Chapter 6
CAPITAL REQUIREMENTS

INTRODUCTION

This chapter presents the projected capital requirements for the Sonoma – Marin rail service. A discussion of the individual capital items and their costs by service option appear below. These items are:

- Rolling stock types – DMUs and conventional equipment;
- Right-of-way improvements to support commuter rail operations;
- Signalization;
- Bridge improvements;
- Stations – construction and land acquisition
- A maintenance facility
- Sound walls to mitigate noise impacts

At the end of the chapter, all cost items are summed to present total cost per service option. The costs are presented on a total dollar basis, as well as on an apples-to-apples comparative basis of total cost per mile.

ROLLING STOCK ANALYSIS

Three types of rolling stock compliant with FRA standards for crashworthiness were considered as viable start-up technologies for the Sonoma Marin rail service[1]. The three types are:

- Conventional locomotive-hauled equipment, i.e., a diesel locomotive and bi-level passenger cars;
- Rebuilt Budd Rail Diesel Cars (called hereafter Budd cars); and
- FRA Compliant Diesel Multiple Units (DMUs);

The technologies were described in general terms in the Chapter 3. Greater detail on these options appears below. The Commission has made no final decision on which type of rolling stock will be used for start-up, other than that the equipment must comply with FRA standards for crashworthiness. The purpose of including the following detail is to facilitate the consideration of which technology to select for the start-up of service. Budd cars are not included in the operating cost analysis (Chapter 5) for the final capital cost requirements

[1] FRA Compliant rail passenger vehicles can be operated simultaneously with freight trains and passenger excursion trains.

considered in this chapter. However, specifics of this rolling stock type appear below for comparative purposes.

Rolling Stock Characteristics

Obtained from manufacturers and operators for the equipment types, the following information relates to those characteristics that provide a meaningful basis of comparison. These are characteristics that a potential buyer should know in order to make an informed decision. The characteristics are:

- Model identification
- Features
- Other Users
- Lead time for Delivery
- Purchase Cost
- Maintenance Cost
- ADA Compliance
- Length
- Weight
- Seated Capacity and Bicycle Accommodations
- Acceleration
- Deceleration
- Top Speed
- Fuel Consumption
- Emissions
- Noise

Manufacturers contacted included:

- General Motors' Electro-Motive Division (EMD), the maker of the F59 PHI locomotive used by the Los Angeles Metrolink service and Caltrans, among others;
- Bombardier, maker of a widely used bi-level commute car used by Metrolink, the Coaster, and Altamont Commuter Express (ACE); and
- ADtranz, designer of the ostensibly compliant DMU 90-2, once proposed for the Pennsylvania Department of Transportation (PennDOT), the DMU 90-3, and of the non-compliant GTW contracted for New Jersey Transit (NJT).

LTK Engineering Services provided detail on the rebuilt Budd cars used by Dallas Area Rapid Transit (DART) for the Trinity Railway Express service. LTK currently maintains this equipment. In addition, officials at Metrolink, the Altamont Commuter Express (ACE), and

Vancouver's West Coast Express commuter service provided insights on locomotive-hauled equipment.

The findings appear as Table 6-1, Rolling Stock Comparison. While the information appearing in the table is laid out in a straightforward manner, a clearer understanding of the key points required that it appear in a railroad operating context. For example, the seated capacities of a locomotive-hauled passenger car and a DMU by themselves present very little meaningful information. Rather, the question should be this: How much seated capacity is needed per train set – either locomotive-hauled or DMU? By knowing this critical variable, a meaningful discussion can begin on:

- How long will the train be? (Train length is of importance particularly in San Rafael, where blocking intersections will be a critical concern.)
- What are the capital cost requirements?
- What are the operating and maintenance (O&M) cost requirements?
- What are the implications regarding fuel consumption, emissions, and noise?

Based on ridership for the Cloverdale to San Rafael service option, a maximum seating capacity of under 200 persons per train set would be sufficient to assure every person gets a set at start-up as well as 10 years into the future. Two Bombardier cars, three RDC Budd cars, and an ADtranz DMU 90-3 all could comfortably accommodate this number of riders. With this key passenger figure established, an applies-to-apples comparison of the technologies can begin.

Also discussed below are the various rolling stock characteristics with regard to engine emissions and noise levels. Input on emissions came from Caltrans, with regard to locomotive-hauled train sets only. No specifics with regard to diesel exhaust emissions regarding DMUs and RDC Budd cars were available. The results of a preliminary analysis of comparative noise levels of the rolling stock types also appear below.

Lastly, it should be noted that while DMU 90-2s and 90-3s have been designed, they do not exist at the time of this writing. None has been built to date. Also, no other manufacturer has built a DMU that is compliant with FRA crashworthiness standards. ADtranz is currently manufacturing an FRA Non-compliant DMU or Light DMU for New Jersey Transit, the GTW. Other manufacturers of non-compliant DMUs are Siemens, maker of the *RegioSpringer*, which was demonstrated in Sonoma and Marin in 1997, Altsom, and Kinki Sharyo.

Length

With a seating capacity of 284, a two-car locomotive-hauled train set would have an overall length of 228 feet; an F59 PHI locomotive is 59 feet long, and each bi-level car is 85 feet long. Having a seated capacity of 85 persons per car, a train set comprised of three Budd cars would be required to handle 200 seated passengers. The three Budd cars would have a total length of 267 feet. One DMU 90-3 train set (consisting of three cars or units) would have a total length of 255 feet. With seating for 272, the DMU 90-3 was envisioned for the two longer distance options from Healdsburg and Cloverdale to San Rafael. With seating for 170, DMU 90-2 (consisting of two cars or units) would be sufficient for handling passenger volumes for the three shorter distance routes. A DMU 90-2 has a length of 170 feet. All train set options would fit into the 280-foot distance between 3rd and 4th Streets in San Rafael, the proposed location for a downtown station.

Purchase Cost

The purchase and rebuilding cost for a Budd car at about $2 million, based on the $1.8 million that DART paid to put these cars in service in 1995. Given a capacity of 85 seats per car, the per-seat cost would be about $23,000. ADtranz has estimated the purchase price of a DMU 90-2 at $6 million. Given its maximum seated capacity of 170, the per-seat cost would be about $35,000. The per-seat purchase cost for DMU 90-3 would be slightly more than $31,000. These DMU and Budd car per-seat costs would not change, regardless of the number of units purchased. Calculation of a per-seat purchase cost for locomotive-hauled equipment, however, does vary with the length of the train. A train set consisting of a locomotive and two cars, having a seated capacity of 284, would cost about $6 million, or $21,000 per seat.

Maintenance

For the estimation of maintenance costs, identical staffing requirements were assumed for the various technologies for each of the service options. However, differences in staffing levels per option confuse a meaningful comparison of maintenance costs among the options. Assuming identical staffing levels for a single option alone, the only real difference in estimated maintenance costs would arise for spare parts cost, which is slight.

Availability

EMD, Bombardier and ADtranz reported lead times for their equipment of up to two years. EMD stated locomotives conceivably could be delivered in as soon as one year. LTK estimated that the rebuilding of a Budd car could take up to two years.

Acceleration

As a “rule of thumb”, the self-propelled technologies will have higher acceleration rates than locomotive-hauled equipment. That being said, the differences are not major. Acceleration is commonly cited in terms of miles per hour per second (mphps) to a specific speed. Based on data provided by EMD, the estimated acceleration would be at 0.67 mphps to 50 mph for a conventional train with three cars. LTK estimated a Budd car acceleration at 0.8 mphps to 50 mph. ADtranz calculated that a DMU 90-2 unit would accelerate at 0.75 mphps to 50 mph, and that a DMU 90-3 would accelerate slightly slower at 0.73 mphps to the same speed. For all technologies, acceleration rates tend to be higher at lower speeds. For example, LTK said the Budd cars tested at 1.5 mphps to 20 mph.

Table 6-1
Rolling Stock Comparison

	Locomotive	**Commute Car**	**Rebuilt Budd Car Equipment**	**ADtranz Two-Car DMU**	**ADtranz Three-Car DMU**
Model or Description	F59 PHI.	Bombardier Aluminum Bi-Level (cab and trailer).	Budd RDC-1 or RDC-2.	DMU 90-2, a modified IC-3 proposed for PennDOT.	DMU 90-3
Features	Aerodynamic. Has fuel injection to reduce emissions.	Bi-level design with 2 sets of 53-inch doors at lower level. Some are cab cars and others are coaches.	Self-propelled, single level cars with vestibule steps. Operating cabs at both ends.	Articulated single-level two-car unit with vestibule steps. Operating cab at each end of each articulated unit.	Articulated single-level three-car unit with low floor design. Operating cab at each end of each articulated unit.
Other Users	Amtrak, Metrolink, West Coast Express, Caltrans.	Metrolink, Coaster, Altamont Commuter Express (ACE), West Coast Express, Go Transit.	DART's Trinity Railway Express, BC Rail.	None on order.	None on order.
Availability and delivery time	12 months from signed contract and letter of credit.	15 to 18 months. 15 months, if line is up and running. 18 months from "cold " start.	36 available from VIA[2]. Rebuilding will require 18 to 24 months.	24 months.	24 months.
Cost Estimate	$2-2.5 million per locomotive, assuming order of 5 to 10 locomotives.	Based on an order of 15 cars, $1.9 million for a cab car, and $1.8 million for a coach car. Add $50,000 per car for a 10-car order. Subtract $25,000 per car for a 20-car order.	$2 million per unit (DART paid $1.8 million in 1995). This figure includes purchase of the vehicle from VIA and an extensive rebuilding.	$6 million for a two-car articulated unit.	$8.5 million for a three-car articulated unit.
Maintenance Costs	See bi-level maintenance cost.	Varies per service option.	Not calculated.	Varies per service option.	Varies per service option.

2 Based on discussion with Oregon DOT, following inspection of available cars.

ADA Access	Not applicable.	Folding ramp through low-level doors to special raised platform.[3]	DART has built high platforms from which wheelchairs can access Budd car vestibule over throw plate.	Will conform to ADA requirements.	Will conform to ADA requirements.
Table 6-1 Cont.	**Locomotive**	**Commute Car**	**Rebuilt Budd Car Equipment**	**ADtranz Two-Car DMU**	**ADtranz Three-Car DMU**
Length	58.6 feet.	85 feet.	89 feet.	170 feet.	255 feet.
Weight	140 tons.	61 tons for a cab car, 59 tons for a coach car.	65 tons.	142.2 tons.	211 tons.
Seated Capacity	Not applicable.	Cab car: 140; Coach car: 144.	85	170	272
Purchase Cost per Seat	See bi-level car purchase cost per seat.	$21,000 assuming two cars	$23,000	$35,000	$31,000
Acceleration to 50 mphps	0.67 mphps.	Not applicable.	0.8 mphps.	0.75 mphps	0.72 mphps.
Deceleration	2 - 2.5 mphps full service; 2.5 - 3 mphps emergency.	Not applicable.	2.5 mphps full service; 2.75 mphps emergency.	2.5 mphps full service.	2.5 mphps full
Top Speed	110 mph	100 mph	100 mph	90 mph	90 mph
Fuel Consumption	2.2 gallons per mile.	Not applicable.	0.4 gallons per mile.	0.42 gallons per mile.	0.44 gallons per mile.

Deceleration

EMD, LTK and ADtranz reported deceleration rates that also show relatively minor differences between technologies. In Figure 6-1, rates appear in terms of a "full service brake", or normal braking circumstances as opposed to an "emergency brake." Full service braking rates for all technologies fall within a range of 2 to 2.5 mphps.

Fuel Consumption

In Table 6-1, fuel consumption appears in terms of gallons per mile. Operator comments indicated that a conventional train with two cars would consume diesel fuel at a rate of about 2.2 gallons per mile. Based on data provided by LTK, three Budd cars would consume fuel at a lower rate of about 1.2 gallons per mile. ADtranz figures indicated that a DMU 90-2 on the three shorter distance routes would consume fuel at about 0.42 gallons per mile, and a DMU 90-3 on the two longer distance routes would consume fuel at about 0.44 gallons per mile.

Emissions

[3] System in use at Coaster, Metrolink, and Altamont Commuter Express (ACE).

Emissions tests, conducted for the F 59 locomotive (predecessor to the F 59 PHI) as part of the acquisition program for Caltrans (which uses the locomotive in its various Capital, San Joaquin and San Diegan corridor services), indicated that it would meet the current standards for locomotives manufactured before 2001 (Tier 0). As the standards become more stringent over time, the manufacturers have the responsibility for building vehicles that meet current standards.

As noted, DART is operating rebuilt Budd cars now. DART purchased them approximately three years ago from VIA Rail in Canada. At the time of purchase, the car bodies were rebuilt to update them and comply with Americans with Disabilities Act (ADA) standards. The engines were not re-manufactured, and no emissions testing was completed. VIA Rail replaced the Budd car engines about 11 years ago. LTK, the maintenance contractor for the DART Budd cars, indicated that they meet all non-road emission standards of the Environmental Protection Agency (EPA). These are found in 40 Code of Federal Regulations (CFR 40), Part 89.

There are no DMUs 90-2s or DMU 90-3s in operation. As a result, no emissions data is available. ADtranz, the manufacturer, indicated that it would be required to meet the applicable 40 CFR 89 standards of the EPA.

Noise

A preliminary assessment the Day-Night Sound Level (Ldn), which describes cumulative 24-hour noise exposure, indicated a comparatively low level of noise exposure. Ldn is often used in the assessment of community noise impacts. Preliminary results showed Ldn in a range of 52 to 59 decibels (dBA) measured at 100 feet for DMU equipment types. Typically, urban and suburban neighborhoods are in the range of Ldn 50 to 70. The analysis was done for the operation of 24 trains per day (the start-up service level), with two trains operating outside the 7 a.m. and 10 p.m. windows.

Ldn was estimated for operating speeds between 30 and 60 mph on typically good track conditions. The conventional diesel locomotive would have slightly higher noise levels during operation. Given their engine size, predictably Ldn for Budd cars would be similar to DMUs. As speeds increase and the wheel/rail noise becomes more dominant, the difference between the noise levels for the locomotive-hauled train sets, the Budd cars, and the DMUs diminishes.

Train Sets Needed to Support Service Options

Train sets required for the five service options appear in Table 6-2, Rolling Stock Requirements for Start-up. The trains set calculations reflect the number of train sets required to support the service options, plus spares. Estimated costs for rolling stock appear below as well, broken out in terms of DMUs and conventional locomotive-hauled equipment.

Table 6-2
Rolling Stock Requirements for Start-up
1999 Dollars

Rolling Stock	Healdsburg	Cloverdale	Healdsburg	Cloverdale	Petaluma

Type	to San Rafael		to San Rafael		to Petaluma		to Petaluma		to San Rafael	
	Sets	$ million	Sets	$ million	Sets	$ million	Sets	$ million	Sets	$ million
DMUs	5	42.5	5	42.5	4	24	4	24	3	18
Conventional	5	30	5	30	4	16[4]	4	16	3	12

The cost differential between DMUs and conventional equipment is substantial. In the case of the two longer distance options, it is about 41 percent, in favor of the conventional equipment. One reason why DMUs would cost so much is that no prototype of the equipment exists. No compliant DMUs have yet been ordered, though there has been recurring interest in the vehicles expressed by various transportation agencies, including the Pennsylvania Department of Transportation (PennDOT). They must be built from the ground up, which requires significant engineering and retooling expense. Once these vehicles enter high volume production, however, unit costs should drop. There has also been recurring interest in forming a consortium of transportation agencies for the purpose of making one sizable common order, which would have the potential for reducing unit costs.

As the Sonoma Marin rail service shifts to 30-minute headways, rolling stock requirements will also increase. Initial planning assumed that these expenses would be incurred in the seventh year of the service, with the train sets in operation in the eighth year. These costs appear in Table 6-3, Rolling Stock Requirements for Eighth Service Year.

Table 6-3
Rolling Stock Requirements for Eighth Service Year
1999 Dollars

Rolling Stock	Healdsburg		Cloverdale		Healdsburg		Cloverdale		Petaluma	
Type	to San Rafael		to San Rafael		to Petaluma		to Petaluma		to San Rafael	
	Sets	$ million	Sets	$ million	Sets	$ million	Sets	$ million	Sets	$ million
DMUs	2	17	2	17	1	6	1	6	1	6
Conventional	2	12	2	12	1	4	1	4	2.5[5]	10

RIGHT-OF-WAY IMPROVEMENTS

Calculation of right-of-way costs includes three elements. These are:

- Trackwork required to bring the NWP right-of-way up to a level that could support commuter rail;
- A signaling system, that likely would be required by the FRA; and
- Repairs to bridges to support commuter rail.

[4] Train sets comprised of one locomotive and one car, totaling about $4 million each, would be sufficient for the Healdsburg – Petaluma, the Cloverdale – Petaluma, and the Petaluma – San Rafael options.

[5] This figure actually reflects the costs of one additional locomotive and four bi-level cars (est. average $2 million for each vehicle) would be needed by the eighth service year, rather than literally two and a half train sets.

Each of these elements and their components are discussed in detail below, relative to the five service options.

Trackwork

Trackwork includes various items required to bring the current NWP right-of-way up to a standard to support commuter rail. The Commission was supportive of a recommendation that the upgrade allow for FRA Class 4 maximum operating speeds of 70 mph. This implies a signaling system, which is discussed separately. The components of a Class 4 upgrade from the line as it is currently being rebuilt for freight service today are:

Table 6-4
Comparison of Trackwork Costs for Sonoma-Marin Rail Start-up Options
Millions of 1999 Dollars

Components	Healdsburg to San Rafael	Cloverdale to San Rafael	Healdsburg to Petaluma	Cloverdale to Petaluma	Petaluma to San Rafael
Main line trackwork	20.3	27.0	11.2	17.9	9.1
Grade crossings	9.3	10.4	3.4	4.5	6.0
Sidings	1.5	2.0	1.0	1.5	0.5
Layover/Storage	0.4	0.4	0.4	0.4	0.4
Salvage	(1.3)	(1.9)	(0.8)	(1.4)	(0.5)
Total	30.2	37.9	15.2	22.9	15.5

Healdsburg to San Rafael: At 51 miles, this is the second longest of the five route options. As a result, it has a comparatively high figure for rehabilitating track to FRA Class 4 standards. Trackwork elements include new track, ties, and surfacing. Eighty-six grade crossings were investigated, with most needing some rehabilitation. Three passing tracks or sidings would be required for this option at start-up, at a cost of about $.5 million apiece. Included in the estimate is a layover/storage track. The total is reduced by the salvage value of the track replaced along the route.

Cloverdale to San Rafael: This is the longest route option with 68 route miles. As a result, it has the highest cost for rehabilitation of the track. The route includes 110 grade crossings, most of which need rehabilitation. Four sidings will be required for start-up. Like all the route options, it includes an estimate for layover track. Salvage value is the highest of all options. The total upgrading cost is reduced by the salvage value of track along the route.

Healdsburg to Petaluma: This route is 29.5 miles long. Accordingly, trackwork costs are less than the two longer distance options. It includes 51 grade crossings, most of which need rehabilitation. Start-up will require two sidings. A layover/storage track is part of the total cost calculation, which is reduced by the salvage value of the track replaced.

Cloverdale to Petaluma: This route is 47 miles long and has 75 grade crossings, most of which will need rehabilitation. Three sidings will be needed at start-up, along with a layover track additional to storage track at a maintenance facility. The total is reduced by the salvage value of track to be replaced.

Petaluma to San Rafael: At 21 miles, this is the shortest route option. As a result, it has the lowest trackwork cost on an absolute basis. However, it should be noted that on a cost per mile basis, the trackwork on this segment costs the most. This is because of the cost of upgrading track between Ignacio and downtown San Rafael, most of which has not carried rail traffic in about 15 years. One siding will be needed for start-up, as well as layover track. The total is reduced by the salvage value of track to be replaced.

As service expands with 30-minute headways, additional sidings will be required. In the seventh service year, the added costs by option will be:

- The Healdsburg to San Rafael and the Cloverdale to San Rafael options each will require four new sidings for a cost of $2 million.
- The three shorter distance options each will require two new sidings for a cost of $1 million.

Some of the sidings built to support 45-minute headways will become surplus capacity as the service goes to 30-minute headways. However, these sidings will contribute to operating flexibility useful should slow NWP freight trains operate on the line during passenger train periods.

Signals

A similar analysis was performed for the cost of the signalization of the route options. A signaling system is required if trains are to operate over 60 mph on FRA Class 4 track. The signal system assumed Sonoma – Marin rail is Centralized Traffic Control (CTC). Under CTC, a dispatcher remotely controls signals and switches, providing full control over train operations. CTC provides for greater utilization of the route compared to older, more passive systems such as Automatic Block Signals (ABS). Under ABS, the signals merely indicate that adjacent blocks or track segments are occupied. For example, when a train enters a block, the signals for trains coming in the opposite direction turn red for not only that block but for one block ahead to prevent a collision. Also, under ABS, switches are not remotely controlled, and must be operated or "hand-thrown" by train crews in order to enter a siding. Train crews receive instructions from a dispatcher by radio. A comparison of CTC signaling costs at start-up for the five service options appears in Table 6-5.

Table 6-5
Comparison of CTC Signalization Costs for Start-up
Costs in millions of 1999 dollars

Components	Healdsburg to San Rafael	Cloverdale to San Rafael	Healdsburg to Petaluma	Cloverdale To Petaluma	Petaluma To San Rafael
Sidings and control points	2.9	3.9	2.0	2.9	1.0
Office systems	0.2	0.2	0.2	0.2	0.2
CTC field equipment	0.4	0.4	0.4	0.4	0.4
Construction management (10%)	0.4	0.5	0.3	0.4	0.2
Final design	0.4	0.5	0.3	0.4	0.2
Contingencies (15%)	0.6	0.8	0.5	0.6	0.3
Grade crossing signalization	9.8	13.1	5.2	8.6	4.1
Total	14.7	19.4	8.8	13.5	6.2

Cloverdale to downtown San Rafael has the highest signalization costs. The result is a function of two factors: the number of sidings and the number of grade crossings, which are higher than for all other option. This option will need three sidings at start-up. There are also 110 grade crossings, most of which will need improved grade crossing protection.

The new sidings required to support 30-minute headways in later years will in turn require new signaling. For the service options, the additional signalization costs are:

- The Healdsburg to San Rafael and the Cloverdale to San Rafael options each will require new signals four new sidings for a cost of $5.4 million.
- The three shorter distance options each will require new signals for two new sidings for a cost of $2.7 million.

BRIDGES

A reconnaissance-level assessment of the major bridges between San Rafael and Cloverdale provided data to enable an estimate of bridge rehabilitation costs. In all, five bridges were surveyed. These were:

- Gallinas Drawbridge, Milepost 20.91
- Open Deck Timber Trestle Bridge, Milepost 24.81
- Novato Creek Bridge, Milepost 26.93
- Petaluma Creek Swing Bridge, Milepost 37.10
- Russian River Bridge, Milepost 67.62

The purpose of this visual inspection was to evaluate the structural condition of the above bridges to carry passenger train traffic and to provide an order of magnitude cost estimate for any proposed repair (or replacement). For purpose of cost estimating, it was assumed that the "as originally designed" capacities of the existing bridges would be adequate for carrying passenger trains, since the bridges were designed and used to carry freight traffic. An existing bridge, which exhibits no sign of deterioration or distress, or which is repaired to its original as-built state, would then be deemed adequate to support passenger train traffic.

There were no existing drawings available for these bridges at the time this report was prepared. Based on the field observation of the existing timber trestle member sizes, however, bridge engineers from MK Centennial (MKC) presumed that the existing bridges had been designed for a loading equal or equivalent to the Cooper E60 loading. The Cooper rating system is the standard rating system for the design of railroad bridges. The engineers opined that this loading would be sufficient for passenger service.

Due to the limited scope of the field inspection, items below water or ground surfaces (such as piers, footings, piles, etc.) and items requiring lifts or boats to access (such as bearing assemblies, pins, underside of stringers, member connections, etc.) were excluded from the field inspection.

Also, due to the limited nature of the inspection, lack of availability of the existing bridge drawings, and the time and budgetary constraints, the rating of the existing bridges according to the American Railroad Engineer Association (AREA) Manual Sections 7.2.10, 8.19.1, 15.7.1 (or any other rating criteria) is excluded from the scope of this report. The Cooper E60 equivalent loading mentioned above should, therefore, be considered a rough capacity estimate but not a formal rating.

MKC estimated a total cost of improvements for the four of the five bridges at under $2.9 million. The engineers determined that rebuild costs for the Novato Creek Bridge were not required. A breakout of the cost estimates appears in Table 6-6.

Table 6-6
Estimate of Bridge Improvement for Start-up
1999 Dollars

Item	Gallinas Drawbridge	Open Deck Timber Trestle Bridge	Petaluma Creek Swing Bridge	Russian River Bridge
Concrete trestle $2850 per track-ft [6]	238 ft $678,000	$233,000[7]	–	–
Wood trestle repairs $3 per Foot Board	–		1,200 board ft. $3,600	2,000 BF $6,000
Structural steel cleaning and painting, $ 20 per sq. ft.	3400 sq. ft. 68,000		9,000 sq. ft. $180,000	35,000 sq. ft. $700,000
Timber fenders $400 per linear ft. of fender	–		160 linear ft. $64,000[8]	–
Riprap Lump sum	–		Lump sum $5,000	–

[6] Includes removal of the existing trestle and engineering.

[7] For replacement of wooden trestle with double track concrete structure.

[8] Golden Gate Bridge, Highway and Transportation District (GGT) reported receiving an estimate of $1,700 per linear ft. for this item, totaling $272,000.

Seismic retrofit	Not applicable[9]	Not applicable[10]	Not included	Not included
Subtotals	$746,000	$233,000	$252,600	$706,000
35 percent contingency	$229,000	$82,000	$88,400 plus $250,000[11]	$247,000
Total cost per bridge	$975,000	$315,000	$591,000[12]	$957,000

Rounding the figures above and applying them to the service options result in the following calculation option-specific costs appearing in Table 6-7.

Table 6-7
Comparison of Bridge Repair Costs at Start-up
Millions of 1999 Dollars

Bridge	Milepost	Healdsburg to San Rafael	Cloverdale to San Rafael	Healdsburg to Petaluma	Cloverdale to Petaluma	Petaluma to San Rafael
Gallinas	20.91	1.0	1.0	-	-	1.0
Open Trestle	24.81	0.3	0.3	-	-	0.3
Petaluma Creek	37.10	0.6	0.6	-	-	0.6
Russian River	67.62	1.0	1.0	1.0	1.0	-
Total		2.9	2.9	1.0	1.0	1.9

As indicated above, the major bridge costs are for the longer distance options, which utilize all four bridges in need of repair. The Healdsburg to Petaluma and the Cloverdale to Petaluma options include just one bridge in need of repair. However, the shortest option, Petaluma to San Rafael, would utilize three bridges needing rehabilitation. As a result, its costs are comparatively higher. All repairs must be effected prior to start-up.

STATIONS

An analysis of costs for building stations appears in Tables 6-8, 6-9, and 6-10. Station costs include construction and land acquisition. A Cloverdale to downtown San Rafael option would have 11 stations. Total construction costs would be $11.3 million. Each station would include a specific number of parking spaces (calculated as 75 percent of estimated commuter trips in

[9] No seismic retrofitting as this will be a new structure.

[10] Same as Footnote 6.

[11] For replacement of swing bridge motor and pilings.

[12] MKC also provide an estimate for a new Petaluma Creek Bridge swing bridge totaling $1.1 million, and $1.3 million for a lift bridge. Another approach would be to build a bridge with a span of sufficient height to clear water traffic on Petaluma Creek (eliminating the requirement for a swing or lift feature). Such a bridge would require major grade work on both sides of the bridge. For example, raising the span 10 feet would require a ramp 1,000 feet long on each side. This sort of bridge would likely cost several times the amounts estimated for a new swing or lift bridge.

2012), a platform with lighting and other amenities, a minimum of two ticket vending machines (TVMs), and a bus turn around area. No station construction costs appear for Cloverdale, as this station already exists. The Geyserville, Healdsburg and Windsor stations are to be located on sites that have already been identified for park-and-ride lots. The number of parking spaces needed at these sites reflects the differences between spaces projected for the rail service and the space needs previously identified by the Sonoma County Transit planners. Planners related the agency's vision that these sites would one day be served by rail. While just one station was assumed for Novato, it is noted that the Novato City Council's adopted plans call for two transit sites – one near downtown and one at Hamilton. Construction costs appear in Table 6-8 below.

Also, although not covered in the station costs estimates, bicycle parking and locker facilities would be highly desirable.

Table 6-8
Station Construction Costs for Start-up
1999 Dollars

Station	Construction Costs									
	Park'g Spaces	**Spaces Planned**	**Spaces Needed**	**$/Pk'g space**	**Total Constr. Cost Park'g**	**Platform, Light'g, Wir'g, Shelter**	**Ticket Machines**	**Bus Drop-off**	**Contin-gency 20%**	**Total Constr. Cost**
Cloverdale				2,500	-		130,000		26,000	156,000
Geyserville	30	30	-	2,500	-	400,000	130,000		106,000	636,000
Healdsburg	95	100	-	2,500	-	400,000	130,000		106,000	636,000
Windsor	142	115	27	2,500	67,500	400,000	130,000		119,500	717,000
Santa Rosa	246		246	2,500	615,000	400,000	260,000	125,000	280,000	1,680,000
Rohnert Pk	113		113	2,500	282,500	400,000	130,000	125,000	187,500	1,125,000
Cotati	111		111	2,500	277,500	400,000	130,000	125,000	186,500	1,119,000
Petaluma	229		229	2,500	572,500	400,000	260,000	125,000	271,500	1,629,000
Novato	173		173	2,500	432,500	400,000	260,000	125,000	243,500	1,461,000
Civic Cntr	36		36	2,500	90,000	400,000	260,000	125,000	175,000	1,050,000
San Rafael	64		64	2,500	160,000	400,000	260,000	125,000	189,000	1,134,000
Total										**11,343,000**

Station costs also include site acquisition. These were estimated by determining a land acquisition cost per square foot in each community and then multiplying this number by the "foot print" of each station area. No acquisition cost appears for the platform, as the platform would be located in the rail right-of-way. No land cost appears for Cloverdale, as it already exists. Also, no costs appear for Geyserville and Healdsburg, as these sites have already been acquired for park-and-ride lots. Windsor has a slight land cost, to accommodate parking above what is already planned for the park-and-ride lot. As shown in Table 6-9, total site acquisition costs for the 11 stations are $6.5 million. Construction and site acquisition costs together total about $18 million.

Table 6-9
Station Site Acquisition and Total Station Costs
1999 dollars

	Site Acquisition Costs						Total Cost	Earmarks	Net Cost
Station	**Spaces Needed**	**Parking Sq.Ft.**	**Transit Sq.Ft**	**Total Sq.Ft.**	**Cost per Sq.Ft.**	**Total Site Cost**	**Site and Constr.**	**FTA Funds**	**Funds Needed**
Cloverdale							156,000		156,000
Geyserville	-	0		-	7	0	636,000		636,000
Healdsburg	-	0		-	10	0	636,000		636,000
Windsor	27	10,800		10,800	7	75,600	792,600		792,600
Santa Rosa	246	98,400	3,000	101,400	15	1,521,000	3,201,000	1,000,000	2,201,000
Rohnert Pk	113	45,200	3,000	48,200	13	626,600	1,751,600	250,000	1,501,600
Cotati	111	44,400	3,000	47,400	13	616,200	1,735,200	1,000,000	735,200
Petaluma	229	91,600	3,000	94,600	15	1,419,000	3,048,000	1,000,000	2,048,000
Novato	173	69,200	3,000	72,200	15	1,083,000	2,544,000		2,544,000
Civic Center	36	14,400	3,000	17,400	20	348,000	1,398,000		1,398,000
San Rafael	64	25,600	3,000	28,600	30	858,000	1,992,000		1,992,000
Total						**6,547,400**	**17,890,400**	**3,250,000**	**14,640,400**

Appearing above as well as Federal Transit Administration (FTA) earmarks for stations in Santa Rosa, Rohnert Park, Cotati, and Petaluma. These total over $3.25 million, resulting in a total net funds net cost for stations of under $15 million.

Station costs tailored for the various service options appear in Table 6-10. Costs appear in two ways: total costs, and costs net of existing federal earmarks.

Table 6-10
Comparison of Station Costs for Start-up
1999 Dollars

Station	Healdsburg To San Rafael	Cloverdale to San Rafael	Healdsburg to Petaluma	Cloverdale to Petaluma	Petaluma to San Rafael
Cloverdale		156,000		156,000	
Geyserville		636,000		636,000	
Healdsburg	636,000	636,000	636,000	636,000	
Windsor	792,600	792,600	636,000	636,000	
Santa Rosa	3,201,000	3,201,000	2,029,650	2,029,650	
Rohnert Pk	1,751,600	1,751,600	1,225,930	1,225,930	
Cotati	1,735,200	1,735,200	1,217,730	1,217,730	
Petaluma	3,048,000	3,048,000	1,953,150	1,953,150	1,953,150
Novato	2,544,000	2,544,000			1,545,150
Civic Center	1,398,000	1,398,000			974,700
San Rafael	1,992,000	1,992,000			1,276,800
Total	**17,098,400**	**17,890,400**	**7,698,460**	**8,490,460**	**5,749,800**

FTA earmarks	3,250,000	3,250,000	3,250,000	3,250,000	1,000,000
Net cost	**13,848,400**	**14,640,400**	**4,448,460**	**5,240,460**	**4,749,800**

Predictably, the Cloverdale to downtown San Rafael option has the highest total and net costs for stations, a function of serving more stations than any other option. Serving the least stations, Petaluma to downtown San Rafael has the least total costs. Costs for parking and transit related services are reduced for the shorter distance options, as ridership will be lower. The adjustment reduces total costs for those stations that are common to both the longer distance options and the shorter distance options.

It is desirable that there should be common design standards for stations. However, communities should be involved in design work in order to give the stations their community "signature" or distinction. It is also desirable that all publicly owned right-of-way and stations be utilized in order to minimize capital costs. Therefore, final capital costs for stations may vary from these pro forma calculations.

MAINTENANCE FACILITY

Train sets would be maintained at a facility, whose location would vary depending on the service option. For the Healdsburg to Petaluma and to San Rafael options, the facility would be located in north Healdsburg. For the Cloverdale to Petaluma and to San Rafael options, the facility would be in Cloverdale. For the Petaluma to San Rafael option, the facility would be in north Petaluma. An estimate of maintenance facility costs appears in Table 6-11 below.

Table 6-11
Comparison of Maintenance Facility Capital Costs at Start-up
Millions of 1999 Dollars

Facility Component	Healdsburg to San Rafael	Cloverdale to San Rafael	Healdsburg to Petaluma	Cloverdale to Petaluma	Petaluma to San Rafael
Building	3.9	3.9	2.7	2.7	2.7
Equipment	1.8	1.8	1.3	1.3	1.3
Sitework	1.1	1.1	1.1	1.1	1.1
Total	6.8	6.8	5.1	5.1	5.1

The paradigm for costing purposes was the Trinity Railway Express equipment maintenance facility in Dallas. Built on 25 acres, the facility has all the equipment that Sonoma and Marin rail service would require. Using its 1995 construction and equipment purchase costs as a base, adjustments were made to reflect the scale of operations anticipated for the Sonoma – Marin service. The Trinity-based costs also were updated to reflect inflation over the intervening four-year period.

In the table above, building costs are scaled to the size of the operations represented by the five service options. The higher building costs are for the longer distance options. This is because these options will require more rolling stock than the shorter distance options. More rolling stock (conventional, Budd cars, and DMUs) will in turn require a larger maintenance facility and more equipment. Site work will remain the same for all options. Each of the facility components is discussed briefly below.

The facility would be adequate for both start-up and expanded operations; no additional capital costs are included for later years. The property for the facility would be leased, and therefore would be an operating cost rather than a capital cost. Alternatively, a site might be purchased.

Maintenance Building

This is the facility where train sets would be serviced. It would house maintenance equipment (machinery) and spare parts. The building is larger for the longer distance options, which will have more train sets to maintain. It would also include fueling, sanding and car washing facilities.

Equipment

Housed in the maintenance building would be overhead hoist and machinery for bending, grinding, welding, and rolling stock washing and fueling. Unlike the Trinity Rail Express, equipment would also include a drop table and a used (sufficient) wheel turning machine for about $1 million. Both are needed for the annual overhaul of equipment that will be performed at the maintenance facility.

Sitework

The area for the maintenance facility should be flat, with good access to nearby road systems. This cost includes the grading, building the access roads to the site, and digging storm water drainage systems.

ENVIRONMENTAL IMPACT MIGITATION

Added to the capital cost calculation is mitigation for noise, which is identified in Chapter 8 as a potentially significant environmental impact. The cost included is for sound walls, as discussed below. A discussion of the permitting process for improvements in wetlands also follows. However, as obtaining permits is a process issue rather than a cost issue, no cost was included in the capital cost calculation. The cost for an Environmental Impact Report, which likely will be required for this project, is included.

Sound Walls

The preliminary environmental analysis revealed potentially sensitive noise receptors occurring along nine miles of the rail route between Cloverdale and downtown San Rafael. These receptors are in Geyserville, south of Healdsburg, Windsor, Santa Rosa, Rohnert Park, Petaluma, Novato, Ignacio, Hamilton Air Force Base, and San Rafael. No background noise level measures have been performed to date, so the extent of potential impact of a start-up is not known for all of these locations. Such fieldwork would be part of the development of an Environmental Impact Report, which likely would be required prior to start-up.

The report did find that mitigation for noise likely would be required along track running approximately 2,000 feet from Puerto Suello Hill to Mission Avenue near downtown San Rafael. Typical mitigation for noise impacts includes sound walls. These can be of various types of materials from timber to concrete and brick. Assuming that a bottom-end number per linear foot for a sound wall is about $500 per linear foot, a minimum cost for a sound wall along this section of the route would be about $1 million. At the time of this writing, a proposed widening of US 101 along this section is being evaluated. Should this improvement come to pass, houses along the west side of the highway would be removed, and the rail line would be relocated further west. In such an event, the need for mitigation may well remain. With tracks shifted to the west, a new set of houses further to the west may become the new sensitive noise receptors. It appears prudent, therefore, to anticipate this cost in addition to the other capital costs for the project.

As regards to other sound mitigation that may be required, a calculation is problematic. This is because the extent to which mitigation would be necessary is dependent on various factors. One is the degree of sensitivity to noise, which can only be determined by measurement. Another is the likelihood of communities to request sound walls or like mitigation. Not all communities will want sound walls, as walls might divide communities and obstruct views. Nevertheless, assuming the minimum cost per linear foot for sound walls, nine miles of sound walls would come at a total cost of about $24 million – a dauntingly high sum.

However, as it is likely that more areas than just Puerto Suello Hill will require sound walls, it is logical to assume some added cost for sound mitigation. It appears reasonable to add $5 million for the three shorter distance options to $10 million for the two longer distance options.

Permits for Improvements in Wetlands

Sonoma – Marin track improvements allowing for commuter rail operating speeds would occur in known wetlands areas. The improvements include not only rebuilding of existing track but the building of new sidings as well. Also, the improvements to bridges could impact creek habitats. The specific permits that likely would be required appear in the environmental assessment. However, these likely will come at far less of a cost than sound mitigation. Rather, obtaining the required permits is more of a process issue rather than a cost issue. Obtaining permits will take time, and the required time must be built into the schedules for upgrading the line. For example, the permits will not allow improvements to take place during migratory and breeding seasons. Assuming competent construction planning, these scheduling considerations are not likely to render any option meaningfully better or worse than other options.

TOTAL CAPITAL COST

All individual capital cost items identified above and required for start-up of Sonoma Marin rail service appear by service option in Table 6-12, Total Capital Costs for Start-up. The total costs are summed in two ways – one assuming use of DMU rolling stock, and the other assuming use of conventional locomotives and bi-level cars. As one would expect, the longest distance option, Cloverdale to San Rafael, has the highest total costs. However, in the apples-to-apples comparison of total costs per mile in Table 6-13, this service option has the second lowest cost.

Table 6-12
Total Capital Costs for Start-up
Millions of 1999 Dollars

Capital Cost Component	Healdsburg to San Rafael	Cloverdale to San Rafael	Healdsburg to Petaluma	Cloverdale to Petaluma	Petaluma to San Rafael
ROW Improvements	30.2	37.9	15.2	22.9	15.5
Signalization	14.7	19.4	8.8	13.5	6.2
Bridge Improvements	2.9	2.9	1.0	1.0	1.9
Stations (Const. & Site)	17.1	17.9	7.7	8.5	5.7
Maintenance Facility	6.8	6.8	5.1	5.1	5.1
Sound Walls	10.0	10.0	5.0	5.0	5.0
EIR	0.8	0.8	0.6	0.6	0.6
DMU	42.5	42.5	24.0	24.0	18.0
Conventional	30.0	30.0	16.0	16.0	12.0
Total Capital Cost (DMU)	125.0	138.2	67.4	80.6	58.0
Total Capital Cost (Conv.)	112.5	125.7	59.4	72.6	52.0

Table 6-13
Total Capital Costs per Mile
Millions of 1999 Dollars

Cost by Equipment Type	Healdsburg to San Rafael	Cloverdale To San Rafael	Healdsburg to Petaluma	Cloverdale to Petaluma	Petaluma to San Rafael
Cost (DMU) per Mile	2.45	2.03	2.28	1.73	2.70
Cost (Conv.) per Mile	2.21	1.84	2.01	1.55	2.42