from Earlier Baseline O&M Estimate



The Authority also employs Monte Carlo simulations in another manner, as part of a top-down or ‘Reference-Class’ analysis and it was this analysis that was deemed most appropriate for business planning. While reference class analysis cannot provide the granularity of a traditional bottom-up approach that is most useful from an internal management standpoint, the results of the reference-class analysis are based on actual project outcomes and are not dependent on the quality or comprehensiveness of internal risk identification or assessment efforts. The results a traditional or bottom-up risk analysis approach are typically captured in a risk register. As recommended in DOT IG guidance and elsewhere, the risk register is eminently useful for systematizing and documenting the identification, assessment and mitigation of individual risks. For this reason, it is key tool in CHSRs’ risk management efforts as described in CHSRs’ Risk Management Plan.

Table 34. Reference Project Cost Variances from Plan

System Boldface indicates HSR	O&M Cost Variance from Plan
Sprinter	-1%
FrontRunner	1%
LGV Rhone-Alpes	4%
LGV Nord	6%
Music City Star	27%
RER E	34%
Median	5%
Mean	12%

The risk register and underlying bottom-up approach does, however, have potentially significant limitations with regards to the accurate quantification of risk exposure. Chief of these is that the degree to which such an effort captures the actual risk exposure is dependent on the ability of participants to comprehensively identify and then accurately quantify the impact of said risks. To a greater or lesser extent, it is also affected by certain modeling decisions such as correlation between individual risks—the actualization of some affects the likelihood and impact of others, sometimes making them more likely and/or expensive,



sometimes less. For the vast majority of project risks, there is no objective means for determining the appropriate correlation factor. Additionally, in order to be complete, this methodology also requires a determination of the dollar value of any identified schedule impacts, which in turn requires a significant amount of foresight regarding not just *what* risk may strike a project but also *when*. The extent to which these activities are carried out by project personnel and/or stakeholders also introduces the potential for optimism bias. For business planning purposes, as opposed to internal tracking and risk management purposes, the key objective for CHSRS was and is to develop an accurate, objective measure of the risk exposure as measured by the potential variance between actual (eventual) and estimated costs together with the probability of a given variance. Given the relative weaknesses of a bottom-up approach for such a determination, CHSRS is employing a reference-class methodology for O&M cost risk quantification.

In reference-class analysis, the algorithm is given a set of outcomes from other, similar projects and then uses these in a Monte Carlo simulation to, in a sense, work backwards to determine a probability distribution that would lead to the given set of outcomes. From this resulting distribution, we can determine how likely a particular outcome is for this project based on the outcomes of other similar projects. This is akin to asking a number of people who live in your town how long it takes them to drive to another town. From this sample, you could develop a general idea of what's a reasonable amount of time to allot for your trip and what is not. The Monte Carlo simulation simply allows for much more specific predictions, e.g. 'there is a 75% chance that your trip will take between 41 and 57 minutes' or 'there is a 2% chance that your trip will take longer than 80 minutes'.

For the O&M risk analysis, the Authority identified six reference projects (see Table 34). Based on these results, the Authority parameterized a risk exposure curve as follows:

1. Minimum: Low estimate without contingency
2. Most Likely: Medium cost scenario with contingency + 5%
3. Maximum: Medium cost scenario with contingency + 34%

The minimum value was taken to be the absolute best case scenario. Most Likely parameter was taken as the Medium cost scenario + 5% based on the two most 'on-point' cases in the reference set—the LGV Rhone-Alps and LGV Nord, both high-speed rail systems. The Maximum is based on the worst-case (largest cost overrun as a percentage of the original cost estimate) for the RER E line.

These parameters were input to a Monte Carlo simulation(s) and Individual simulations were run for each year of each phase, IOS, B2B and P1B as well as for each year of All (combining IOS, B2B and P1B), based on the risk-adjusted cost estimates for those years and phases. To avoid correlation issues between years, the totals were calculated independently of the individual years by applying the same parameterization to the total cost (all years combined in \$2012) for each of IOS, B2B, P1B and All phases. Each simulation consisted of 5,000 iterations. The parameters for each exposure curve along with the results of these analyses, the totals for each phase, are presented in Table 35.



Table 35. Probabilistic outcomes of Monte Carlo simulations for each phase and combined (All phases).⁴³

Parameters	IOS O&M _{TOT}	B2B O&M _{TOT}	P1B O&M _{TOT}	ALL O&M _{TOT}
Min: Low w/o Contingency	\$ 10,237	\$ 2,374	\$ 2,809	\$ 15,420
Mode: (Medium w/ contingency)*1.05	\$ 16,870	\$ 7,438	\$ 7,913	\$ 32,221
Max: (Medium w/ contingency)*1.34	\$ 21,529	\$ 9,492	\$ 10,099	\$ 41,120
OUTPUT	\$ 16,541	\$ 6,936	\$ 7,427	\$ 30,904
Percentile				
1%	\$ 11,828	\$ 3,801	\$ 4,229	\$ 19,819
5%	\$ 12,923	\$ 4,622	\$ 5,057	\$ 22,573
10%	\$ 13,643	\$ 5,132	\$ 5,574	\$ 24,324
15%	\$ 14,173	\$ 5,494	\$ 5,943	\$ 25,590
20%	\$ 14,615	\$ 5,789	\$ 6,243	\$ 26,628
25%	\$ 15,004	\$ 6,044	\$ 6,504	\$ 27,536
30%	\$ 15,360	\$ 6,274	\$ 6,739	\$ 28,360
35%	\$ 15,693	\$ 6,484	\$ 6,956	\$ 29,123
40%	\$ 16,011	\$ 6,682	\$ 7,159	\$ 29,845
45%	\$ 16,318	\$ 6,871	\$ 7,353	\$ 30,541
50%	\$ 16,618	\$ 7,054	\$ 7,541	\$ 31,213
55%	\$ 16,915	\$ 7,232	\$ 7,724	\$ 31,873
60%	\$ 17,213	\$ 7,407	\$ 7,906	\$ 32,534
65%	\$ 17,515	\$ 7,582	\$ 8,087	\$ 33,194
70%	\$ 17,826	\$ 7,759	\$ 8,270	\$ 33,869
75%	\$ 18,150	\$ 7,941	\$ 8,458	\$ 34,565
80%	\$ 18,496	\$ 8,130	\$ 8,655	\$ 35,302
85%	\$ 18,878	\$ 8,334	\$ 8,867	\$ 36,101
90%	\$ 19,319	\$ 8,562	\$ 9,106	\$ 37,011
95%	\$ 19,887	\$ 8,843	\$ 9,401	\$ 38,163
99%	\$ 20,674	\$ 9,198	\$ 9,777	\$ 39,674
Values in \$Millions				

⁴³ Note each column, IOS, B2B, P1B and All is the product of an individual simulation and values for any particular probability in IOS, B2B and P1B cannot be summed to determine the All value for that probability.



16 Breakeven Analysis

To help evaluate operational viability, a breakeven analysis was performed using a Monte Carlo risk analysis. The analysis determined a probability for revenues to be equal to or greater than O&M costs. The analysis used the same farebox revenue and O&M cost models discussed in Section 4 and in Section 5 of the Draft 2014 Business Plan and in this Technical Supporting Document. The result of the Monte Carlo analysis conducted on the farebox revenue forecast is documented in the Ridership and Revenue Technical Supporting Document “Draft 2014 Business Plan – Draft Ridership and Revenue Technical Memorandum.” The results provide a probability distribution pairing different profit or loss outcomes with their likelihood, which allows the Authority to determine the probability of system revenues equaling or exceeding O&M costs.

The results of the risk analysis show that the IOS has an 89 percent probability of generating positive cash flow over the five year ramp-up period. The analysis looked at this period cumulatively in order to reflect how a private operator would manage and mitigate its financial risk over a potential contract period. As ridership continues to increase, the probability improves to 97 percent by year five (2026).

Given the multi-year nature of the planned operating contract, the breakeven projections and the expertise of a private sector operator, the Authority fully anticipates that the ramp-up period cash flows can be well-managed through contractual payment structures and short-term working capital and that the system will not require an operating subsidy as defined in Proposition 1A.

Table 36 presents the results of the risk analysis during (i) the ramp-up period of the IOS covering the first five years of the system; (ii) the first year of operations for the Bay to Basin phase; (iii) the first year of operations for the Phase 1 phase; and (iv) an out year of operations for Phase 1. Consistent with new high-speed rail systems around the world, the first year of operations on the IOS is expected to be the most sensitive to operating costs as operations commence and early ridership begins to grow. Table 36 shows that as the IOS progresses through the ramp-up period the probability of equaling or exceeding breakeven reaches almost 100%.

Table 36. Probability of system revenue exceeding O&M costs in select years

Phase	IOS		Bay to Basin	Phase 1	
Timing	Ramp-up	Mature	First Year Start-up	First Year Start-up	Mature
	2022 – 2026	2026	2027	2029	2040
Breakeven Probability	89%	97%	92%	87%	99%



Appendix 1—Assumptions Register

#	Area	Assumption
Universal		
1	Opening Years	<ul style="list-style-type: none"> • IOS—2022 • B2B—2027 • P1B—2029
2	Fringe Benefits	<ul style="list-style-type: none"> • \$18,742 for the health, vision, dental, and retiree health plans • 5.55% of wage up to \$16,380 for RUIA • 12.1% of wage up to \$89,900 for Railroad Retirement Tier 2 • 6.2% of wage up to \$110,100 for Railroad Retirement Tier 1 • 7.45% with no limit (1.45% for Medicare and 6% for FELA)
3	Overtime	Employees are not paid overtime.
4	Frontline	One frontline supervisor is assumed for every 10 non-contracted positions.
5	Frontline	Front line supervisors earn 10% more than each category's highest wage
6	G&A Staffing	G&A personnel are assumed to be 10% of the total workforce (including frontline supervisors).
7	Staff Availability Factors	Each regular crew assignment is multiplied by a factor of 1.63 (365 days per year/224 days per year = 1.63) for 7-days per week crews and 1.13 (253 days per year/224 available days per year = 1.13) for 5-days per week crews.
8	Staff Availability Factors	The availability assumption is not applicable to contractors and management and administrative staff.
9	Seasonality	The same number of trains, and therefore the same number of crews, will operate every day. Crews will work a 40-hour workweek, with relief days covered by separate crews.
10	Real Inflation on Wages	A 0.267 percent per year real inflation rate is applied to wages based on historic differences in the rate of increase of the wages in the California Trade, Transportation, and Utilities sector and CPI.
11	Shared Facility Costs	The costs for shared facilities (i.e. the Caltrain corridor and others) have been fully accounted for in the model pending agreements that would allow some of these costs to be shifted to other operators.
Train Operations		
1	Crews	It is assumed that each crew will be able to cover one round trip per day (two legs) and crew changes will be used, where necessary, to maintain this efficiency.
2	Single-Trainset Crews	For a single-consist train: 1 train engineer, 1 conductor, 1 assistant conductor, and 1 on-board attendant if there is no food service and 2 on-board attendants if there is food service



#	Area	Assumption
3	Double-Trainset Crews	For a double-consist train: 1 train engineer, 1 conductor, 1 assistant conductor, and 2 on-board attendants if there is no food service and 4 on-board attendants if there is food service
4	Protect Crews	<ul style="list-style-type: none"> Protect crews consist of 1 train engineer, 1 conductor, and 1 assistant conductor The number of Protect Crews assumes 2 tours per day with crews stationed at each system terminal.
5	Roustabouts	<ul style="list-style-type: none"> Roustabout crews consist of 1 train engineer, 1 conductor, and 1 assistant conductor Roustabouts are assumed to be on for 2 tours per day and they will be based at each maintenance facility of Level III or higher
6	Drill Crews	<ul style="list-style-type: none"> Drill crews consist of 1 train engineer, 1 conductor Each Level V facility (HMF) is assumed to have 1 drill crew for 3 tours per day while each other facility and yard is assumed to have 1 drill crew for 2 tours per day
7	Wages and Availability	<ul style="list-style-type: none"> Train Engineer - \$71,005, 7-day availability Conductor - \$68,528, 7-day availability Asst. Conductor - \$54,164, 7-day availability On-Board Attendant - \$40,831, 7-day availability
8	Energy Cost	\$0.09 per kWh based on the 2012 CPUC RPS
9	Energy Consumption	41.5 kWh per trainset mile during IOS and Bay to Basin and 43.0 kWh per trainset mile during Phase 1 Blended
10	Uniforms, Vehicles, and Supplies	<ul style="list-style-type: none"> Uniform: \$280 per on-board employee per year. This does not apply to frontline employees or management. Vehicles: \$28,752 per car with 1 car at each terminal and 4 cars at the HMF. Supplies and Cell Phones: \$393 per year per frontline employee for office supplies. \$650 per year per frontline employee for cell phones. Travel: Based on the assumption that each employee would do a daily roundtrip and return to their home bases, and the additional staff added to allow for that, it is assumed that on-board personnel will not incur travel costs or have to stay overnight between runs.
Dispatching		
1	OCC	<ul style="list-style-type: none"> There will be 1 OCC on the system The OCC will have 1 DOC, 1 DDOC, and 5 dispatchers in the IOS, 9 dispatchers in B2B and 10 dispatchers in P1B The OCC will be on for 3 tours per day
2	RCC	<ul style="list-style-type: none"> There will be 1 RCC for every blended (interlined) portion of track The RCC will have 1 DOC, 1 DDOC, and 9 dispatchers The RCC will be on for 2 tours per day



#	Area	Assumption
3	TCF	<ul style="list-style-type: none"> • There will be one TCF in each Level A and B station • Level B stations will have 1 DDOC and 2 dispatchers, Level A stations will have 1 DDOC and 6 dispatchers during operations (2 tours per day) and 1 DDOC and 1 dispatchers during non-revenue operating hours (1 tour per day)
4	Yard	<ul style="list-style-type: none"> • Each maintenance facility is assumed to have 2 train dispatchers for yard dispatch duties (except the San Fernando facility in the IOS). • Yard dispatchers are assumed to be on for 3 tours per day at the HMF and 2 tours per day at each of the other facilities.
5	Wages and Availability	<ul style="list-style-type: none"> • Director Operations Control (DOC)—\$106,005, 7-day availability • Deputy DOC - \$92,153, 7-day availability • Train Dispatcher - \$78,300, 7-day availability
6	Vehicles and Supplies	<ul style="list-style-type: none"> • Vehicles: 2 cars at the OCC at \$28,752 per car per year • Supplies and cell phones: \$393 per year per dispatch employee for office supplies. \$650 per year per frontline employee for cell phones.
Maintenance of Equipment		
1	Regulatory Inspection Staffing	<p>Each maintenance facility will perform regulatory inspections. Each team that will be doing routine maintenance will each consist of 13 people as follows:</p> <ul style="list-style-type: none"> • Supervisor • 7 Technicians • Laborers • Storehouse employees
2	Regulator Inspection Teams	<p>The maintenance facilities will have the following number of teams in each phase:</p> <ul style="list-style-type: none"> • IOS: <ul style="list-style-type: none"> ○ HMF—3 teams over 3 tours ○ Palmdale—2 teams over 2 tours • Bay to Basin: <ul style="list-style-type: none"> ○ HMF—3 teams over 3 tours ○ Palmdale—3 teams over 3 tours ○ Gilroy—2 teams over 2 tours • Phase 1 Blended: <ul style="list-style-type: none"> ○ HMF—3 teams over 3 tours ○ Palmdale—4 teams over 3 tours ○ Gilroy—2 teams over 2 tours ○ San Francisco—3 teams over 3 tours



#	Area	Assumption
3	Regulator Inspection Frequency	<p>Assumptions for occurrence of inspections:</p> <ul style="list-style-type: none"> • Daily, every 48 hours, 182.5 inspections per year per trainset • Monthly, every 30 days, 12.167 inspections per year per trainset • 92 days, 4 inspections per year per trainset
4	Regulator Inspection Materials Costs	<p>Material costs for these inspections:</p> <ul style="list-style-type: none"> • Daily, \$500 per inspection • Monthly, \$2,230 per inspection • 92 days, \$500 per inspection
5	Overhaul Staffing (Bogey Inspection)	<p>Overhauls occur only at HMF and once they start additional personnel are added beyond the requirements of the regulatory inspections. For each 600,000 miles that a trainset covers, a Bogey Inspection (BI) needs to be performed. Once Bogey Inspections begin, the following staff need to be added at the HMF:</p> <ul style="list-style-type: none"> • 6 Supervisors • 37 mechanical technicians • 17 electrical technicians • 8 laborers • 10 storehouse employees
6	Overhaul Staffing (Overhaul General Inspection)	<p>For every 1.2 million miles, each trainset needs to have an overhaul general inspection (OGI). Once these starts, the following personnel need to be added at the HMF (on top of the personnel hired for the BIs:</p> <ul style="list-style-type: none"> • 4 Supervisors • 20 mechanical technicians • 16 electrical technicians
7	Overhaul Material Costs	<p>Bogie/truck inspections(BI) cost \$127,000 per inspection Overhaul General Inspection (OGI) cost \$880,000 per inspection</p>
8	Energy	<ul style="list-style-type: none"> • Maintenance facility utility costs are estimated at 27 kWh per square foot
9	Facility Levels	<ul style="list-style-type: none"> • Level 5: HMF • Level 3: Palmdale • Level 2: Gilroy • Level 3: San Francisco
10	Facility Size	<ul style="list-style-type: none"> • HMF—727,800 sq. ft. • Palmdale—303,505 sq. ft. • Gilroy—252,645 sq. ft. • San Francisco—303,505 sq. ft.
11	Cost Rationalization	<p>7-year rolling average with the first half of the model's period difference allocated 1/6, 1/3, 1/2 for the first three years and the second half of the model's period difference spread evenly over the last three years</p>



#	Area	Assumption
12	Wages and Availability	<ul style="list-style-type: none"> • MOE Supervisors - \$74,964, 7-day for inspections, 5-day for overhauls • MOE Technicians (including electrical and mechanical technicians) - \$59,233, 7-day for inspections, 5-day for overhauls • Storehouse Employees - \$42,919, 7-day for inspections, 5-day for overhauls • Laborers - \$47,845, 7-day for inspections, 5-day for overhauls
13	Uniforms, Vehicles, Tools, Supplies, IT/Software	<ul style="list-style-type: none"> • Uniform: \$280 per MoE employee per year. This does not apply to frontline employees or management. • Vehicles: \$28,752 per car with 2 cars at each maintenance facility and 4 at the HMF. Additionally, \$38,940 per flatbed stake truck with 2 flatbed stake trucks at each maintenance facility and 4 flatbed stake trucks at the HMF. • Supplies and Cell Phones: \$393 per year per frontline employee for office supplies. \$650 per year per frontline employee for cell phones. • Tools: 5 percent of total labor cost • IT/Software: \$5,000 per user profile with 10 user profiles for each maintenance facility.
Maintenance of Infrastructure		
1	Units/Gangs	<ul style="list-style-type: none"> • Basic MOI Facility - A work force / equipment component providing Maintenance and Inspection functions. A Basic MOI Facility component will be added for each new line segment placed into service. This component includes work force and equipment to address responsibilities in the Track (including visual track inspection), Structures, Signal, Communications, Overhead Catenary System (OCS), Electric Traction (ET), and Utilities areas. It does not include track surfacing and alignment responsibilities which will be provided by a system work force. • Initial System Unit - a work force / equipment component, not attached to a specific facility, which has system-wide (or major line segment responsibility in an expanded system) responsibility for machine vision inspection, track replacement, alignment, surfacing and rail grinding, as well as, catenary repair, replacement and tensioning. The Initial System Unit will be augmented by the local MOI Facility Unit as required. • HMF Addition - a work force / equipment component work, added to a Basic MOI Facility component to maintain the yard track, switches, signals, and structures at the Heavy Maintenance Facility • Crane/Tractor Unit - Two specialty pieces of equipment, a Kirow Crane and a Tractor Low Boy with Flat Bed Trailer with operators expected to be added to the system concurrently but will work as needed and not necessarily in



#	Area	Assumption
		<p>concert.</p> <ul style="list-style-type: none"> • 2nd System Unit - a work force / equipment component, not attached to a specific facility, which will share system-wide responsibility with the Initial System Unit, for track replacement, alignment, and surfacing. The 2nd System unit will be added when the Gilroy / San Jose segment is added to the original route from Merced to San Fernando Valley. The Kirow Crane and Tractor Low Boy with Flat Bed Trailer Unit (listed above) are planned to be added in conjunction with the 2nd System Unit. • Facility Gang Addition - a work force / equipment component, added to a Basic MOI Facility component, work to provide additional support due to the challenges presented in certain locations. This component will be added for each Level 3 MOE facility (and for the Level 2 facility presently planned for Gilroy due to the number of trains expected to use that facility), system extension from San Fernando Valley to Los Angeles and from San Jose to San Francisco, and when service through the Tehachapi Mountains begins.
2	Units/Gangs	<p>The phases will have the following number of MOI Gangs (based on the build-up described above):</p> <ul style="list-style-type: none"> • IOS: <ul style="list-style-type: none"> ○ Basic MOI Facility - 3 ○ Initial System Unit - 1 ○ Second System Unit - 0 ○ HMF Addition - 1 ○ Crane/Tractor Unit - 0 ○ Facility Gang Additions - 2 • Bay to Basin: <ul style="list-style-type: none"> ○ Basic MOI Facility - 4 ○ Initial System Unit - 1 ○ Second System Unit - 1 ○ HMF Addition - 1 ○ Crane/Tractor Unit - 1 ○ Facility Gang Additions - 3 • Phase 1 Blended: <ul style="list-style-type: none"> ○ Basic MOI Facility - 5 ○ Initial System Unit - 1 ○ Second System Unit - 1 ○ HMF Addition - 1 ○ Crane/Tractor Unit - 1 ○ Facility Gang Additions - 6
3	Staffing Levels	See Table 16.
4	Materials	15% of MOI labor costs



#	Area	Assumption
5	Tools, uniforms, etc.	5% of MOI labor costs
6	Vehicles	See Table 17.
7	Vehicle Costs	See Table 18.
8	Wages and Availability	See Table 19.
9	Uniforms, Supplies, IT/Software	<ul style="list-style-type: none"> • Uniform: \$280 per MOI employee per year. This does not apply to frontline employees or management. • Supplies and Cell Phones: \$393 per year per frontline employee for office supplies. \$650 per year per frontline employee for cell phones. • IT/Software: \$5,000 per user profile with 10 user profiles for each maintenance base.
Station Operations and Train/Station Cleaning		
1	Station Levels	See Table 20.
2	Station Staffing Tours	Stations are assumed to be staffed for 2 tours per day, except the Building Systems Manager for Level B stations in the IOS, where she/he is assumed to be on for one tour per day.
3	Station Staffing Levels	<p>The stations are assumed to have the following staffing per tour:</p> <ul style="list-style-type: none"> • Level C <ul style="list-style-type: none"> ○ Agent/Station Manager - 1 ○ Ticket Clerk/Customer Service Rep - 3 • Level B <ul style="list-style-type: none"> ○ IOS <ul style="list-style-type: none"> Agent/Station Manager—1 Ticket Clerk/Customer Service Rep - 3 ○ Bay to Basin/Phase 1 Blended: <ul style="list-style-type: none"> Agent/Station Manager—1 Ticket Clerk/Customer Service Rep - 5 • Level A <ul style="list-style-type: none"> ○ Agent/Station Manager - 1 ○ Ticket Clerk/Customer Service Rep - 6
4	Train Cleaning Location	<ul style="list-style-type: none"> • Trains going from revenue service to revenue service will generally be cleaned in the stations where they are being turned. • Trains going from revenue service to deadhead or from deadhead to revenue service will be cleaned at the maintenance facilities.



#	Area	Assumption
5	Train Cleaning Staff at Stations	<ul style="list-style-type: none"> Station Train Cleaning Teams will consist of 10 people. However, these teams can be split into half-teams when necessary. The number of teams that will be used to clean trains will be one team per 15 trains being turned from revenue to revenue service in that station rounded to the nearest half-team with no cleaning staff if three or fewer trains will be turned.
6	Train Cleaning Staff at Maintenance Facilities	<ul style="list-style-type: none"> Yard Train Cleaning Teams will consist of 12 people and will work in conjunction with the yard maintenance teams. The number of cleaning teams and tours at each facility depends on the amount of maintenance anticipated to take place there. The number of teams and tours is the same as the number of regulatory inspection teams.
7	Energy	<ul style="list-style-type: none"> Stations are assumed to use 14.3 kWh per square foot. For station sizes, please see Table 28.
8	Wages and Availability	<ul style="list-style-type: none"> Agent/Station Manager - \$66,255, 7-day availability Ticket Clerk - \$49,147, 7-day availability Trainset and Station cleaning - \$36,616, 7-day availability
9	Uniforms, Vehicles, Supplies, IT/Software	<ul style="list-style-type: none"> Uniform: \$280 per station employee per year. This does not apply to frontline employees or management. Vehicles: \$28,752 per car with 1 car at each terminal. Additionally, \$38,940 per flatbed stake truck 1 flatbed stake truck at the HMF. Supplies and Cell Phones: \$393 per year per frontline employee for office supplies. \$650 per year per frontline employee for cell phones. \$71 per year per cleaning employee for cleaning supplies. IT/Software: \$5,000 per user profile with 2 user profiles for each station and 4 user profiles at each terminal.
Police and Security		
1	Police and Security Staffing Levels	For station and maintenance facility/base police and security staffing levels please see Table 28.
2	Wages and Availability	<ul style="list-style-type: none"> Sworn Police Officer- \$75,000, No availability (already applied) Unsworn Officer - \$36,000, No availability (already applied)
3	Equipment, vehicles, supplies, fuel, and disposables	For costs for equipment, vehicles, supplies, fuel, and disposables please see Table 29.



#	Area	Assumption
Commercial Costs		
1	Marketing/Advertising Costs	<ul style="list-style-type: none"> Assumed 3 campaigns per year with an effective frequency of 5 For counties that will have advertising in each phase, please see Table 30 and for their populations by year please see County Population Projections. Cost per 1,000 impressions is assumed to be \$10.77
2	Distribution Costs and Credit Card Fees	<ul style="list-style-type: none"> Call center volumes assumed to be 4 percent of sales in first two years and 2 percent thereafter 2/3 of call center costs are assumed to be for ticket purchase, 1/3 for information A 15% commission on call center costs is assumed Website is assumed to be able to generate revenue through advertising that will offset website costs All ticket sales are assumed to be with credit cards Credit card fees are assumed to average 2.27 percent of revenue
3	Bus Costs	<ul style="list-style-type: none"> Connecting bus services cost \$3.16 per mile Connecting bus services average 7.4 percent deadhead miles.
General & Admin Costs		
1	Staffing Levels	<ul style="list-style-type: none"> G&A staffing is assumed to be 10 percent of total other staffing Within G&A, the following breakdown is assumed: <ul style="list-style-type: none"> Executive—5 percent Senior Managers—10 percent Mid-Managers—25 percent Administrative and low-level corporate staff—60 percent
2	Wages and Availability	<ul style="list-style-type: none"> Executive—\$200,000, no availability Senior Managers—\$150,000, no availability Mid-Managers—\$100,000, no availability Administrative and low-level corporate staff—\$50,000, no availability
3		<ul style="list-style-type: none"> Vehicles: \$28,752 per car with 8 cars in the IOS, 12 cars in Bay to Basin, and 16 cars in Phase 1 Blended. Supplies and Cell Phones: \$393 per year per G&A employee for office supplies. \$650 per year per management employee (does not include admin/junior corporate staff) for cell phones. IT/Software: \$5,000 per user profile with each G&A staff member having a profile. Travel: \$1000 per year per mid-manager for travel, \$3,000 per senior manager, \$10,000 per executive manager.



#	Area	Assumption
Insurance		
1	Total Insurance Cost	\$25 million during the IOS, \$40 million during Bay to Basin, \$50 million during Phase 1 Blended
Contingency		
1	Unallocated Contingency	5 percent of subtotal costs
2	Allocated Contingency	See Table 32.
Operations Startup and Commissioning		
1	Testing and Commissioning	Included in capital costs
2	Rolling Stock Procurement Schedule	Illustrative schedule for MoE cost estimating is shown in Table 33.



Appendix 2—Wages

Wages for the staff positions described in this TM were obtained from an exhaustive analysis of wages for similar positions on existing rail systems across the country. The wages were gathered from available public and private sources and include over 100 data points across the various positions. The wages were regionally adjusted based on the Bureau of Labor Statistics data on mean annual wages for each region/state. This appendix lays out the wages that were collected and the geographic adjustments that were made to produce California wages. The geographic adjustment process was as follows:

General

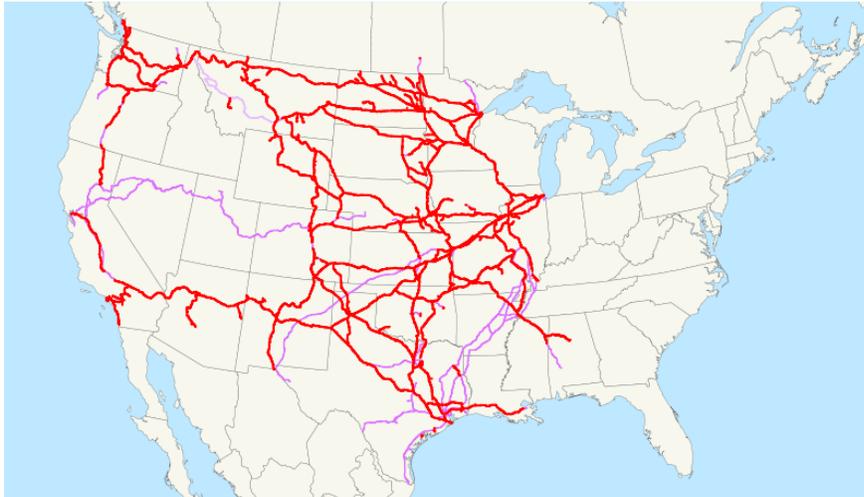
To convert the provided wages to their California equivalent, the mean average annual wages for the following locations were used based on the locations of the original data sources.

Source	Mean Average Wage
Amtrak	National
BLS	California
L.A. MTA	Los Angeles-Long Beach-Santa Ana
LIRR	New York-Northern New Jersey-Long Island
Maryland MTA	Maryland
Metrolink	Los Angeles-Long Beach-Santa Ana
Metro North	New York-Northern New Jersey-Long Island
SFMTA	Northern California
Unions	National
WMATA	District of Columbia
Other	National



BNSF

The BNSF system covers the following census regions West North Central (ND, SD, NE, KS, MN, IA, MO) West South Central (OK, TX, AR, LA), Mountain (MT, ID, NV, WY, UT, CO, AZ, NM) and Pacific (AK, WA, OR, CA, HI). The factor applied to the BNSF wages to convert them to California values uses a weighted average (by employment) of the 2010 annual mean wages of those regions.⁴⁴



CSX

The CSX system covers the following census regions Middle Atlantic (NY, NJ, PA), South Atlantic (MD, DC, VA, NC, SC, GA, FL), East North Central (WI, IL, IN, MI, OH) and East South Central (KY, TN, MS, AL). The factor applied to the CSX wages to convert them to California values uses a weighted average (by employment) of the 2010 annual mean wages of those regions.⁴⁵



⁴⁴ <http://www.bls.gov/ncs/ocs/compub.htm>

⁴⁵ <http://www.bls.gov/ncs/ocs/compub.htm>



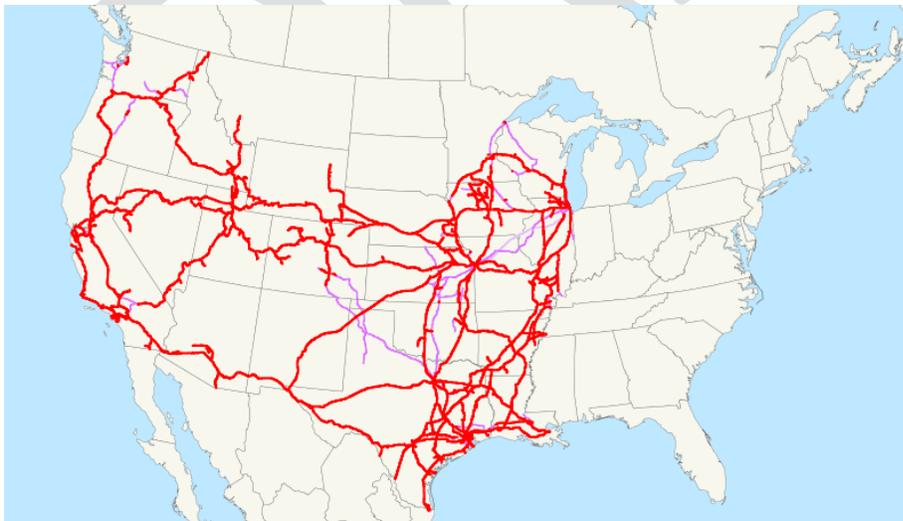
Norfolk Southern (NS)

The NS system covers the following census regions Middle Atlantic (NY, NJ, PA), South Atlantic (MV, MD, DC, VA, NC, SC, GA, FL), East North Central (WI, IL, IN, MI, OH) and East South Central (KY, TN, MS, AL). The factor applied to the NS wages to convert them to California values uses a weighted average (by employment) of the 2010 annual mean wages of those regions.⁴⁶



Union Pacific (UP)

The UP system covers the following census regions East North Central (WI, IL, IN, MI, OH), West North Central (ND, SD, NE, KS, MN, IA, MO) West South Central (OK, TX, AR, LA), Mountain (MT, ID, NV, WY, UT, CO, AZ, NM) and Pacific (AK, WA, OR, CA, HI). The factor applied to the UP wages to convert them to California values uses a weighted average (by employment) of the 2010 annual mean wages of those regions.⁴⁷



⁴⁶ <http://www.bls.gov/ncs/ocs/compub.htm>

⁴⁷ <http://www.bls.gov/ncs/ocs/compub.htm>



Table 2-1. Wage conversion factors from other geographic locations to California

Conversion From	Conversion to California
National	1.11
California	1.00
New York-Northern New Jersey-Long Island	0.92
District of Columbia	0.69
Maryland	1.00
Southern California	0.81
Central Valley	1.20
Northern California	1.01
BNSF	1.10
CSX	1.13
Norfolk Southern	1.13
Union Pacific	1.11



Table 2-2. Raw wage data collected by position (before adjustment to California wages)

Employee (s)	Amtrak	AAR	BART	BLS	BNSF	CSX	LA MTA	LIRR	Maryland MTA	Metrolink	Metro North	NS	UP	SFMTA	Unions	VTA	WMATA	Other	Median
	National	National	NoCal	California	West/Midwest	South/Midwest	SoCal	NY/NJ/Long Island	MD/DC/VA/WV	SoCal	NY/NJ/Long Island	South/Midwest	Midwes/West	NoCal	National	NoCal	MD/DC/VA/WV	National	
MOE																			
MOE Supervisor			\$90,402				\$88,292									\$93,069			\$90,402
MOE Technician	\$51,896				\$56,805	\$52,062	\$58,521	\$64,865	\$44,023	\$60,174		\$54,392	\$45,053		\$56,555		\$53,248		\$54,392
Storeroom Employee	\$38,542		\$62,955				\$47,190							\$53,284		\$51,866			\$51,866
Train and Station Cleaning Staff (non-contract)	\$32,968					\$30,883	\$37,005							\$47,660		\$41,456			\$37,005
Transportation																			
<i>On-Board Staff</i>																			
Locomotive Engineer	\$65,343			\$47,611				\$75,390		\$80,660	\$79,562				\$52,083				\$70,367
Conductor				\$52,208				\$75,390		\$67,704	\$75,481				\$51,753				\$67,704
Asst. Conductor	\$40,352							\$68,126							\$48,768				\$48,768
On-Board Attendant				\$40,643							\$44,536								\$42,590
<i>Dispatchers</i>																			
Director Operations Control (DOC)			\$117,112				\$92,757			\$108,522	\$116,656								\$112,589
Deputy DOC																			
Train Dispatcher			\$91,171	\$59,260	\$85,000		\$75,461	\$94,582		\$93,854	\$80,073			\$99,595	\$91,885	\$73,862			\$88,086
<i>TCF</i>																			
Train Dispatcher			\$91,171	\$59,260	\$85,000		\$75,461	\$94,582		\$93,854	\$80,073			\$99,595	\$91,885	\$73,862			\$88,086
<i>Yard</i>																			
Train Dispatcher			\$91,171	\$59,260	\$85,000		\$75,461	\$94,582		\$93,854	\$80,073			\$99,595	\$91,885	\$73,862			\$88,086
<i>Stations</i>																			
Agent/Station Manager	\$71,610		\$62,856					\$73,285			\$71,903			\$72,801					\$71,903
Ticket Clerk/Customer Service Rep	\$41,475		\$69,451				\$43,837	\$58,248			\$56,684			\$61,016		\$52,851			\$56,684
<i>Station Cleaning</i>																			
Train and Station Cleaning Staff (non-contract)	\$32,968					\$30,883	\$37,005							\$47,660		\$41,456			\$37,005
MOI																			
<i>Track, Surfacing, Rail Grinding, and Inspection, Structures, Stations/Wayside, and Elec Trans/Sub Sta Teams</i>																			
Foreman	\$64,293		\$76,651					\$82,398			\$73,712					\$82,830			\$76,651
Asst. Foreman											\$70,757								\$70,757
Inspector			\$77,446				\$56,472	\$70,566		\$74,274	\$70,429			\$55,227					\$70,498
<i>Assistant Inspectors</i>																			
Welder	\$50,315		\$61,510		\$49,483		\$58,929	\$64,817			\$58,179			\$72,646					\$58,929
Welder Helper											\$51,514								\$51,514
Equipment Operator	\$47,466		\$58,224			\$45,115								\$53,694					\$50,580
Truck Driver	\$44,325				\$42,224		\$44,283							\$68,455					\$44,304
Laborers					\$44,408	\$44,762	\$47,270						\$39,374	\$55,227					\$44,762
Plumber							\$53,498	\$65,487			\$59,430			\$88,827					\$62,458
Mechanic					\$51,771	\$52,208	\$54,180						\$44,595			\$75,857			\$52,208
<i>Signal, Communications, and OHC Teams</i>																			
C&S Foreman			\$81,756					\$91,409			\$74,056					\$104,268			\$86,582
Asst. Foreman								\$84,204			\$68,565								\$76,385
Communications Engineer			\$77,373				\$70,428	\$83,671											\$77,373
Comm. Inspector							\$64,570												\$64,570
Systems Engineer			\$83,028					\$87,535						\$51,450					\$83,028
Signal Engineer								\$72,227						\$51,450					\$61,838
Electrician (hi. volt.)	\$55,619				\$52,208		\$65,206	\$55,619		\$59,157	\$54,517	\$45,178	\$83,239						\$55,619
Lead Wiremen								\$44,023		\$60,013									\$52,018
Signal Inspector	\$62,650						\$64,077	\$70,764		\$75,108									\$67,420
Communications Technician			\$74,211		\$53,290	\$49,962	\$61,271	\$71,664	\$44,023	\$53,199			\$39,770			\$76,177			\$53,290
Signal Apprentice					\$46,322	\$40,352							\$51,813						\$46,322
Signal Maintainer					\$68,139	\$59,176		\$69,060		\$63,594									\$65,866
Engineering Technician							\$75,390			\$71,129						\$70,248	\$65,240		\$70,688
Facility Electrician			\$74,049		\$52,208		\$59,012						\$45,178	\$89,394		\$72,527			\$65,770



Table 2-3. Wage data collected by position (adjusted to California wages)

	Amtrak	AAR	BART	BLS	BNSF	CSX	LA MTA	LIRR	Maryland MTA	Metrolink	Metro North	NS	UP	SFMTA	Unions	VTA	WMATA	Other	Median
MOE																			
MOE Supervisor			\$72,816				\$89,367									\$74,964			\$74,964
MOE Technician	\$57,638				\$62,476	\$58,608	\$59,233	\$59,742	\$43,893	\$60,906		\$61,231	\$50,121		\$62,813		\$36,782		\$59,233
Storeroom Employee	\$42,807		\$50,708				\$47,764							\$42,919		\$41,776			\$42,919
Train and Station Cleaning Staff (non-contract)	\$36,616					\$34,766	\$37,455							\$38,389		\$33,392			\$36,616
Transportation																			
<i>On-Board Staff</i>																			
Locomotive Engineer	\$72,573			\$47,611				\$69,436		\$81,641	\$73,278				\$57,846				\$71,005
Conductor				\$52,208				\$69,436		\$68,528	\$69,520				\$57,479				\$68,528
Asst. Conductor	\$44,817							\$62,746							\$54,164				\$54,164
On-Board Attendant				\$40,643							\$41,019								\$40,831
<i>Dispatchers</i>																			
Director Operations Control (DOC)			\$94,330				\$93,886	\$106,005		\$109,842	\$107,443								\$106,005
Deputy DOC																			
Train Dispatcher			\$73,435	\$59,260	\$93,487		\$76,379	\$87,112		\$94,996	\$73,749			\$80,221	\$102,052	\$59,494			\$78,300
<i>TCF</i>																			
Train Dispatcher			\$73,435	\$59,260	\$93,487		\$76,379	\$87,112		\$94,996	\$73,749			\$80,221	\$102,052	\$59,494			\$78,300
<i>Yard</i>																			
Train Dispatcher			\$73,435	\$59,260	\$93,487		\$76,379	\$87,112		\$94,996	\$73,749			\$80,221	\$102,052	\$59,494			\$78,300
<i>Stations</i>																			
Agent/Station Manager	\$79,534		\$50,629					\$67,497			\$66,225			\$58,639					\$66,225
Ticket Clerk/Customer Service Rep	\$46,064		\$55,941				\$44,371	\$53,648			\$52,208			\$49,147		\$42,570			\$49,147
<i>Station Cleaning</i>																			
Train and Station Cleaning Staff (non-contract)	\$36,616					\$34,766	\$37,455							\$38,389		\$33,392			\$36,616
MOI																			
<i>Track, Surfacing, Rail Grinding, and Inspection, Structures, Stations/Wayside, and Elec Trans/Sub Sta Teams</i>																			
Foreman	\$71,407		\$61,740					\$75,890			\$67,890					\$66,717			\$67,890
Asst. Foreman											\$65,169								\$65,169
Inspector			\$62,380				\$57,159	\$64,993		\$75,178	\$64,867			\$44,484					\$63,624
Assistant Inspectors																			
Welder	\$55,883		\$49,544		\$54,424		\$59,646	\$59,698			\$53,584			\$58,514					\$55,883
Welder Helper											\$47,445								\$47,445
Equipment Operator	\$52,718		\$46,898			\$50,788								\$43,249					\$48,843
Truck Driver	\$49,229				\$46,440		\$44,822							\$55,138					\$47,835
Laborers					\$48,842	\$50,390	\$47,845						\$43,804	\$44,484					\$47,845
Plumber							\$54,149	\$60,315			\$54,736			\$71,547					\$57,525
Mechanic					\$56,940	\$58,772	\$54,839						\$49,612			\$61,100			\$56,940
<i>Signal, Communications, and OHC Teams</i>																			
C&S Foreman			\$65,852					\$84,190			\$68,207					\$83,985			\$76,096
Asst. Foreman								\$77,554			\$63,150								\$70,352
Communications Engineer			\$62,322				\$71,285	\$77,063											\$71,285
Comm. Inspector							\$65,356												\$65,356
Systems Engineer			\$66,877					\$80,622						\$41,441					\$66,877
Signal Engineer								\$66,522						\$41,441					\$53,982
Electrician (hi. volt.)	\$61,773					\$58,772		\$60,056	\$55,455		\$54,485	\$61,371	\$50,260	\$67,046					\$59,414
Lead Wiremen									\$43,893		\$55,273								\$49,583
Signal Inspector	\$69,582						\$64,857	\$65,175			\$69,176								\$67,176
Communications Technician			\$59,775		\$58,610	\$56,244	\$62,017	\$66,004	\$43,893		\$48,998		\$44,243			\$61,358			\$58,610
Signal Apprentice					\$50,946	\$45,426							\$57,641						\$50,946
Signal Maintainer					\$74,942	\$66,617		\$63,606			\$58,571								\$65,111
Engineering Technician								\$69,436			\$65,511					\$56,583	\$45,065		\$61,047
Facility Electrician			\$59,644		\$57,421		\$59,730						\$50,260	\$72,004		\$58,418			\$59,031



Appendix 3—MOI Position Descriptions

Table 3-1. MOI position descriptions

Track, Surfacing, Rail Grinding, Inspection, Structures, Stations/Wayside, and Electric Trans/Sub Station Teams	
Foreman	All work crews perform prescribed work under the supervision of the Foreman. This position requires the experience, training, and proven ability to lead employees to successfully and safely complete work as assigned. Read work orders and prescribe corrective action applying appropriate materials and personnel. This person is responsible to report time and material usage for work completed, and advises the EIC at the completion of a work task that the track is safe for revenue service and his work group is clear of the main track. A Maintenance leader may have expertise in a special area such as Production Surfacing, Turnout-Surfacing, CWR Repair, Structures or other maintenance activities and be assigned accordingly.
Asst. Foreman	This position reports to the Foreman and assists the Foreman in the supervision of work crews. An Asst. Foreman may be assigned due to the size of the work crew, the complexity of the work or the geographic span of the work site.
Inspector	Track Inspectors perform regulatory visual inspections of all mainline tracks and report findings. Inspections will be performed on foot and by Hi-Rail vehicles at slow speeds. They review all climatic, and wheel/rail reporting and determine at field locations the accuracy of data reported by remote and wireless reporting equipment. Structures Inspectors perform regulatory visual inspections of all bridges, aerial structures, tunnels, culverts, buildings, and system facilities. Inspections are performed on foot and by Hi-Rail Trucks and Bucket Trucks
Assistant Inspectors	Assistant Inspectors accompany Inspectors to assist in operation of the Hi-Rail Inspection Vehicle and with visual/manual inspections
Welder	Welders are responsible to complete all welding and grinding requirements for track, bridges, aerial structures, tunnels, and other related tasks. Welders to be qualified for Ox-Acetylene, Wire-Feed, and In-Field electronic welding applications. Working in consist with work gangs; their work is performed as prescribed by the Daily Work Orders. They are equipped with a Hi-Rail specially outfitted vehicle such to perform any welding task.
Welder Helper	Reports to the Welder and performs all tasks as necessary to support and protect welding operations as they are performed. Responsible to maintain and store all welding equipment in a safe and practical manner including protection of the welder during hot work.
Equipment Operator	Equipment operators are trained on specific equipment units for their safe and practical use. They may also be trained on multiple equipment units and assigned various work assignments each work window. They report to the Foreman as assigned and have total responsibility for safe and practical operation of assigned equipment.
Truck Driver	Truck Driver must be CDL Licensed in the State of California and specifically trained to travel and operate equipment as assigned. They will report to the supervisor of the work crew as assigned and be totally responsible for the operation, maintenance, and safe operation of their assigned equipment.
Laborers	These positions support the work group as assigned under the direction of the Foreman leader and are responsible to provide such non-technical, miscellaneous labor services as required for an assigned task.
Plumber	Plumbers shall be licensed as required by the State of California and qualified accordingly for the inspection, maintenance, and repair of all water and sewer systems to include gravity and pressurized systems. They will report to the appropriate supervisor as assigned and must be responsible for any the inventory and reporting of any materials utilized.



Appendix 4—MOE Cost Rationalization Example

The model approximates the operations and maintenance planning that would be done by the system operator to maintain a relatively stable profile of bogey inspection overhaul general inspection costs. The approximation involves a seven-year rolling average for all years besides the first and last three and then an approximate allocation for those years. Below is an example using dummy numbers to demonstrate how the process is applied in the model.

The example dataset includes the following numbers:

	Total	Year	1	2	3	4	5	6	7	8	9	10
Initial Set	48.0		1	2	4	3	8	4	8	7	3	8

Applying the rolling average to all of the years except for the first and last three yields the following results:

	Total	Year	1	2	3	4	5	6	7	8	9	10
Rolling Average	20.6					4.3	5.1	5.3	5.9			

To fill in the first and last three years, the model calculates the total from the first half of the years and subtracts the total from the rolling average for those years and then allocates the rest to the empty years. For this example, for the first half, the total from the initial set was 18 while the total from the rolling average was 9.4. So the difference ($18 - 9.4 = 8.6$) is allocated between the first three years as $1/6$ in the first year, $1/3$ in the second year, and $1/2$ in the third year. This creates the following values:

	Total	Year	1	2	3	4	5	6	7	8	9	10
First 3 Years Allocation	8.6		1.4	2.9	4.3							

The same method is applied to the second half of the costs and the last three years but the assumed allocation is simply $1/3$ in each year. The results of the last three years of allocation produce this:

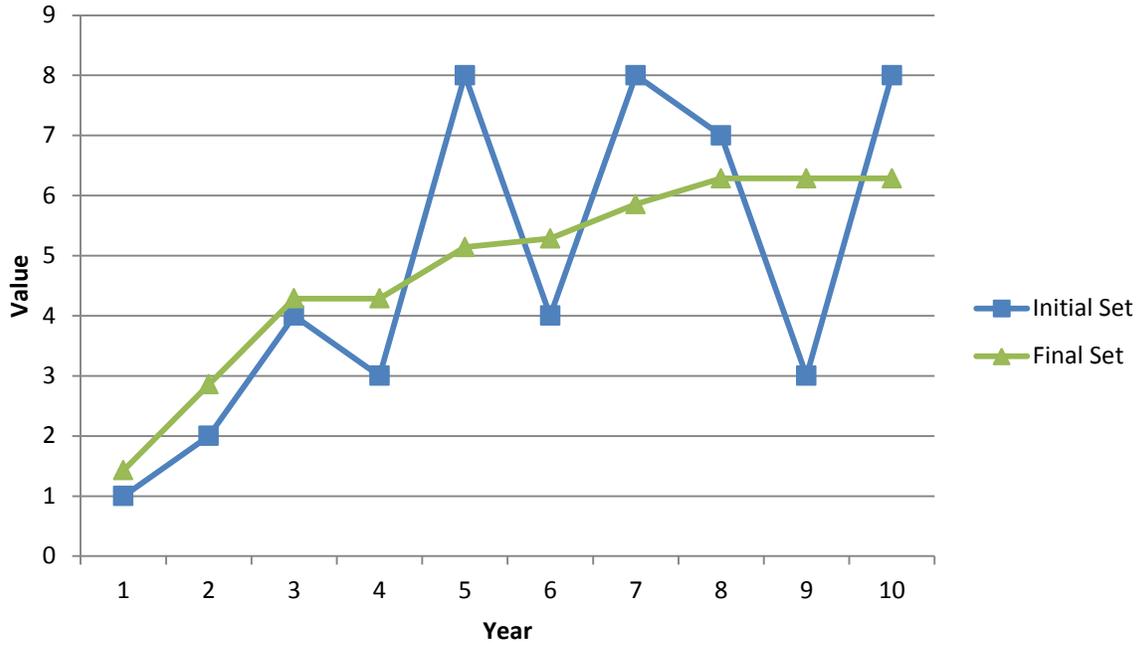
	Total	Year	1	2	3	4	5	6	7	8	9	10
Last 3 Years Allocation	18.9									6.3	6.3	6.3

The final result of the rolling average and allocation produces the following results:

	Total	Year	1	2	3	4	5	6	7	8	9	10
Initial Set	48.0		1	2	4	3	8	4	8	7	3	8
Final Set	48.0		1.4	2.9	4.3	4.3	5.1	5.3	5.9	6.3	6.3	6.3



The impact of the rationalization is best seen graphically:



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Appendix 5—County Population Projections

Population (Thousands)	2020	2025	2030	2035	2040	2045	2050	2055	2060
Alameda	1,656.16	1,750.56	1,842.79	1,940.10	2,037.90	2,140.25	2,247.73	2,360.61	2,479.16
Alpine	0.89	0.84	0.80	0.77	0.76	0.74	0.73	0.72	0.71
Amador	41.10	42.27	43.60	44.86	46.14	47.44	48.78	50.16	51.58
Butte	238.13	248.49	258.48	270.59	285.04	300.48	316.75	333.91	351.99
Calaveras	53.67	56.39	59.36	62.24	65.13	68.10	71.20	74.45	77.84
Colusa	24.27	25.53	26.84	28.13	29.43	30.75	32.14	33.58	35.10
Contra Costa	1,194.86	1,278.19	1,360.49	1,447.16	1,534.81	1,626.83	1,724.37	1,827.76	1,937.34
Del Norte	30.41	31.06	31.71	32.40	33.06	33.73	34.41	35.11	35.83
El Dorado	202.90	215.61	229.21	244.93	261.57	279.43	298.52	318.90	340.68
Fresno	1,050.92	1,108.90	1,167.19	1,234.03	1,312.94	1,397.61	1,487.75	1,583.70	1,685.83
Glenn	30.31	31.25	32.19	33.13	34.07	35.03	36.01	37.02	38.05
Humboldt	132.74	134.17	135.58	136.98	138.40	139.82	141.25	142.70	144.15
Imperial	193.98	206.36	218.59	231.75	245.84	260.88	276.84	293.77	311.73
Inyo	16.61	16.44	16.34	16.27	16.24	16.21	16.18	16.16	16.13
Kern	926.83	979.59	1,036.40	1,095.41	1,155.66	1,222.11	1,292.38	1,366.70	1,445.29
Kings	169.95	180.19	190.70	202.70	216.59	231.69	247.84	265.12	283.60
Lake	72.61	75.62	78.84	81.94	85.07	88.27	91.59	95.03	98.60
Lassen	36.64	37.49	38.30	39.13	39.96	40.79	41.64	42.50	43.39
Los Angeles	11,023.59	11,601.31	12,161.71	12,747.91	13,317.36	13,908.59	14,526.06	15,170.95	15,844.47
Madera	187.14	207.40	229.22	253.09	279.18	308.06	339.92	375.08	413.88
Marin	266.32	273.78	280.95	288.64	295.50	302.42	309.50	316.75	324.17
Mariposa	18.72	19.05	19.42	19.78	20.14	20.50	20.88	21.25	21.64
Mendocino	87.06	87.45	87.77	88.04	88.37	88.68	88.99	89.30	89.61
Merced	288.23	306.97	325.67	345.85	367.41	390.42	414.88	440.86	468.47
Modoc	8.68	8.56	8.46	8.40	8.35	8.31	8.28	8.24	8.20



Population (Thousands)	2020	2025	2030	2035	2040	2045	2050	2055	2060
Mono	13.56	13.81	14.04	14.26	14.49	14.73	14.96	15.20	15.44
Monterey	451.02	472.68	492.50	512.96	533.34	554.88	577.29	600.61	624.87
Napa	148.05	155.05	160.88	167.05	175.22	183.82	192.85	202.32	212.25
Nevada	105.41	108.61	111.87	115.05	118.29	121.55	124.90	128.35	131.89
Orange	3,405.27	3,584.57	3,761.56	3,953.23	4,160.22	4,388.87	4,630.09	4,884.57	5,153.04
Placer	463.80	521.14	581.81	649.26	720.70	798.29	884.24	979.45	1,084.90
Plumas	19.41	19.02	18.72	18.43	18.19	17.97	17.76	17.56	17.35
Riverside	2,531.53	2,730.15	2,931.60	3,140.38	3,350.87	3,583.73	3,832.77	4,099.11	4,383.97
Sacramento	1,592.05	1,692.90	1,800.84	1,925.46	2,057.34	2,198.95	2,350.31	2,512.09	2,685.00
San Benito	54.34	54.67	54.92	55.32	55.81	56.36	56.92	57.49	58.06
San Bernardino	2,112.93	2,179.12	2,250.60	2,329.86	2,411.91	2,507.74	2,607.39	2,710.99	2,818.71
San Diego	3,570.85	3,834.19	4,075.13	4,325.24	4,618.56	4,936.72	5,276.80	5,640.30	6,028.84
San Francisco	901.74	941.75	980.89	1,021.91	1,060.06	1,098.75	1,138.85	1,180.41	1,223.49
San Joaquin	795.15	838.18	881.92	931.87	983.63	1,038.43	1,096.27	1,157.34	1,221.81
San Luis Obispo	323.28	343.41	364.02	388.79	419.25	452.64	488.69	527.61	569.63
San Mateo	781.77	812.21	841.81	872.97	901.67	930.72	960.70	991.66	1,023.61
Santa Barbara	450.38	472.24	493.44	515.16	536.65	560.42	585.25	611.18	638.26
Santa Clara	1,985.62	2,100.09	2,211.84	2,330.67	2,453.92	2,583.33	2,719.57	2,863.00	3,013.98
Santa Cruz	275.12	289.02	301.66	316.27	341.48	369.37	399.53	432.16	467.45
Shasta	195.41	202.22	207.17	212.16	218.90	226.04	233.41	241.02	248.88
Sierra	2.92	2.83	2.78	2.74	2.72	2.70	2.68	2.67	2.65
Siskiyou	44.81	44.96	45.09	45.25	45.39	45.54	45.68	45.82	45.97
Solano	423.11	433.18	442.17	452.51	462.39	472.67	483.19	493.93	504.92
Sonoma	534.23	559.91	585.19	615.40	652.64	692.91	735.67	781.06	829.26



Population (Thousands)	2020	2025	2030	2035	2040	2045	2050	2055	2060
Stanislaus	567.87	600.94	635.76	678.88	734.21	793.60	857.80	927.18	1,002.18
Sutter	98.79	100.62	103.11	107.80	114.18	120.91	128.03	135.56	143.55
Tehama	66.77	69.15	71.66	74.15	76.62	79.15	81.76	84.45	87.24
Trinity	15.08	15.53	15.99	16.47	16.93	17.40	17.89	18.39	18.90
Tulare	538.62	588.45	637.49	688.25	738.79	793.29	851.81	914.65	982.12
Tuolumne	56.73	57.08	57.57	57.95	58.39	58.82	59.26	59.71	60.15
Ventura	909.77	960.92	1,014.95	1,072.01	1,132.28	1,201.88	1,275.75	1,354.16	1,437.40
Yolo	238.83	259.22	280.94	305.53	331.56	359.64	390.09	423.12	458.95
Yuba	81.71	84.64	88.05	93.29	99.99	107.06	114.63	122.73	131.41
Grand Total	41,708.66	44,065.93	46,398.61	48,900.79	51,531.52	54,351.50	57,325.80	60,462.87	63,771.60



Appendix 6—Amtrak Thruway and Rural Intercity Bus Costs

Amtrak California Connecting Bus Service ⁴⁸		
San Joaquin & Pacific Surfliner Routes	Route	Full Year Estimated Expense/ Bus Miles
1	BFD-LAX	\$3.46
3	RDD-SKN	\$3.11
4	LAX-SBA	\$2.80
6	SJC-SKN	\$3.20
7	WTS-MTZ	\$3.00
9	BFD-LVS	\$3.06
10	BFD-SBA	\$3.31
12	BFD-PMD	\$3.16
15	MCD-YOS	\$1.99
17	SBA-SLO	\$3.09
18	HNF-SLO	\$2.68
19	BFD-IND	\$3.12
34	SKN-SFC	\$4.07
39	FUL-IDO	\$2.60
WEIGHTED AVERAGE		\$3.16

⁴⁸ Provided by Caltrans Division of Rail



Caltrans Rural Intercity Bus Study⁴⁹

Table 3-9: PERFORMANCE OF CURRENT S.5311(F) PROJECTS

Agency	S111(f) Route	Total Passengers	Revenue Miles	Revenue Hours	Total Operating Costs	Farebox Recovery Ratio
Redwood Coast Transit Authority	Arcata-Smith River	12,847	138,576	4605	\$ 193,673.00	54.90%
Inyo-Mono Transit	Crest Route	4,467	106,812	2660	\$ 313,451.00	28.06%
Kern Regional Transit	East Kern Express	63,974	403,989	10640	\$ 643,720.00	18.56%
	Mojave Ridgecrest	7,907	75,654	1850	\$ 111,940.13	12.69%
San Benito County Local Transportation Authority - County Express	Intercounty - Greyhound	3,075	28,286	982	\$ 49,683.45	9.42%
Marin Transit	South Route 61	14,022	65,956	3,701	\$178,565	9.3%
	Coastal Route 62	542	7,256	332	\$16,472	4.5%
	(new route implemented 4/1/07); North Route 68	16,491	66,539	3,756	\$185,306	10.4%
San Diego Metropolitan Transit System	888	6,453	74,505	2,348	207,669	8.0%
	891	1,000	19,697	675	54,902	4.7%
	892	939	17,206	594	47,959	5.0%
	894	25,527	132,169	4,523	368,398	17.8%
	867	5,572	69,803	2,647	194,563	7.3%
	889	2,052	34,581	1,564	96,388	5.5%
	891A	108	2,686	87	7,487	3.7%
	892A	125	3,917	118	10,918	2.9%
	893	133	4,164	132	11,606	2.9%
Monterey Salinas Transit	Line 23 Salinas-King City	79,868	213,771	7496:37:00	\$705,688	
	Line 53 South County-Monterey Peninsula Express	3,320	44,397	1417:14:00	\$130,861	
San Luis Obispo RTA	RTA Route 10	104,547	230,067	8,482.32	\$746,967	14.90%
Lake Transit	Route 7 - Lakeport-Ukiah	8,406	114,038	3,873	\$182,108	7.4%
	Route 4 - Clearlake Extension	4,193	17,023	559	\$26,284	13.0%
Napa County Transportation Planning Agency	Vine Route 11 - St. Helena, Calistoga, Santa Rosa FY 06/07	2751		2097	158,025	5%
	Vine Route 11 - St. Helena, Calistoga, Santa Rosa FY 05/06	2610			165,858	4%
	Vine Route 11 - St. Helena, Calistoga, Santa Rosa April - June, 2005	445		423.53	77325	1%
YARTS	Hwy 140	59,469	238,570	7282	819,111	26.35
	Hwy120E/395	1954	49930	669	75,568	
Sam Trans	Route 294	106,535.00	156,268.00	5,156.73	\$ 565,183	21.30%
Modoc Transportation Agency / Sage Stage	Alturas - Susanville - Reno	1,696	63,083.2	1,812.0	\$ 123,378.11	20.5%
	Alturas - Burney - Redding	761	30,007.0	909.8	58,689.70	15.9%
	Alturas - Tulelake - Klamath Falls	1,077	21,475.0	662.0	26,791.91	29.8%
Blue Lake Rancheria of California	Blue Lake Rancheria to Blue Lake to Arcata					

⁴⁹ KFH Group, "California Statewide Rural Intercity Bus Study, Final Draft", Caltrans Division of Mass Transportation, 2007, table 3-9, online at <http://www.dot.ca.gov/hq/MassTrans/Docs-Pdfs/5311/Bus-Study/Chapter-3.pdf>.



Appendix 7—Allocated Contingency Risk/Uncertainty Ratings and Percentages

Last Updated 11/29/13

Table 7-1. Overall team member assessment and allocated contingency percentages

Cost Factor	Team Member 1 Assessment	Team Member 2 Assessment	Team Member 3 Assessment	Team Member 4 Assessment	Average	Contingency
Labor						
MOE	4	4	4	4	4.00	20.00
MOI	3	4	3	4	3.50	22.50
On-board staff (including roustabouts, drill crews, and protect crews)	3	4	3	5	3.75	21.25
Dispatching	5	5	5	4	4.75	16.25
Train Cleaning and Station Maintenance Staff	4	5	4	4	4.25	18.75
Stations	3	3	4	4	3.50	22.50
Police and Security	4	4	no opinion	5	4.33	18.33
G&A	3	4	4	4	3.75	21.25
Materials, Tools, and Other Direct Costs						
MOI Materials (including stations)	3	4	4	3	3.50	22.50
MOI Tools, Uniforms, etc.	2.5	5	5	3	3.88	20.63
MOI Vehicle Leasing Rates	2	3	3	4	3.00	25.00
Vehicles besides MOI and Police and Security	3	4		4	3.67	21.67
Police and Security Vehicles	4	4		4	4.00	20.00
Police and Security Equipment	4	4		4	4.00	20.00
Station Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4	4		5	4.33	18.33
On-board Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4	4		5	4.33	18.33
Dispatch Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4	4		5	4.33	18.33



Cost Factor	Team Member 1 Assessment	Team Member 2 Assessment	Team Member 3 Assessment	Team Member 4 Assessment	Average	Contingency
MOI Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4	4		5	4.33	18.33
MOE Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4	4		5	4.33	18.33
G&A Employee Supplies and Expenses (e.g. uniforms, IT, cell phones, office supplies, etc.)	4	4		5	4.33	18.33
MOE Tools, Uniforms, etc.	2.5	5	5	3	3.88	20.63
MOE Regulatory Inspections	3	4	4	4	3.75	21.25
MOE General Overhauls and Bogey Inspections	3	5	4	2	3.50	22.50
Utilities						
Train Operations Energy	3.5	5	4	4	4.13	19.38
Stations and Maintenance Facilities Energy	4	3	3	4	3.50	22.50
Station and Maintenance Facility Water and Sewer	3.5	2		4	3.17	24.17
Other Costs						
Bus Costs	4.5	2	4	3	3.38	23.13
Advertising	4	4	no opinion	3	3.67	21.67
Credit Card Sales	4	4	no opinion	4	4.00	20.00
Distribution (Call Center)	3	4	no opinion	4	3.67	21.67



Appendix 8—FRA Work Breakdown Structure

Below is the chart of accounts produced by the model in the form of the FRA-developed work breakdown structure for O&M costs.

100 - Maintenance of Way	
101	MoW Track
101.1	MOI Track Salary + Benefits
101.1.01	MOI Track Foremen
101.1.02	MOI Track Inspectors
101.1.03	MOI Track Assistant Inspectors
101.1.04	MOI Track Equipment Operators
101.1.05	MOI Track Laborers
101.1.06	MOI Track Mechanics
101.1.07	MOI Track Truck Drivers
101.1.08	MOI Track Welders
101.1.09	MOI Track Welder Helpers
101.2	MOI Surfacing Salary + Benefits
101.2.01	MOI Surfacing Foremen
101.2.02	MOI Surfacing Assistant Foremen
101.2.03	MOI Surfacing Inspectors
101.2.04	MOI Surfacing Equipment Operators
101.2.05	MOI Surfacing Mechanics
101.2.06	MOI Surfacing Truck Drivers
101.3	MOI Rail Grinding Salary + Benefits
101.3.01	MOI Rail Grinding Equipment Operators
101.3.02	MOI Rail Grinding Laborers
101.3.03	MOI Rail Grinding Technicians
101.4	MOI Condensed Track Inspection Salary + Benefits
101.4.01	MOI Condensed Track Inspection Equipment Operators
101.4.02	MOI Condensed Track Inspection Laborers
101.4.03	MOI Condensed Track Inspection Technicians
101.5	MOI Work Train Salary + Benefits
101.5.01	MOI Work Train Locomotive Engineer
101.5.02	MOI Work Train Conductor
101.6	MOI Track, Surfacing, Grinding and Track Inspection Tools, etc.
101.6.01	Track
101.6.02	Surfacing
101.6.03	Rail Grinding
101.6.04	Condensed Track Inspection
101.6.05	Work Train



	101.7	MOI Track, Surfacing, Grinding and Track Inspection Vehicle Leasing Costs
	101.7.01	Track
	101.7.02	Surfacing
	101.7.03	Rail Grinding
	101.7.04	Condensed Track Inspection
	101.7.05	Work Train
	101.8	MOI Track, Surfacing, Grinding and Track Inspection Materials Costs
	101.8.01	Track
	101.8.02	Surfacing
	101.8.03	Rail Grinding
	101.8.04	Condensed Track Inspection
	101.8.05	Work Train
	102	MoW Communications & Signal
	102.1	MOI Signal Salary + Benefits
	102.1.01	MOI Signals Foremen
	102.1.02	MOI Signals Equipment Operators
	102.1.03	MOI Signals Systems Engineers
	102.1.04	MOI Signals Engineers
	102.1.05	MOI Signals Inspectors
	102.1.06	MOI Signals Maintainers
	102.2	MOI Communication Salary + Benefits
	102.2.01	MOI Communications Foremen
	102.2.02	MOI Communications Equipment Operators
	102.2.03	MOI Communications Engineers
	102.2.04	MOI Communications Technicians
	102.2.05	MOI Communications Inspectors
	102.3	MOI Signal and Communications Tools etc.
	102.3.01	Signal
	102.3.02	Communications
	102.4	MOI Signal and Communications Vehicle Leasing Costs
	102.4.01	Signal
	102.4.02	Communications
	102.5	MOI Signal and Communications Materials Costs
	102.5.01	Signal
	102.5.02	Communications
	103	MoW Electric Traction
	103.1	MOI Overhead Catenary Salary + Benefits
	103.1.01	MOI Overhead Catenary Foremen
	103.1.02	MOI Overhead Catenary Assistant Foremen
	103.1.03	MOI Overhead Catenary Inspectors
	103.1.04	MOI Overhead Catenary Equipment Operators



	103.1.05	MOI Overhead Catenary Laborers
	103.1.06	MOI Overhead Catenary Truck Drivers
	103.1.07	MOI Overhead Catenary Lead Wiremen
	103.1.08	MOI Overhead Catenary Electricians
	103.2	MOI Electric Transmission Salary + Benefits
	103.2.01	MOI Electric Transmission Foremen
	103.2.02	MOI Electric Transmission Inspectors
	103.2.03	MOI Electric Transmission Equipment Operators
	103.2.04	MOI Electric Transmission Laborers
	103.3	MOI Overhead Catenary and Electric Transmission/Substation Tools, etc.
	103.3.01	Overhead Catenary
	103.3.02	Electric Transmission/Substation
	103.4	MOI Overhead Catenary and Electric Transmission/Substation Vehicle Leasing Costs
	103.4.01	Overhead Catenary
	103.4.02	Electric Transmission/Substation
	103.5	MOI Overhead Catenary and Electric Transmission/Substation Materials Costs
	103.5.01	Overhead Catenary
	103.5.02	Electric Transmission/Substation
	104	MoW Bridges and Buildings
	104.1	MOI RR Structures Salary + Benefits
	104.1.01	MOI RR Structures Foremen
	104.1.02	MOI RR Structures Inspectors
	104.1.03	MOI RR Structures Equipment Operators
	104.1.04	MOI RR Structures Laborers
	104.1.05	MOI RR Structures Truck Drivers
	104.2	MOI ROW Structures Salary + Benefits
	104.2.01	MOI ROW Structures Foremen
	104.2.02	MOI ROW Structures Inspectors
	104.2.03	MOI ROW Structures Equipment Operators
	104.2.04	MOI ROW Structures Laborers
	104.2.05	MOI ROW Structures Truck Drivers
	104.3	MOI Stations / Wayside
	104.3.01	MOI Stations / Wayside Foremen
	104.3.02	MOI Stations / Wayside Equipment Operators
	104.3.03	MOI Stations / Wayside Laborers
	104.3.04	MOI Stations / Wayside Truck Drivers
	104.3.05	MOI Stations / Wayside Electricians
	104.3.06	MOI Stations / Wayside Plumbers
	104.4	MOI RR & ROW Structures and Stations Tools etc.
	104.4.01	RR Structures
	104.4.02	ROW Structures



	104.4.03	Stations/Wayside
	104.5	MOI RR and ROW Structures Vehicle Leasing Costs
	104.5.01	RR Structures
	104.5.02	ROW Structures
	104.5.03	Stations/Wayside
	104.6	MOI RR and ROW Structures Vehicle Leasing Costs
	104.6.01	RR Structures
	104.6.02	ROW Structures
	104.6.03	Stations/Wayside
	105	MoW Support
	105.1	Frontline
	105.1.01	MOI Track Frontline
	105.1.02	MOI Surfacing Frontline
	105.1.03	MOI Rail Grinding Frontline
	105.1.04	MOI Condensed Track Inspection Frontline
	105.1.05	MOI Signals Frontline
	105.1.06	MOI Communications Frontline
	105.1.07	MOI Overhead Catenary Frontline
	105.1.08	MOI Electric Transmission Frontline
	105.1.09	MOI RR Structures Frontline
	105.1.10	MOI ROW Structures Frontline
	105.1.11	MOI Stations / Wayside Frontline
	105.1.12	MOI Work Train Frontline
	106	MoW Supplies & Expenses
	106.1	MOI Supplies & Expenses
	106.1.01	Total Uniform and Supplies Costs
	106.1.02	Total IT/Software Costs
	106.1.03	Total Cell Phones Costs
	107	MoW Allocated Contingencies
	107.1	Allocated Contingencies
	107.1.01	MOI Labor (Allocated Contingency)
	107.1.02	MOI Materials (including stations) Allocated Contingency Rate (Allocated Contingency)
	107.1.03	MOI Tools etc. Allocated Contingency Rate (Allocated Contingency)
	107.1.04	MOI Vehicle Leasing Rates Allocated Contingency Rate (Allocated Contingency)
	107.1.05	MOI Supplies + Expenses (Allocated Contingency)



200 - Maintenance of Equipment	
201	MoE Turnaround
201.1	Station Train Turn Salaries (Turn Based)
201.1.01	Station Train Turn Salaries (Turn Based)
201.2	MOE Inspection Cleaners Salary + Benefits
201.2.01	MOE Inspection Cleaners Total Salary and Benefits
202	Loco Maintenance
203	Car Maintenance
203.1	Monthly and Quarterly Inspection Costs
203.1.01	Annual Monthly Inspection Cost
203.1.02	Annual 92-Day Inspection Cost
203.2	MOE Technician Wages + Fringe (Ex Overhauls)
203.2.01	MOE Inspection Supervisors Total Salary and Benefits
203.2.02	MOE Inspection Technicians Total Salary and Benefits
203.2.03	MOE Inspection Laborers Total Salary and Benefits
203.2.04	MOE Inspection Storehouse Employees Payroll
203.3	MOE Tools etc. (Ex Overhauls)
203.3.01	MOE Tools etc. (Ex Overhauls)
203.4	Routine Inspection Costs
203.4.01	Annual Daily Inspection Cost
204	Major Repairs - Expensed
204.1	Overhaul and Bogie Inspection Crew Salaries + Benefits
204.1.01	Smoothed MOE Technician Wages + Fringe
204.2	Overhaul and Bogie Inspection Materials Costs
204.2.01	Smoothed Trainset MOE Costs
204.3	MOE Tools etc.
204.3.01	MOE Tools etc.
205	MoE Support
205.1	Frontline
205.1.01	MOE Technician Frontline (Ex-Overhauls) Total Salary and Benefits
205.1.02	Train Turn Frontline Total Salary and Benefits
206	MoE Energy
206.1	Maintenance Facility Energy Usage
206.1.01	HMF Square Feet Maintenance Facility Energy Cost
206.1.02	San Fernando Square Feet Maintenance Facility Energy Cost
206.1.03	Palmdale Square Feet Maintenance Facility Energy Cost
206.1.04	Gilroy Square Feet Maintenance Facility Energy Cost
206.1.05	San Francisco Square Feet Maintenance Facility Energy Cost
207	MoE Vehicles
207.1	Vehicles
207.1.01	Total Cost of Vehicles for MOE



208	MoE Supplies & Expenses
208.1	Employee Supplies & Expenses
208.1.01	Total Uniform and Supplies Costs
208.1.02	Total IT/Software Costs
208.1.03	Total Cell Phones Cost
208.2	Water & Sewer
208.1.01	Total Water Costs for Maintenance Facilities
208.1.02	Total Sewer Costs for Maintenance Facilities
209	MoE Allocated Contingencies
209.1	Allocated Contingencies
209.1.01	MOE Labor (Allocated Contingency)
209.1.02	MOE Tools etc. Allocated Contingency Rate (Allocated Contingency)
209.1.03	MOE Regulatory Inspections Allocated Contingency Rate (Allocated Contingency)
209.1.04	Maintenance Facilities Energy Allocated Contingency Rate (Allocated Contingency)
209.1.05	Train Cleaning Staff Allocated Contingency Rate (Allocated Contingency)
209.1.06	MOE General Overhauls and Bogey Inspections Allocated Contingency Rate (Allocated Contingency)
209.1.07	MOE Supplies + Expenses (Allocated Contingency)
209.1.08	Vehicles for MOE (Allocated Contingency)
209.1.09	Maintenance Facility Water and Sewer (Allocated Contingency)
300 - Transportation	
301	Onboard Services (OBS)
301.1	Onboard Personnel
301.1.01	Assistant Conductors - Single Trainset Total Salary and Benefits
301.1.02	Assistant Conductor - Double Trainset Total Salary and Benefits
301.1.03	On-Board Assistants (OBA) - Single Trainset Total Salary and Benefits
301.1.04	On-Board Assistants (OBA) - Double Trainset Total Salary and Benefits
301.2	Protect Crews
301.2.01	Assistant Conductor - Protect Total Salary and Benefits
302	Trainmen & Enginemen (T&E)
302.1	Onboard Personnel
302.1.01	Locomotive Engineers - Single Trainset Total Salary and Benefits
302.1.02	Locomotive Engineers - Double Trainset Total Salary and Benefits
302.1.03	Conductors - Single Trainset Total Salary and Benefits
302.1.04	Conductor - Double Trainset Total Salary and Benefits
302.2	Protect Crews
302.2.01	Locomotive Engineers - Protect Total Salary and Benefits
302.2.02	Conductor - Protect Total Salary and Benefits



303	Yard
303.1	Yard Dispatch Salaries + Benefits
303.1.01	HMF - Facility Train Dispatcher Total Salary and Benefits
303.1.02	TSMF - Facility Train Dispatcher Total Salary and Benefits
303.2	Roustabout Crews
303.2.01	Assistant Conductor - Roustabout Total Salary and Benefits
303.2.02	Locomotive Engineers - Roustabout Total Salary and Benefits
303.2.03	Conductor - Roustabout Total Salary and Benefits
303.3	Drill Crews
303.3.01	Drill Crew Locomotive Engineers Total Salary and Benefits
303.3.02	Drill Crew Conductors Total Salary and Benefits
304	Fuel
305	Power - Electric Traction
305.1	Systemwide Trainset Energy Costs
305.1.01	Systemwide Single Trainset Energy Cost
305.1.02	Systemwide Double Trainset Energy Cost
306	Train Movement
306.1	OCC
306.1.01	OCC - Director of Operations Control Total Salary and Benefits
306.1.02	OCC - Deputy Director of Operations Control Total Salary and Benefits
306.1.03	OCC - Train Dispatcher Total Salary and Benefits
306.2	RCC
306.2.01	RCC - Director of Operations Control Total Salary and Benefits
306.2.02	RCC - Deputy Director of Operations Control Total Salary and Benefits
306.2.03	RCC - Train Dispatcher Total Salary and Benefits
306.3	TCF
306.3.01	Small Terminal Station TCF Wages and Fringe (Day)
306.3.02	Ultimate Terminal Station TCF Wages and Fringe (Day)
306.3.03	Ultimate Terminal Station TCF Wages and Fringe (Night)
307	Train Movement - Railroad Services
308	Vehicles
308.1	Operations
308.1.01	Total Cost of Vehicles for Operations
308.2	Dispatching
308.2.01	Total Cost of Vehicles for Dispatching



309	Supplies & Expenses
309.1	Employee Supplies & Expenses
309.1.01	Total On-Board Employees Uniform Costs
309.1.02	Total On-Board Frontline Employees Office Supplies Costs
309.1.03	On-Board Frontline Cell Phones Allowance cost
309.1.04	Total Dispatchers Employees Office Supplies Costs
309.1.05	Dispatchers Cell Phones Allowance cost
310	Transportation Support
310.1	Frontline
310.1.01	On-Board Personnel Crew Frontline Total Salary and Benefits
310.1.02	Protect Crew Frontline Total Salary and Benefits
310.1.03	Roustabout Crew Frontline Total Salary and Benefits
310.1.04	Drill Crew Frontline Total Salary and Benefits
310.1.05	HMF/TSMF Frontline Total Salary and Benefits
310.1.06	OCC Crew Frontline Total Salary and Benefits
310.1.07	RCC Crew Frontline Total Salary and Benefits
310.1.08	TCF Crew Frontline Total Salary and Benefits
311	Connecting Bus Services
311.1	Bus Contracts
311.1.01	Total Bus Contract Costs
312	Transportation Allocated Contingencies
312.1	Allocated Contingencies
312.1.01	Bus Costs Allocated Contingency Rate (Allocated Contingency)
312.1.02	On-Board Staff Labor (Allocated Contingency)
312.1.03	Dispatching Labor (Allocated Contingency)
312.1.04	Train Operations Energy Allocated Contingency Rate (Allocated Contingency)
312.1.05	On-Board Supplies + Expenses (Allocated Contingency)
312.1.06	Dispatching Supplies + Expenses (Allocated Contingency)
312.1.07	Vehicles for Operations (Allocated Contingency)
312.1.08	Vehicles for Dispatching (Allocated Contingency)
400 - Sales and Marketing	
401	Sales
401.1	Credit Card/Bank Fees
401.1.01	Credit Card/Bank Fees
402	Information & Reservations
402.1	Call Center
402.1.01	Call Center Commissions
403	Marketing
403.1	Marketing & Advertising Costs
403.1.01	Alameda County Marketing Cost
403.1.02	Alpine County Marketing Cost



	403.1.03	Amador County Marketing Cost
	403.1.04	Butte County Marketing Cost
	403.1.05	Calaveras County Marketing Cost
	403.1.06	Colusa County Marketing Cost
	403.1.07	Contra Costa County Marketing Cost
	403.1.08	Del Norte County Marketing Cost
	403.1.09	El Dorado County Marketing Cost
	403.1.10	Fresno County Marketing Cost
	403.1.11	Glenn County Marketing Cost
	403.1.12	Humboldt County Marketing Cost
	403.1.13	Imperial County Marketing Cost
	403.1.14	Inyo County Marketing Cost
	403.1.15	Kern County Marketing Cost
	403.1.16	Kings County Marketing Cost
	403.1.17	Lake County Marketing Cost
	403.1.18	Lassen County Marketing Cost
	403.1.19	Los Angeles County Marketing Cost
	403.1.20	Madera County Marketing Cost
	403.1.21	Marin County Marketing Cost
	403.1.22	Mariposa County Marketing Cost
	403.1.23	Mendocino County Marketing Cost
	403.1.24	Merced County Marketing Cost
	403.1.25	Modoc County Marketing Cost
	403.1.26	Mono County Marketing Cost
	403.1.27	Monterey County Marketing Cost
	403.1.28	Napa County Marketing Cost
	403.1.29	Nevada County Marketing Cost
	403.1.30	Orange County Marketing Cost
	403.1.31	Placer County Marketing Cost
	403.1.32	Plumas County Marketing Cost
	403.1.33	Riverside County Marketing Cost
	403.1.34	Sacramento County Marketing Cost
	403.1.35	San Benito County Marketing Cost
	403.1.36	San Bernardino County Marketing Cost
	403.1.37	San Diego County Marketing Cost
	403.1.38	San Francisco County Marketing Cost
	403.1.39	San Joaquin County Marketing Cost
	403.1.40	San Luis Obispo County Marketing Cost
	403.1.41	San Mateo County Marketing Cost
	403.1.42	Santa Barbara County Marketing Cost
	403.1.43	Santa Clara County Marketing Cost



	403.1.44	Santa Cruz County Marketing Cost
	403.1.45	Shasta County Marketing Cost
	403.1.46	Sierra County Marketing Cost
	403.1.47	Siskiyou County Marketing Cost
	403.1.48	Solano County Marketing Cost
	403.1.49	Sonoma County Marketing Cost
	403.1.50	Stanislaus County Marketing Cost
	403.1.51	Sutter County Marketing Cost
	403.1.52	Tehama County Marketing Cost
	403.1.53	Trinity County Marketing Cost
	403.1.54	Tulare County Marketing Cost
	403.1.55	Tuolumne County Marketing Cost
	403.1.56	Ventura County Marketing Cost
	403.1.57	Yolo County Marketing Cost
	403.1.58	Yuba County Marketing Cost
	404	Sales and Marketing Allocated Contingencies
	404.1	Allocated Contingencies
	404.1.01	Advertising Allocated Contingency Rate (Allocated Contingency)
	404.1.02	Distribution Allocated Contingency Rate (Allocated Contingency)
	404.1.03	Credit Card Sales Allocated Contingency Rate (Allocated Contingency)
500 - Stations		
	501	Stations
	501.1	Station Maintenance
	501.1.01	Station Maintenance - A Total Salary and Benefits
	501.1.02	Station Maintenance - B Total Salary and Benefits
	501.1.03	Station Maintenance - C Total Salary and Benefits
	501.1.04	Station Maintenance Frontline Total Salary and Benefits
	501.2	Station Service Staff
	501.2.01	Agent/Station Manager –Level C Total Salary and Benefits
	501.2.02	Ticket Clerk—Level C Total Salary and Benefits
	501.2.03	Agent/Station Manager—Level B Total Salary and Benefits
	501.2.04	Ticket Clerk—Level B Total Salary and Benefits
	501.2.05	Agent/Station Manager—Level A Total Salary and Benefits
	501.2.06	Ticket Clerk—Level A Total Salary and Benefits
	501.2.07	Station Crew Frontline Total Salary and Benefits
	501.3	Station Utilities
	501.3.01	Station Energy Usage (kWh) Cost
	502	Vehicles
	502.1	Station Vehicles
	502.1.01	Total Cost of Vehicles for Stations



503	Supplies & Expenses
503.1	Employee Supplies & Expenses
503.1.01	Total Uniform and Supplies Costs
503.1.02	Total Cell Phones Costs
503.1.03	Total Software/IT Costs
503.2	Water & Sewer
503.2.01	Total Water Costs for Stations
503.2.02	Total Sewer Costs for Stations
504	Stations Allocated Contingencies
504.1	Allocated Contingencies
504.1.01	Stations Labor (Allocated Contingency)
504.1.02	Stations Energy Allocated Contingency Rate (Allocated Contingency)
504.1.03	Stations Supplies + Expenses (Allocated Contingency)
504.1.04	Vehicles for Stations (Allocated Contingency)
504.1.05	Station Water and Sewer (Allocated Contingency)
600 - Police, Security & Environmental Safety	
601	Police and Security
601.1	Sworn Police Officers
601.1.01	Sworn Officers at Maintenance Facilities Total Salary and Benefits
601.1.02	Level B/C Station Sworn Officer Salary and Benefits
601.1.03	Level A Station Sworn Officer Salary and Benefits
601.1.05	Sworn Police Officer Frontline Salary and Benefits
601.2	Unsworn Security Officers
601.2.01	Unsworn Officers at Maintenance Facilities Total Salary and Benefits
601.2.02	Level B/C Station Unsworn Officer Salary and Benefits
601.2.03	Level A Station Unsworn Officer Salary and Benefits
601.2.06	Unsworn Police Officer Frontline Total Salary and Benefits
602	Supplies & Equipment
602.1	Personal Equipment
602.1.01	Total Sworn Officer Equipment and Supplies Costs
602.1.02	Total Unsworn Officer Equipment Costs
602.2	Vehicles & Fuel
602.2.01	Total Security Vehicles and Fuel Costs
603	Environmental & Safety
604	Police, Security, & Environmental Allocated Contingencies
604.1	Allocated Contingencies
604.1.01	Station Security Labor (Allocated Contingency)
604.1.02	MOI Security Labor (Allocated Contingency)
604.1.03	MOE Security Labor (Allocated Contingency)
604.1.04	Station Security Equipment (Allocated Contingency)



	604.1.05	MOI Security Equipment (Allocated Contingency)
	604.1.06	MOE Security Equipment (Allocated Contingency)
700 - General & Administration		
	701	Corporate Administration
	701.1	Management and Administration
	701.1.01	Executives (G&A) Total Salary and Benefits
	701.1.02	Senior Management (G&A) Total Salary and Benefits
	701.1.03	Mid-Managers (G&A) Fringe
	701.1.04	Admin/Other Corporate (G&A) Total Salary and Benefits
	702	Centralized Services
	702.1	Insurance
	702.1.01	Total Insurance
	703	Supplies & Expenses
	703.1	Employee Supplies & Expenses
	703.1.01	Total G&A Employees Office Supplies Costs
	703.1.02	G&A IT/Software cost
	703.1.03	G&A Cell Phones Allowance cost
	703.1.04	Total Travel Expenses
	704	Vehicles
	704.1	G&A Vehicles
	704.1.01	Total Cost of Vehicles for G&A
	705	General & Administration Allocated Contingencies
	705.1	Allocated Contingencies
	705.1.01	G&A Labor (Allocated Contingency)
	705.1.02	Insurance Allocated Contingency Rate (Allocated Contingency)
	705.1.03	G&A Supplies + Expenses (Allocated Contingency)
	705.1.04	Vehicles for G&A (Allocated Contingency)



Appendix 9—Illustrative Organization Chart

Below are two illustrative organization charts that incorporate all of the positions currently included in the model. At the current stage of design, a fully developed organizational chart is not feasible as procurement and other decisions are yet to be made so this is meant to depict the levels of the organization that are modeled at this point. The actual organization structure will be determined at a future date. The first organization chart shows the overall corporate organization structure at a very high level. The second organization chart looks at the operations functions included under the Senior Vice President of Operations.

Figure 9-1. Illustrative overall corporate organizational structure

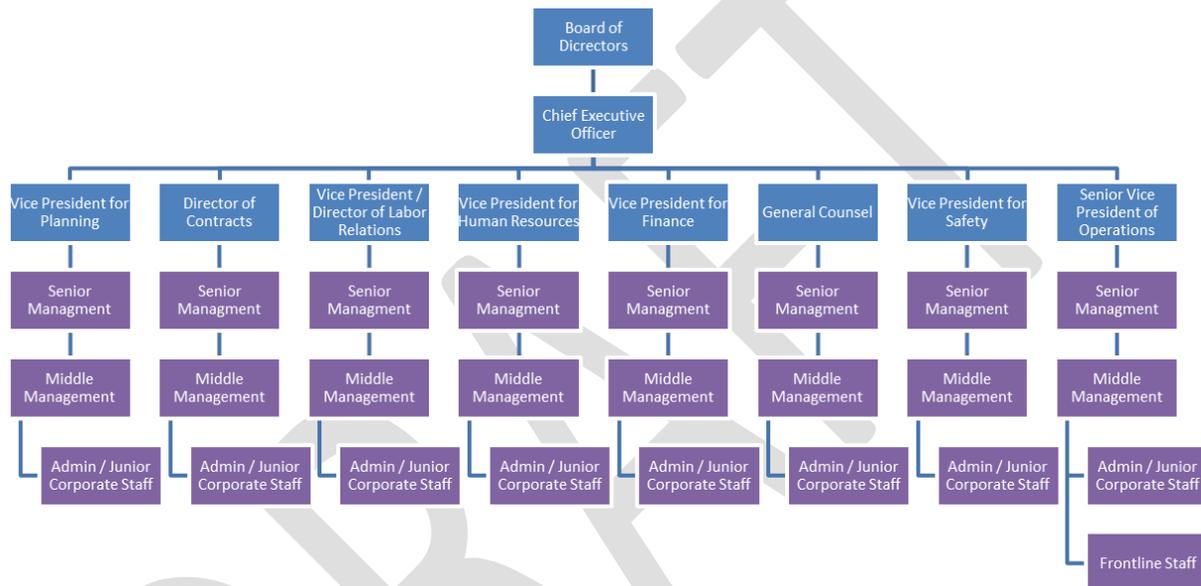


Figure 9-2. Illustrative operations and maintenance staff structure - on-board personnel

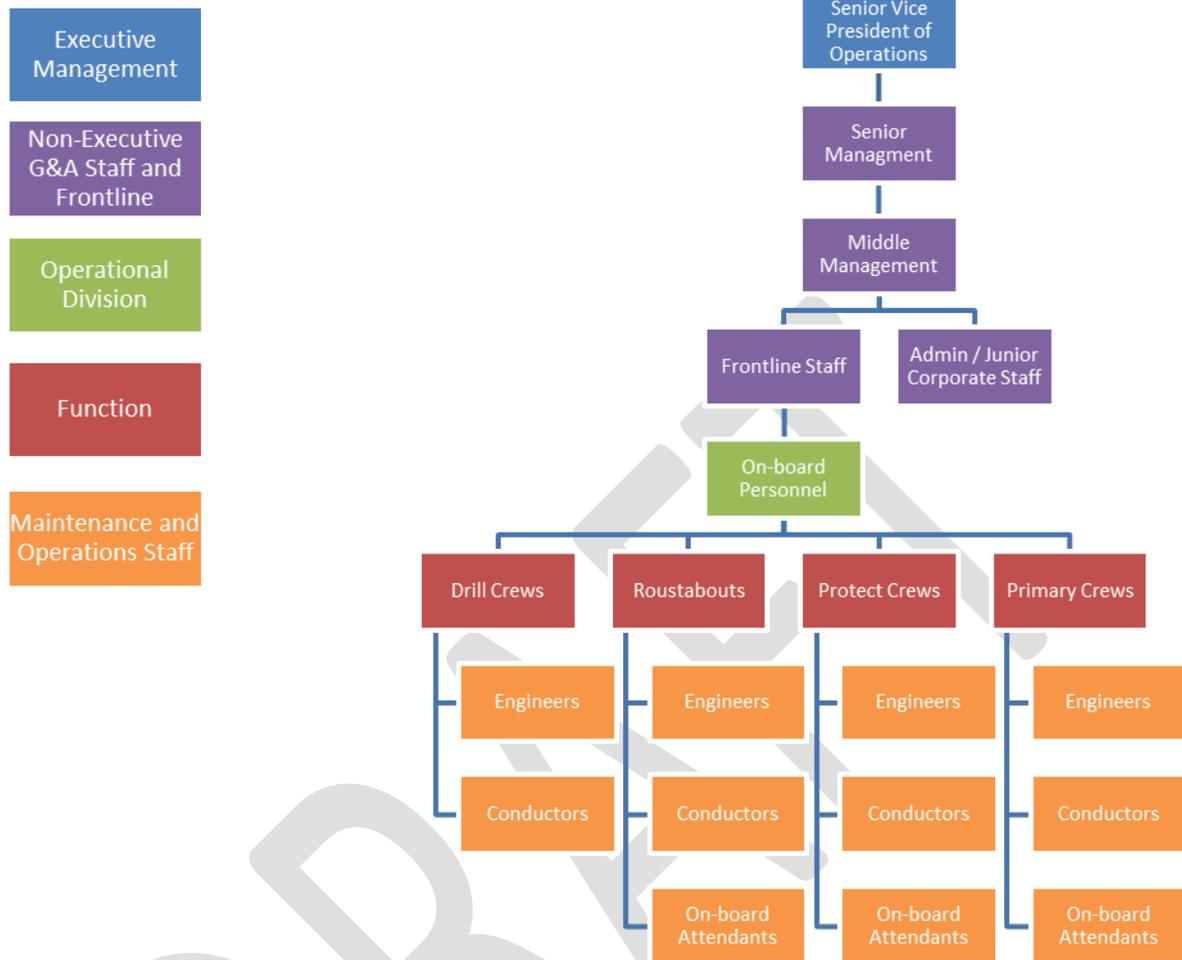


Figure 9-3. Illustrative operations and maintenance staff structure - dispatching

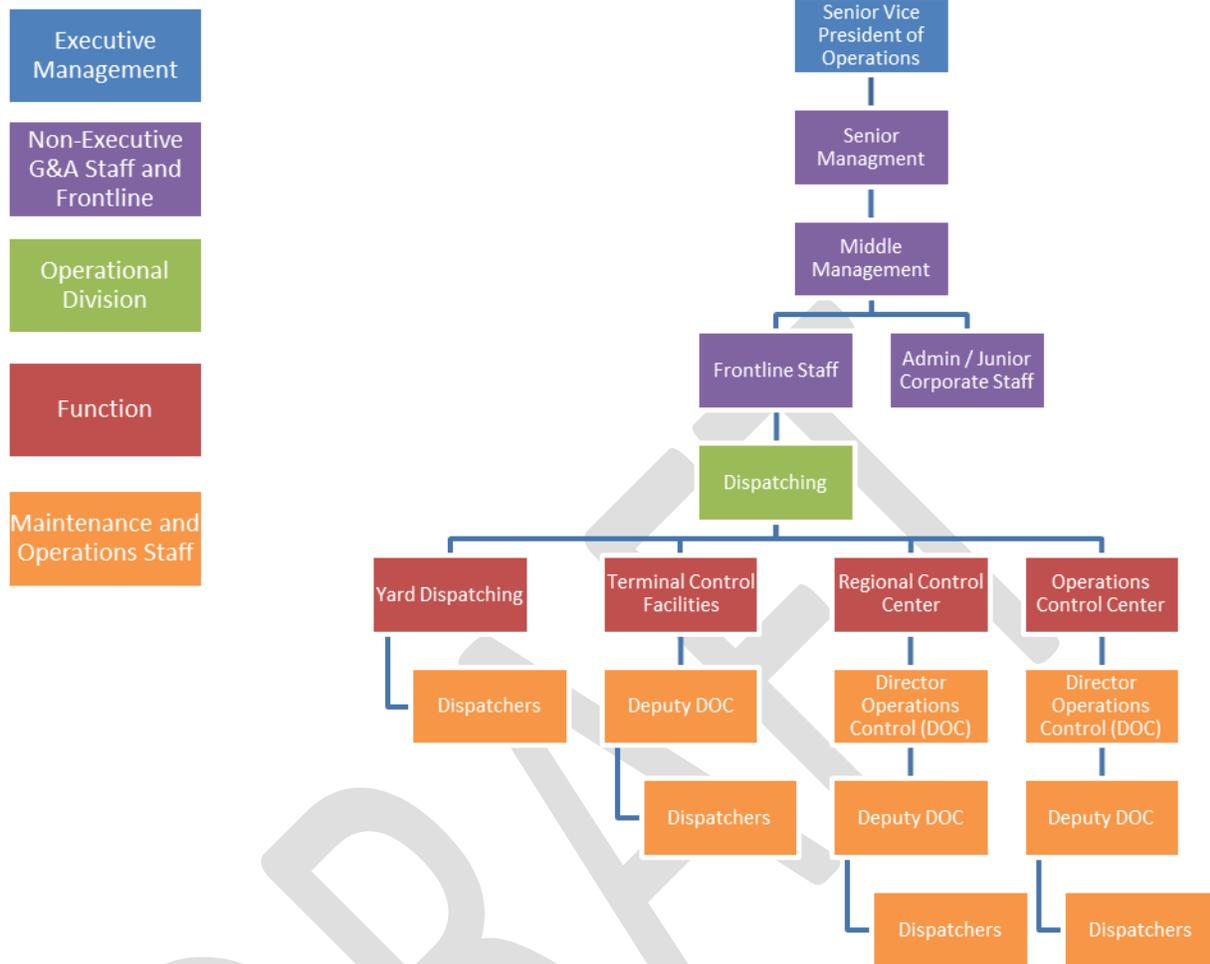


Figure 9-4. Illustrative operations and maintenance staff structure - maintenance of equipment

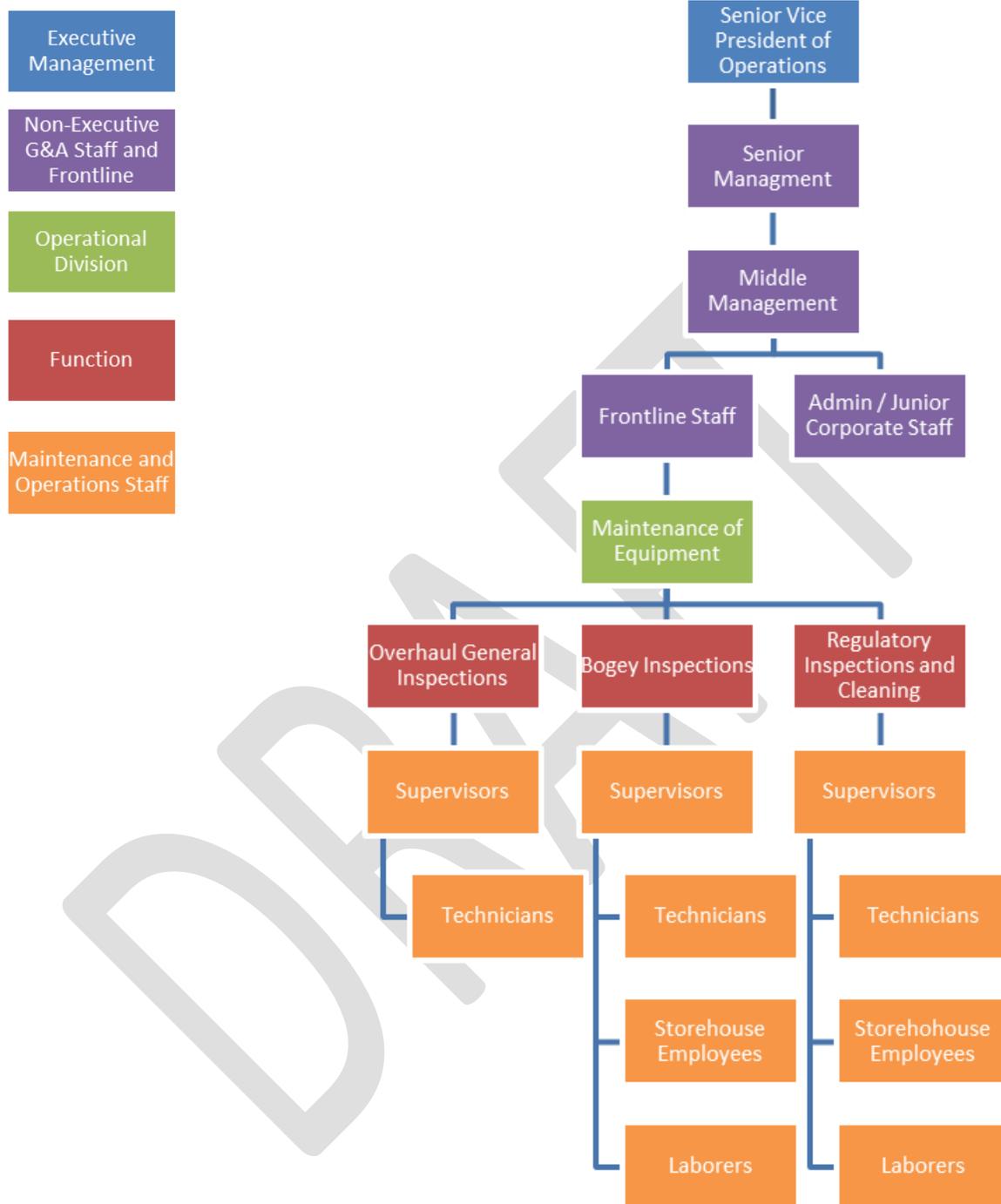


Figure 9-5. Illustrative operations and maintenance staff structure - maintenance of infrastructure basic MOI facility staff

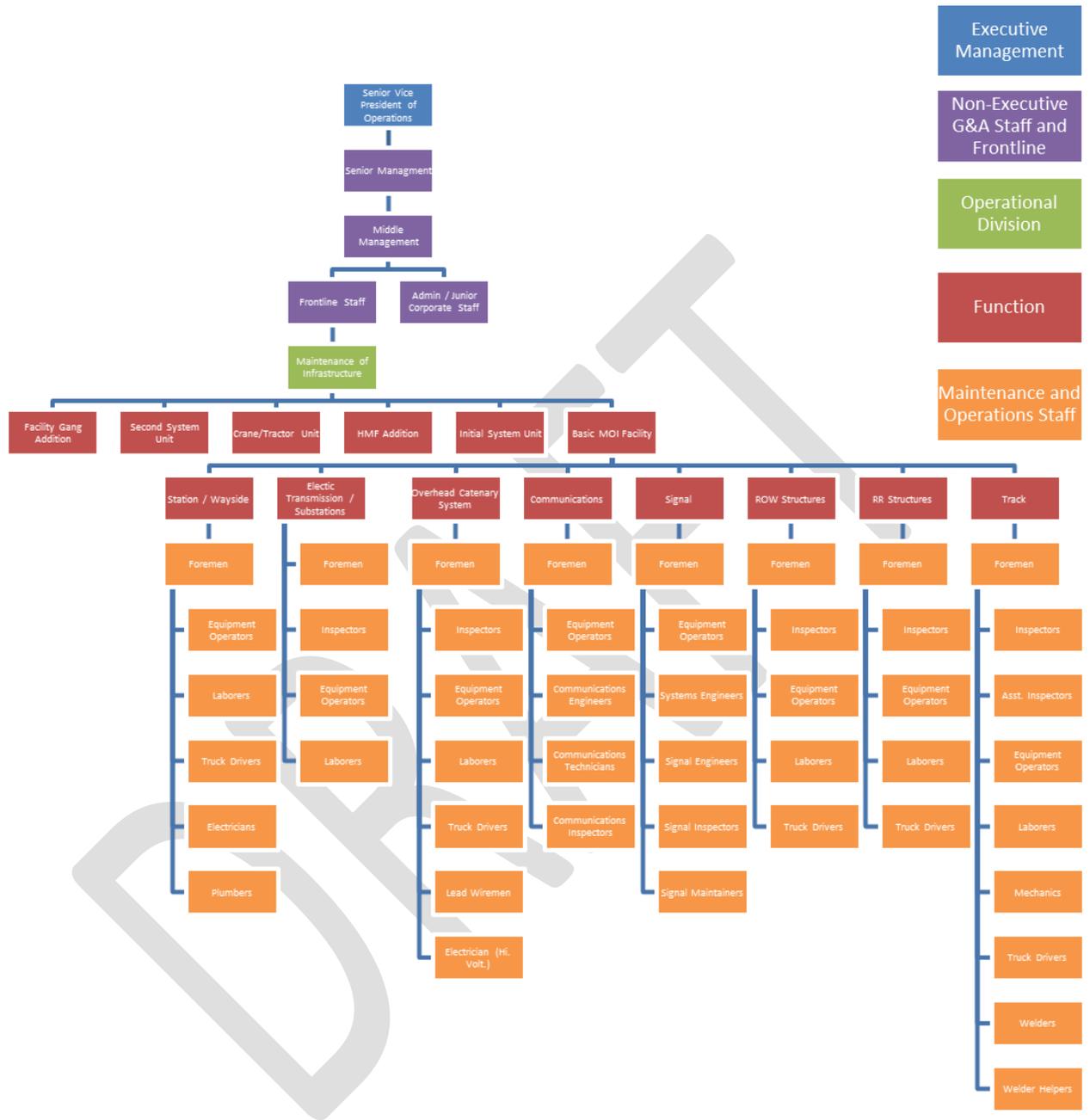


Figure 9-6. Illustrative operations and maintenance staff structure - maintenance of infrastructure all other gangs

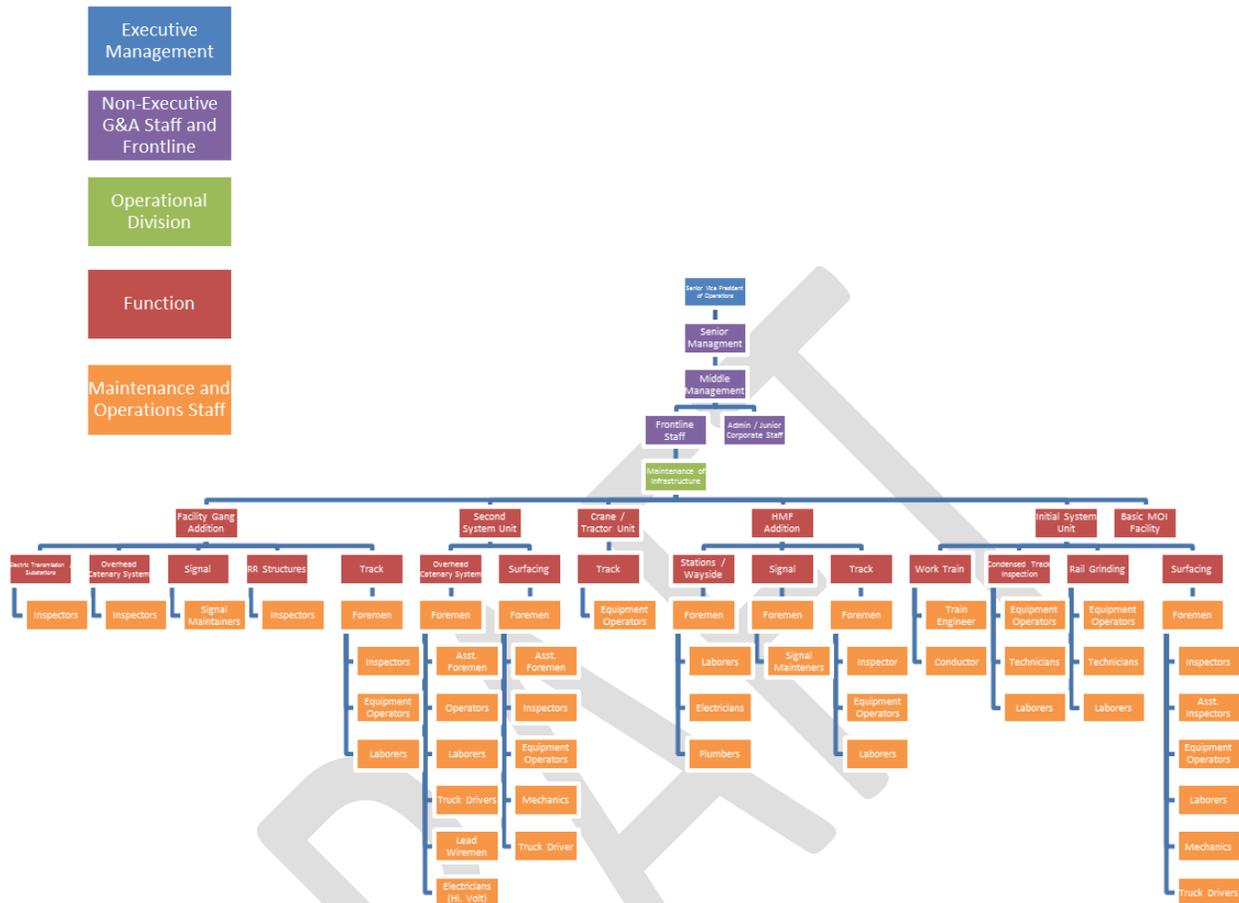


Figure 9-7. Illustrative operations and maintenance staff structure—Stations and Police and Security

