

Draft Plan for Bicycle Carriage on Caltrain

A Necessity for Caltrain's Bicycle Master Plan

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Executive Summary

A plan for bicycle carriage on trains is an indispensable part of Caltrain's Bicycle Master Plan, because 80% of bicycling passengers bring their bicycle onboard the train instead of parking it at the station. Bicycle passengers were Caltrain's fastest growing customer segment, until limited bike capacity nearly halted growth in 2006.

Financial modeling reveals that Caltrain and associated transit agencies would gain about \$350 per day by adding a new bike car with 32 bike spaces instead of a new non-bike car, because bicyclists place the least demand on transit overall. Non-biking riders generally require parking lots or garages, buses, and/or shuttles, burdening roads and transit systems.

The share of Caltrain passengers boarding with bicycles is currently 7%, but predictions show that if sufficient bike space were available today, latent demand would boost bicycle passengers to 10%, and 13% bike space would be needed to ensure no bumping. Bike capacity in 2014 when trains electrify should be nearly 20% to meet expected demand.

Bicycle carriage on trains is a major step toward the three-county transportation authorities' mandate to reduce the number of automobile trips. Far from being a "special interest" service for Caltrain, bicycle bring-along by Caltrain passengers serves the system's and region's goals more perfectly than almost any other trip type and should be supported and enhanced by Caltrain with energy and focus.

Revision History

Version	Description of Change
080807	Original draft document.
080811	<ul style="list-style-type: none"> • Added Section 6.4, <i>Seat Removal to Make Space for Bikes</i>, incorporating information presented at the August 7, 2008 Joint Powers Board meeting. • In response to cyclist's input, changed the example in Section 2.3.1 to Belmont exit station, instead of Hayward Park.
080819	<ul style="list-style-type: none"> • Added SFBC logo to cover page. • In response to cyclists' input, expanded the discussion in Section 6.1, <i>Dwell Time</i>.
080824	<ul style="list-style-type: none"> • Added a footnote on page 6 stating that Caltrain renamed its <i>Draft Bicycle Master Plan</i> to <i>Draft Bicycle Access and Parking Plan</i>. • In response to cyclist's input, added carbon cost to the caption for Table 5 in Section 5.3, <i>Reduction in Greenhouse Gas Emissions</i>. • In response to cyclist's query, added more information to reference number [3] in Section 9, <i>References</i>.

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1 Introduction

1.1 Mission and Goals for Caltrain's Bicycle Master Plan

The mission statement for Caltrain's Bicycle Master Plan is [1]:

Make Caltrain a convenient and user-friendly transit service for bicyclists.

The goals for Caltrain's Bicycle Master Plan are [1]:

- A. Promote bicycling as means of **access** to Caltrain stations.
- B. Encourage the **parking** of bicycles at stations, rather than bringing bicycles on board
- C. Improve **safety and security** for bicyclist-passengers
- D. Communicate **information** to bicyclist-passengers

The Plan's goals do not include[1]:

- Increasing capacity for carrying bikes on board trains.

1.2 Purpose of this Draft Plan

While the goals of Caltrain's Bicycle Master Plan are commendable, the Plan ignores the crisis faced today of insufficient bike space on trains, and does not address the need for increased bike capacity in the future. This Draft Plan for Bicycle Carriage on Caltrain fills the conspicuous gap in Caltrain's Bicycle Master Plan. If the mission statement for the Bicycle Master Plan is to be achieved, bicycle carriage on trains must become an indispensable part of the Plan^a.

2 Bikes and Trains for Intermodal Transportation

2.1 Overview

Trains provide an essential transit service, but that service is rarely door-to-door. The commuter must find a way to get to the train station from their starting point, and to their destination after exiting the train. Public transportation, when available, does not provide 100% coverage. Proximity to transit is an important consideration. In the Bay Area, people who live within a half-mile radius of a transit station are three times more likely to use transit compared with those who live further away [2]. The average person can walk a half mile in about 10 minutes. In that same time, the average bicyclist can cover about two miles. The bicycle enables a 16-fold increase in the number of people within easy reach of a train station. The combination of bicycle and train represents a practical and environmentally friendly intermodal transportation solution.

2.2 Profile of the Bicycle Commuter

The bicyclist using Caltrain during commute hours is likely a professional, who has chosen to ride his or her bike as an alternative to driving for a variety of reasons including time savings, cost savings, and environmental concerns. These are not recreational riders; the bicycle commuter relies on Caltrain to get to work on time for important meetings and appointments.

^a In response to cyclists' strong criticism that Caltrain's *Draft Bicycle Master Plan* ignored bikes on board in favor of bike parking at stations, Caltrain staff renamed their plan the *Draft Bicycle Access and Parking Plan* on August 11, 2008.

The bicycle commuter's personal time is also valuable, and s/he depends on Caltrain for transport from work to evening engagements or to spend time with family. Delays caused by denied access cut into worker productivity and quality of life.

While the typical bicycle commuter using Caltrain may be a professional, Caltrain also serves low income workers. Low income workers ride bicycles, because a bicycle is significantly cheaper than local mass transit to get to the Caltrain station. These bicycle commuters rely on the train for transportation to and from work, and they may have few other commute options due to their financial situation.

2.3 Bikes Onboard

2.3.1 Reasons Cyclists Bring Their Bikes Onboard

Bike carriage on trains is a critical element for a complete transportation solution. Many cyclists need their bicycle at both ends of their commute, because their starting point and final destination are not near the train station. The bicycle commuter needs their bicycle to complete their intermodal trip, because public transportation is either nonexistent, or riding their bicycle is faster and/or more reliable than the available public transportation.

The top four reasons cyclists cited for bringing their bike on board include [3]:

Having my bike with me gives me flexibility	58%
I need to have my bike with me	37%
I bike the other way for exercise	32%
Transit/shuttle connections don't work for me	31%

Only 18% of bicycle commuters cited unsatisfactory bike parking options as a reason for bringing their bikes onboard the train [3]. This indicates that more than 80% of bicyclists would still bring their bikes on board the train, even if satisfactory bicycle parking options were available. Therefore, providing secure bike parking at every station will not eliminate the need for bike carriage on board.

About 40% of cyclists vary their normal commute by sometimes starting or ending at a different station [3], a commute pattern that would be impossible if they had a bicycle parked at each end of their normal commute. The flexibility of having their bicycle with them allows irregular trip chaining, such as running an off-line errand on the way home or attending an engagement after work located by a different station than the normal destination station.

Today's train schedule results in some stations with infrequent service, but a bicycle enables a cyclist to use various stations. For example, train service to Belmont is once per hour. A cyclist traveling from San Francisco 4th & King to Belmont could exit at Belmont, but also at Hillsdale, San Carlos, or Redwood City and easily ride to Belmont. By adding the other exit stations for a morning commute, the cyclist can board any of ten trains between 7am and 9am instead of only two trains. Such flexibility would be impossible without being able to bring one's bike on board the train. It is particularly important to be able to bring bikes on board trains for destinations on the Peninsula, where public transport options can be quite limited and infrequent.

Over 60% of bicycle commuters ride their bike to and from Caltrain to be environmentally friendly [3]. The ability to bring one's bike on board the train permits a bike commuter to complete their daily travel requirements without using an automobile at all.

There are some bicycle commuters, though a distinct minority, who need their bicycle at only one end of their commute. A limited number of others have the willingness, commute pattern, and financial means to own two bicycles, one stored at each end of their commute. For these cyclists, options such as bike lockers, bike cages, and attended bike parking facilities meet their needs. Caltrain's Bicycle Master Plan addresses this minority of cyclists, while this Plan for Bicycle Carriage on Caltrain addresses the vast majority of cyclists.

2.3.2 Folding Bikes

Caltrain does not limit the number of folding bicycles on board trains, but folding bicycles have several disadvantages for the bicycle commuter. Folding bicycles have a small wheel diameter, and are generally not as well suited for longer trips or fast riding. The small wheel diameter makes a folding bike less stable when going over railroad tracks and rough pavement. Drain grates present an extreme hazard, because the small wheel can drop in deeper than a full-size wheel. Folding bicycles are not suitable for heavy riders, because the frames are not as sturdy as a full-size bicycle.

Most cyclists own a regular bicycle for commuting, so Caltrain's repeated directive to "buy a folding bike" means that a cyclist would have to buy a second bicycle, just for commuting on Caltrain. A folding bike costs 20 to 30% more than a non-folding bike of comparable quality, and prices for folding bikes currently range from about \$500 to over \$3000. Marginalizing one group of commuters by telling them to purchase expensive, specialized equipment goes against the premise of public transportation accessible by all.

Finally, folding bikes are a solution to the bike capacity problem onboard trains if only a small minority of passengers use them. If folding bicycles were widely used, space set aside specifically for folding bicycles would be required, just as extra space is required to transport luggage.

2.4 The Effect of Bumping Bicyclists

In the one-year period ending June 2007, 64% of bicyclists reported having been bumped, most of them repeatedly [3]. Routine bumping discourages bicycle commuters from using Caltrain at all, because 80% of bicycle commuters rarely if ever take Caltrain without bringing their bicycle on board [3]. They find other ways besides the train to get to their destination, and the majority of them drive alone [3]. Routine bumping causes frustration, missed appointments, unreliable service, and wasted time standing on the platform, all of which compel the cyclist to find other commute options, resulting in lost revenue for Caltrain.

There is another group of bicycle commuters, the immigrant and/or low paid cyclists who cannot afford to be bumped because they are fired from their jobs if late for work. These cyclists may not use the train in the first place, not because they cannot afford the fare, but because they cannot afford to be fired.

3 Bike Commuters Are on the Rise

3.1 Municipal Transportation Agency Bicycle Count in San Francisco

The San Francisco Municipal Transportation Agency conducted bicycle counts in San Francisco in 2006 and 2007, with the intention of conducting annual counts to monitor cycling trends in San Francisco. The 2007 counts showed a 15% overall increase in the number of cyclists compared to the 2006 counts [4]. This increase is especially significant when viewed in light of the injunction against the City's Bicycle Plan. This injunction has stopped the City from installing any new bicycle facilities since June 2006. Despite a lack of improvements or additions to the City's bicycle route network, cycling use in San Francisco showed an increase.

3.2 Bicycle Traffic on Bike to Work Day in San Francisco

Bicycle counts are conducted each year on Bike to Work Day at the intersection of Market Street and Van Ness Street in San Francisco. While Bike to Work Day is a highly publicized event and draws more bicyclists than an average day, the trends in mode shift are telling and demonstrate a tendency for commuters to leave their cars at home in favor of commuting by bicycle. Figure 1 shows mode shift from automobiles to bicycles over a four year period [5].



Figure 1: Traffic counts between 8am and 9am on Bike to Work Day at the intersection of Market Street and Van Ness Street in San Francisco.

3.3 San Francisco Bicycle Coalition Membership Trend

The San Francisco Bicycle Coalition (SFBC) has been steadily gaining membership. Figure 2 shows that the trend has been consistent, as more people choose to join the SFBC to support and participate in the bicycle advocacy of the organization [6].

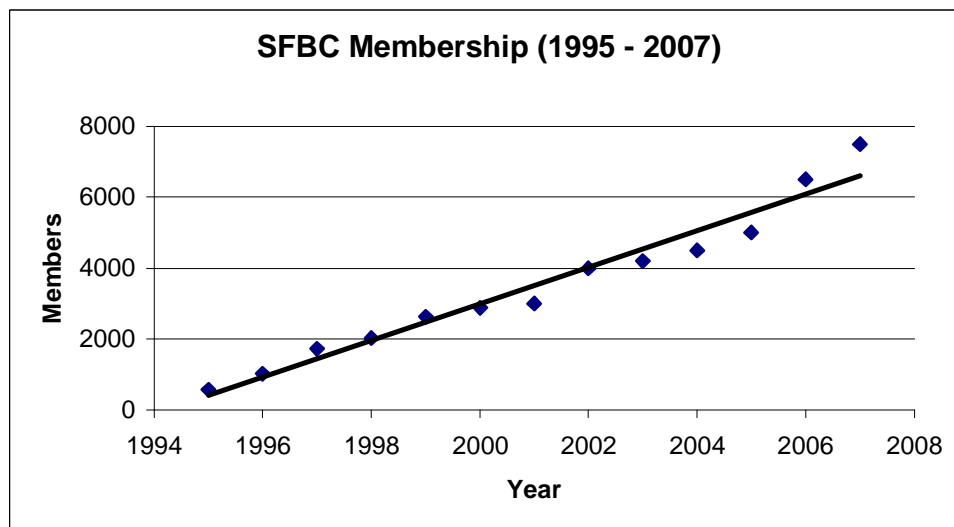


Figure 2: Historical trend in SFBC membership.

Membership in the Silicon Valley Bicycle Coalition (SVBC) has also increased dramatically. In October 2006, the SVBC had 427 members. By March, 2008, the membership had risen to 596, an annualized increase of 28% [7].

The spectacular increase in membership for local bicycle coalitions demonstrates that bicycling is rapidly gaining popularity among the general public.

3.4 Factors Affecting Future Increases

Other factors may cause even greater than expected increases in bike commuters in future years including:

- Rapidly increasing price of gas
- Escalating public concern about global warming
- Bicycle improvements such as bike lanes
- Changing political climate about the positive benefits of bicycling for urban areas
- Electrification is expected to increase demand for bicycles on Caltrain [8]

4 Bikes on Caltrain

4.1 History of Caltrain's Onboard Bicycle Program

Work to develop the onboard bicycle program predates the formation of Caltrain/Peninsula Corridor Joint Powers Board. Bicycle advocates worked with Southern Pacific Railroad for

several years before winning a 4-month demonstration project in 1982 that permitted four bikes being held in the aisle of the cab car. Despite the popularity of the service, Southern Pacific refused to continue the project.

It was not until Caltrain was established in 1992 that provision of the service was resumed; advocates were successful in identifying and allocating funding that allowed Caltrain to remove cab car seats and provide bike racks, resulting in 8 bike spaces per train. By 1996, 24 bikes were accommodated per train and by 2002, the current maximum of 32 had been reached (baby bullet trains accommodate 16 bikes in a single Bombardier car, but sometimes one or even two 32-bike galley cars are provided on a baby bullet train, resulting in irregular, unpredictable capacity, from 16 to 64 bikes).

With the success of the onboard bicycle program come challenges. As more cyclists use Caltrain, the system strains to keep up with demand, and paying passengers are left standing on the platform with their bicycles, even when there are plenty of empty seats.

4.2 Bike Boardings on Caltrain from 2004 to 2008

Caltrain made changes to its service by adding baby bullet trains in June 2004 [9] and adjusting its schedule to eliminate pure local trains from the peak in August 2005 [10]. Both these changes are reported to have increased ridership [10]. Bicycle boardings also increased at a rapid rate, until routine bumping began in 2006. Bumping causes bicyclists to find other commute options, and bicycle boardings suddenly leveled off starting in 2006, as shown in Figure 3.

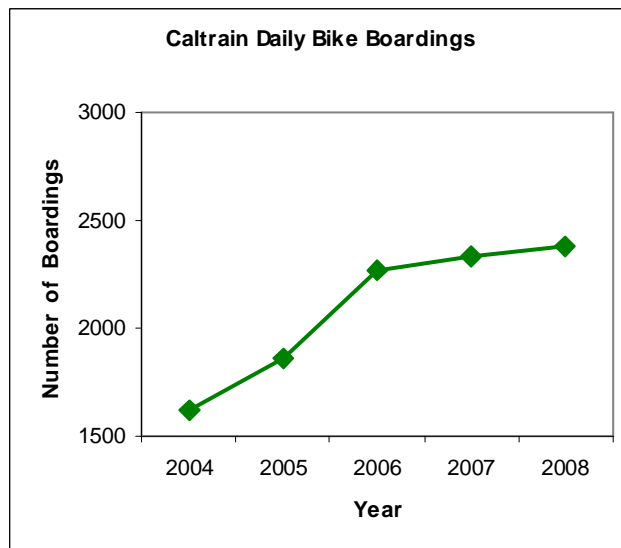


Figure 3: Weekday bike boardings as a function of year. [9,10,11,12,13]

From 2003 to 2006, walk-on passengers increased 16%, whereas bicycle passengers increased 41%. From 2006 to 2008, walk-on passengers increased another 16%, but bicycle passengers increased only 5%, presumably due to limited space for bicycles on trains [9,10,11,12,13,14]

4.3 Projected Bike Boardings on Caltrain to 2025

Prediction of future bike boardings necessarily requires use of a model for extrapolation into future years. Past bicycle boardings cannot be used for extrapolation, because limited capacity has restricted the number of bicyclists riding Caltrain. There is unmet demand for bicycle space on Caltrain today. The question is, exactly when did insufficient space start to hinder ridership? Because Caltrain increased bicycle spaces from 24 to 32 in 2002, bike boardings in years immediately following the increased capacity may be representative of actual demand. For the subsequent years, SFBC membership makes a good model for predicting increase in bike boardings. Figure 4 shows remarkable correlation between SFBC membership and Caltrain bike boardings from 2003 through 2005. Bike boardings began leveling off in 2006, while SFBC membership continued to climb, suggesting that limitations in bike capacity began hindering ridership around 2006.

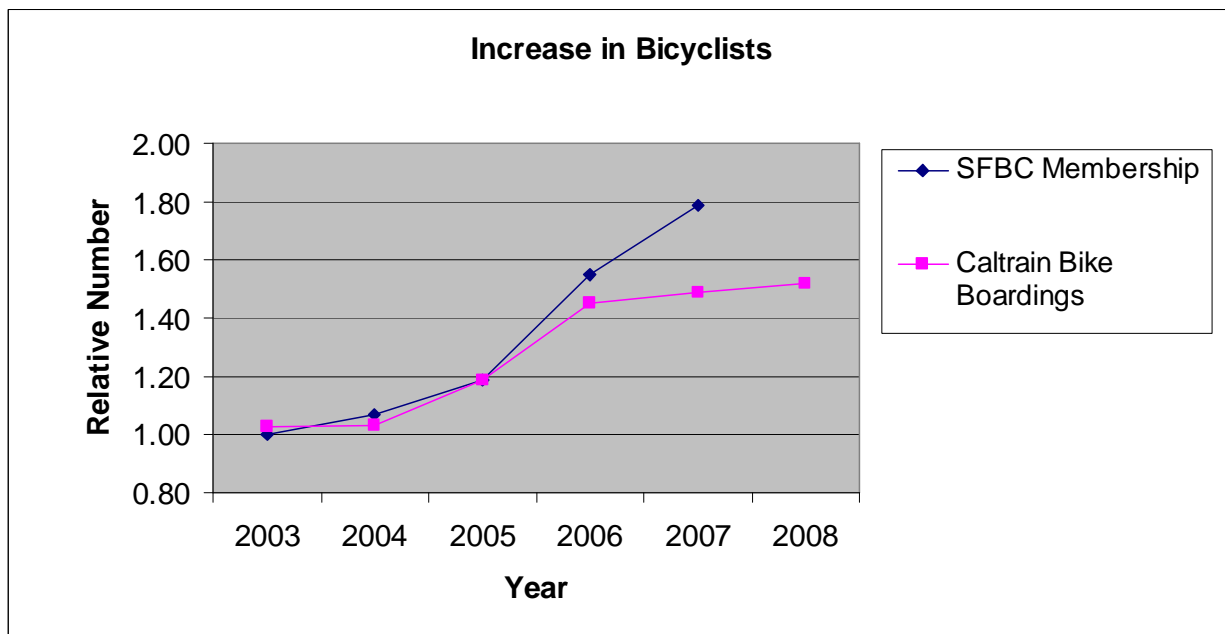


Figure 4: Correlation between SFBC membership and Caltrain bike boardings is strong, until bike capacity limitations on trains cause bike boardings to level off.

As further evidence of SFBC membership being a good predictor of bicycle usage, SFBC membership increased from 2006 to 2007 by 15%, the exact same rate as cycling increased in San Francisco [4].

To coincide with Caltrain's addition of baby bullet trains [11], we consider SFBC membership starting in 2004 as a model for making predictions past 2008. Figure 5 shows a linear increase in SFBC membership from 2004 to 2007. The line can be extended to make predictions in future years.

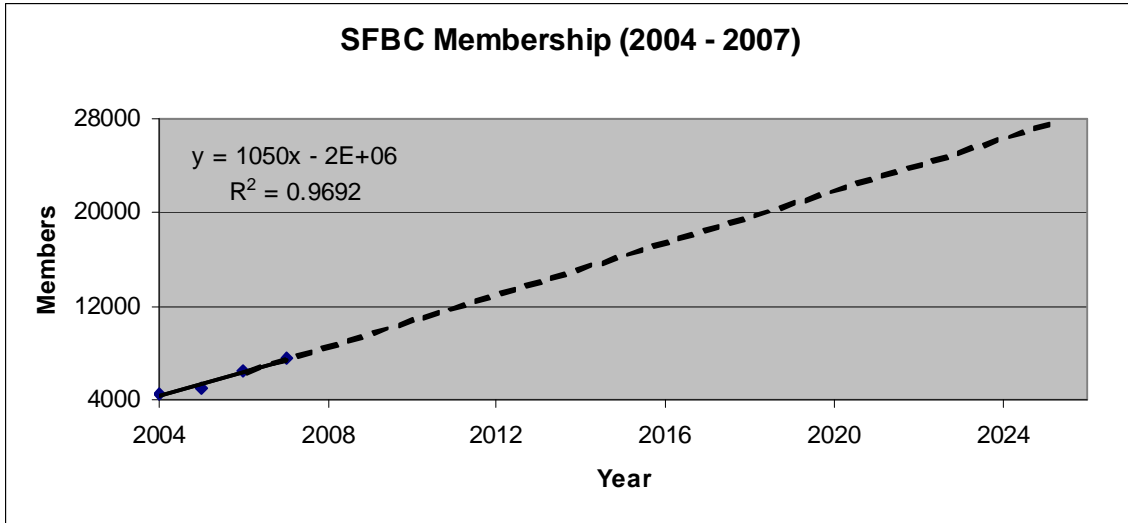


Figure 5: SFBC membership and extrapolation (dashed line) into the future.

The linear equation shown on the graph in Figure 5 can be used to calculate future SFBC membership along with the corresponding increase in bike capacity required on Caltrain. Because 2006 is the year routine bumping began, we use 2006 as the baseline year. Caltrain has not increased bike capacity on trains since 2002, so we assume today’s bike capacity of 7% averaged across all runs^b is comparable to that in 2006. The percentage bike capacity is the number of bike spaces divided by the number of seats. Table 1 shows the projections for bike capacity required on Caltrain to the year 2025 to satisfy predicted bicycle demand.

Year	Minimum Average % Bike Capacity Required on Caltrain	Optimum Average % Bike Capacity Required on Caltrain
2006	7%	n/a
2009	10%	13%
2014	15%	19%
2020	23%	28%
2025	34%	42%

Table 1: Predicted future bike capacity requirements on Caltrain. Minimum assumes 100% load factor, and optimum assumes 80% load factor.

Caltrain staff continually state that there will be more bike capacity in the future, because there will be more trains running in future years. This is a misleading argument, because increased frequency is in response to increased demand. As overall passenger demand increases, bike

^b Taking March 21, 2008 as a typical day, there were 98 train runs comprised of 82 gallery car runs (33 with two bike cars; 29 four-car consists and 53 five-car consists) and 16 Bombardier car runs (12 with two bike cars; all 16 were five-car consists). Total bike space was 4128, and estimated number of seats per car was 130 [13] for a total of 59,930 seats, resulting in an average of 7% bike space per run.

capacity demand is expected to increase proportionately. Therefore, percentage bike capacity is an objective way to represent future needs, independent of an increase in train frequency.

4.4 Differences between Bicycle and Walk-on Boardings

4.4.1 Commute Patterns

Bicycle commuters have a more even daily commute pattern compared with walk-on passengers. More walk-on passengers take the northbound train in the morning, whereas morning bicycle boardings are about equally split between northbound and southbound trains, as shown in Table 2.

	All Boardings	Bicycle Boardings
Traditional peak	60%	49%
Reverse peak	40%	51%

Table 2: AM boardings for traditional peak (northbound morning and southbound evening) and reverse peak (southbound morning and northbound evening) [13,15]

Train service strives to accommodate peak load, so if peak load occurs in one travel direction, trains running in the other direction are underutilized. The more even commute pattern of bicyclists enables better utilization of train service.

4.4.2 Seasonal Variation

There is seasonal variation in Caltrain boardings, with bike boardings more strongly affected. Bike boardings in October were over 42% higher than in February [11]. In contrast, total passenger boardings in October increased only 11% compared with February [11]. Caltrain’s annual passenger counts are conducted in February, a decreased riding time for bicycles due to the weather. As shown in Figure 2, bicycle boardings in February have been negatively impacted by limited capacity starting in 2006. If the annual passenger counts had been conducted in the warmer months instead of February, then bike capacity limitation would have shown a negative impact starting around 2004^c.

4.5 Bicycle Boarding Peak Demand

The system should be designed to meet peak demand, which occurs during morning and evening commute hours. Because current Caltrain consists are used the entire day and assigned randomly to runs, there is no significant difference in average percentage bike capacity onboard trains throughout the day. Bike space per hour is higher during the peak period, because about four trains per hour run during peak hours versus two trains per hours in the off-peak. Nonetheless, as explained in Section 4.3, percentage bicycle space is the important parameter, because it is scalable and does not rely on a specific train schedule. The predictions shown in Table 1 apply to the peak demand period, and are over-capacity for the off-peak hours.

^c Bike boardings from February 2004 to February 2006 increased about 40%, approximately the same amount as bike boardings from February 2004 to October 2004 [10,11].

4.6 Random Scheduling of Bike Capacity

Bike capacity on trains today ranges from 16 spaces on a Bombardier train set with one bike car to 64 space on a gallery train set with two bike cars. There appears to be no effort made to schedule trains with two bike cars during peak demand, as can be seen from the bike capacity count shown in Table 3. The table shows that baby bullet train capacity varies from 16 bikes to 64 bikes. With such wide variation in capacity, and no way to know beforehand how much capacity a train will hold, bicyclists are left playing a guessing game about whether they should attempt to board a baby bullet train, take a later or earlier train, or ride to another station to catch an express or local train. When a baby bullet train that generally has 32 or 64 spaces arrives with only 16 spaces, many bicyclists will be bumped during that run. Such randomness and lack of information leads to frustration and an intolerable unpredictability that forces some cyclists back into their cars.

train number	departure time	bike capacity on 1/15/08	bike capacity on 3/21/08	bike capacity on 6/4/08	bike capacity on 6/19/08
210	6:44am	32	64	32	32
312	6:59am	64	64	16	64
314	7:14am	32	32	16	32
216	7:19am	32	32	64	64
218	7:24am	64	32	32	32
220	7:44am	32	32	32	32
322	7:59am	64	32	32	16
324	8:14am	32	64	32	32
226	8:19am	32	32	32	32
228	8:24am	32	64	32	64
230	8:44am	32	32	32	64
332	8:59am	16	16	16	16

Table 3: Bike capacity for four days in 2008 on rush hour trains leaving San Francisco. Baby bullet trains are highlighted pink, and express trains are highlighted yellow. Bike capacity is generally unpredictable.

4.7 Caltrain's Bicycle Capacity Plan for the Future

4.7.1 2025 Plan

Caltrain's 2025 Plan [16] does not mention bicycle capacity on trains.

4.7.2 2023 Strategic Plan

Caltrain's 2023 Strategic Plan [17] does not mention bicycle capacity on trains.

4.7.3 2017 Short Range Transit Plan

Caltrain's 2017 Short Range Transit Plan [18] reports bicycle capacity on each car in the current fleet, but contains no stated plan for bicycle capacity on trains in the future.

4.7.4 Bikes on Cars Subcommittee Recommendation

Caltrain formed a Bicycle Technical Advisory Group (TAG) in January 2007 for public input on the Bicycle Master Plan. When the group was instructed that bikes on trains would not be addressed, the group repeatedly demanded that attention be directed to this issue. In response, Caltrain formed the Bikes on Cars Subcommittee in June 2007. No meeting minutes were published, and Caltrain staff running the meeting drove the group to make a recommendation of >5% bike capacity in 2014 [19]. This recommendation is alarming, because 5% is a reduction compared with the 7% bike capacity on the existing system, which is already severely under capacity.

5 Financial Analysis

5.1 Overview

All Caltrain passengers are subsidized, because ticket revenue accounts for around only 40% of operating costs [20]. A financial analysis of bicycle carriage on trains must consider not only ticket revenue, but also the additional amenities required by non-bicycling passengers to complete their commute. Most non-bicycle passengers are subsidized more than bicyclists, because non-bicycling passengers require parking lots or publicly subsidized buses and/or shuttles at one or both ends of their commute. Bicyclists do not require any of these costly additions for their commute.

5.2 Addition of a New Bike Car vs. Non-bike Car

The analysis presented here compares the financial impact of adding a new bike car vs. adding a non-bike car. This analysis is especially timely, because Caltrain is adding eight new Bombardier cars to the fleet in 2008. We assumed no cost difference between purchasing a new bike car and a non-bike car. Therefore the model compares the financial impact once the bike car or non-bike car is operating in the current system, with the current train schedule.

We evaluated three scenarios, i.e., most favorable, most probable, and least favorable for cyclists. We collected publicly available data to support each scenario. As shown in Table 4 below, the model reveals that Caltrain and associated transit agencies most probably gain about \$350 per day by adding a bike car with 32 bike spaces instead of a non-bike car. This amounts to annual revenue of nearly \$130,000. The addition of a new bike car has a financially favorable impact that is fiscally imprudent to ignore.

Most favorable outcome	Most probable outcome	Least favorable outcome
\$1026/day	\$349/day	(\$133)/day

Table 4: Daily gain (loss) of adding a new bike car with 32 bike spaces compared with adding a non-bike car.

Detailed calculations for each scenario can be found in Appendices A, B and C. Appendix D contains a table showing the adjustable parameters and associated references.

5.3 Reduction in Greenhouse Gas Emissions

The average cyclist commutes three miles one way [21]. The number of weekday bike boardings on Caltrain in February 2008 was 2382 [13]. Therefore, bicyclists riding Caltrain keep about 7150 auto miles per weekday off Bay Area roads. That amounts to 1,860,000 miles per year of bicycling instead of driving, saving fuel and reducing greenhouse gas emissions.

The California legislature ordered that green house gas emissions in California be cut by 25% by 2020. Carbon dioxide (CO₂), a known as greenhouse gas, is a byproduct of burning fossil fuels, including gasoline. We consider here the amount of carbon dioxide emission reduction by bicycle passengers bringing their bikes onboard Caltrain. Carbon dioxide emissions depend on the make and model of the vehicle, and detailed emission information is readily available on the web [22]. It has been proposed, though not yet implemented in the United States, to impose a tax for polluting based on the amount emitted, commonly called a carbon tax. British Columbia currently imposes a carbon tax of \$10 per ton of carbon emissions, rising to \$30 per ton by 2012, though the true social cost may be closer to \$50 per ton [23]. Table 5 shows the social cost savings per weekday by Caltrain passengers who bicycle to and from the station instead of driving.

car make	CO ₂ emissions (g/km)	CO ₂ emissions (tons/mile)	estimated social cost of carbon (\$/mile)	total bicycle miles per weekday	estimated social cost savings per weekday
Toyota Camry	270	0.000479	\$0.00593	7,150	\$42
Ford Explorer	353	0.000626	\$0.00775	7,150	\$55

Table 5: Social cost savings per weekday from Caltrain’s bikes-on-board program; cost savings are a result of reduced carbon emissions by bicycling instead of driving the car make shown. Carbon cost is estimated at \$50 per ton, and carbon is 27.29% of CO₂ emissions.

The corresponding annual social cost savings are \$10,900 to \$14,300. This savings is not a direct benefit to Caltrain, but it benefits society as a whole.

6 Perceived Issues about Bikes on Trains

6.1 Dwell Time

Caltrain stated in its 2007 Progress Report [24], "The number one cause of Caltrain delays is from bicycles entering and exiting the trains." This statement appears on the same page as a graph (see Figure 6) that shows no significant change in on-time performance from 2003 to 2007. Yet bicycle boardings increased 45% from 2003 to 2007 [12,14]. On-time performance was unaffected during these years of staggering increase in bicycle boardings. The data do not

support the assertion that bicycle boardings cause delays. Because bicycles are required to board last, any delay, no matter who causes it, gets blamed on bicycles. Caltrain is arbitrarily assigning bicycles as the number one cause of delays with no supporting evidence. Caltrain was unable to supply dwell time statistics when requested [25].

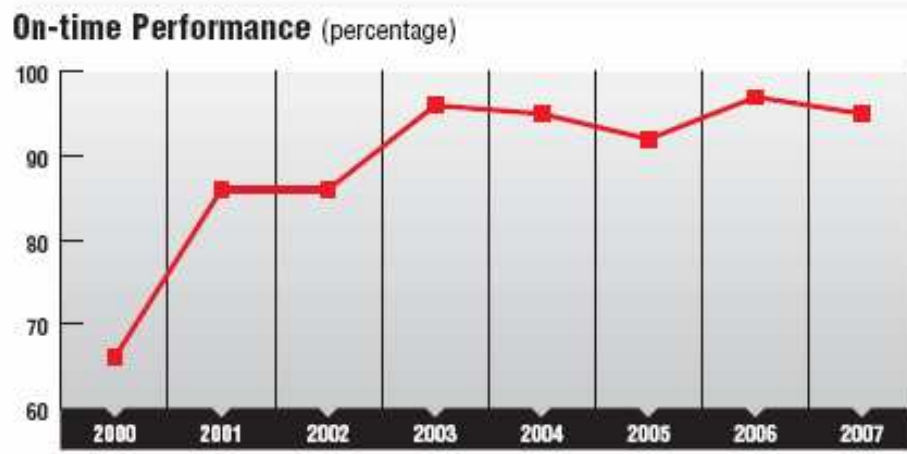


Figure 6: Caltrain's on-time performance, reproduced from Caltrain's 2007 Progress Report [24]

Caltrain reported in its Draft Bicycle Master Plan Key Findings that bicycle passengers cause an estimated 250 hours of dwell time delays per year, and the April 2008 Operations Report was referenced as evidence. To our knowledge, no detailed timing analysis has been conducted. Having no detailed data, we average the 250 hours over all train runs in a year, and we find the dwell time allegedly due to bicycle passengers boarding and alighting amounts to about 32 seconds per run, or about 1 second per stop for a local train.

We acknowledge that it can take bicyclists extra time to board and exit when the bike car is completely packed. The question becomes - is this a bicycle-related dwell time problem, or a bicycle capacity problem, or a system design problem? Consider the following:

- If there were more bike cars and cyclists could reliably board at more places, then dwell time would be minimized.
- If there were sufficient bike spaces available, then it would be easy to maneuver bikes to get in and out, reducing dwell time.
- The Bombardier cars are a better design than the older gallery cars, because the Bombardier cars have two doors and only one step. It is faster and easier to get bikes in and out of the Bombardier cars.

Caltrain frames the issue as bicycle-related dwell time delays, as though bike capacity and system design have nothing to do with it. Instead of blaming alleged dwell time delays on cyclists, Caltrain should be looking at increasing bike capacity and buying cars designed for universal access.

Given the evidence, the dwell time argument appears to be specious and intended to divert attention away from the bicycle capacity problem.

6.2 Safety

At the Bicycle Technical Advisory Group (TAG) meeting on January 14, 2008, Caltrain staff stated that safety is an overriding concern about bikes on trains. When asked for documented incidents of safety issues involving bicycles, Caltrain staff admitted there were no documented incidents. While Caltrain's concern about passenger safety is commendable, the "overriding concern" about bicycles causing safety problems appears to be exaggerated.

6.3 Train Capacity

Trains run with empty seats, while the bike car is packed over-capacity. Walk-on passengers all get on, while bicyclists get bumped. The most readily available data are from the *February 2008 Caltrain Annual Passenger Counts*. The counts showed that only one northbound baby bullet train reached seating capacity at Redwood City. All other trains ran the entire line with empty seats.

The current train configuration results in demand mismatch, with too few bike spaces and too many seats. If the number of bike spaces were increased to meet demand, it is possible that some passengers would

need to stand for part of their commute during the summer months, given that ridership increases in the summer (see Section 4.4.2 above). Standing on public transit is common practice during rush hour, so removing seats for bikes does not necessitate losing a walk-on customer. As things



Cyclists bumped on train 268 at Palo Alto on September 4, 2007.
Photo courtesy of Rob Robinson.



The packed bike car on train 220 leaving San Francisco on July 16, 2008. Photo courtesy of George Lane.

are now, many paying customers have stopped using Caltrain, because they cannot bring their bicycles on board. Table 1 shows that bike space demand is approaching 10%, whereas capacity today is only 7%.

There is a fundamental difference between standing inside the train as a walk-on passenger and being denied boarding as a bicyclist. Bicyclists with paid tickets are left standing on the platform, not knowing if they will get on the following train either, while the walk-on passenger is being transported to their destination.

6.4 Seat Removal to Make Space for Bikes

Caltrain staff has repeatedly stated that seats cannot be removed to make space for bikes, because Caltrain would lose passengers. This assumption has been invalidated by a case study inadvertently conducted by Caltrain in June 2008. On May 30, 2008, Caltrain announced that 14 gallery cars were removed from service for emergency repairs. Spares were put into service, but there were still more four-car trains running in June than usual^d. The missing gallery cars resulted in an effective loss of seating capacity in June compared with previous months, simulating removing seats to make space for bikes without actually doing so. There were on average about 1800 fewer seats (out of nearly 60,000) each weekday the month of June compared with May, yet ridership increased over 5% in June [26], as shown in Figure 7. Given that there is latent demand for bicycle space, removal of seats to create more bike space once the gallery cars are back in service would be expected to increase overall ridership even further.

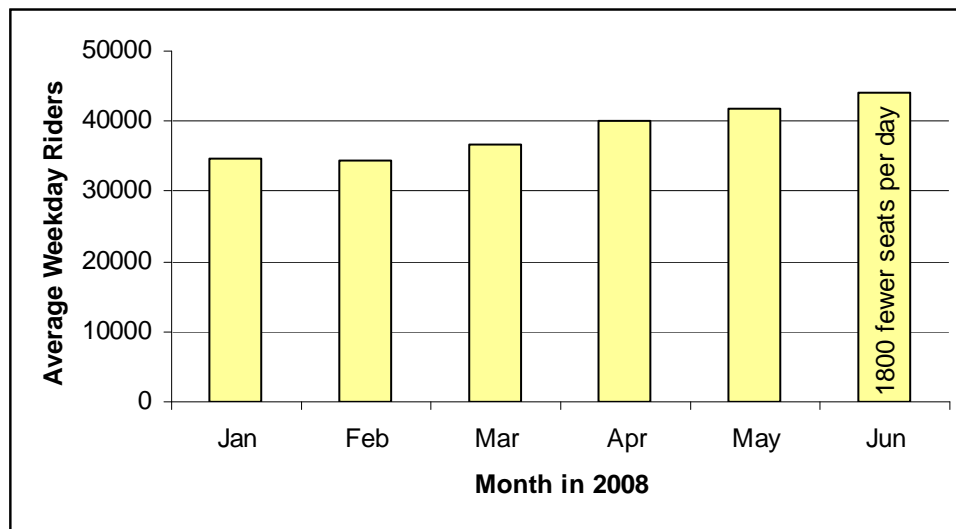


Figure 7: Average weekday ridership on Caltrain in 2008. Fewer seats in June had no negative impact on the number of riders.

Caltrain normally maintains about 15% spare cars, so the case study corresponds to removing about 420 total seats from existing cars to create 420 new bike spaces^e. The proposal in Table 5 accomplishes the objective. This proposal converts eight Bombardier trailer cars to 16-space bike cars, and converts eight gallery trailer cars to 32-space bike cars. There are two Bombardier cab cars that were never retrofitted to hold bikes, so they would be converted to 16-space bike cars. These conversions increase bike capacity from about 7% to nearly 10%, in close alignment with the predicted minimum to meet current demand (see Section 4.3).

^d Caltrain runs a mixture of four-car and five-car trains. In early June, there were 10 four-car trains, and in late June, there were 8 four-car trains. Before gallery cars were removed from service, there were only 6 four-car trains.

^e Caltrain currently runs 20 train sets and 98 runs per day. Therefore, 1800 seats per day corresponds to 357 total seats to remove plus 15% more to account for spare cars, or about 420 total seats to remove. Removal of four seats makes space for four stacked bikes on one bike rack.

Car type	Number of cars	Seats to remove	Total number new bike spaces
Bombardier trailer car	8	16	128
Bombardier cab car numbers 117, 118	2	16	32
Gallery trailer car	8	32	256
Grand total			416

Table 5: Proposal to remove seats to add more bike space. Number of seats removed corresponds to number of seats missing in June due to gallery cars being out-of-service.

7 Recommendations

We recognize that Caltrain has constraints on operations, and we encourage an open dialog between Caltrain operations staff and the San Francisco Bicycle Coalition and bicycle advocates to find ways to overcome obstacles to achieve Caltrain’s Bike Master Plan stated goal of “Make Caltrain a convenient and user-friendly transit service for bicyclists.”

In keeping with that goal, we recommend the following:

Immediate (<3 months)

- Post train assignment each morning on Caltrain’s website to help distribute the load by alleviating the uncertainty in the number of bike spaces on each train.
- Schedule trains with 64 bike spaces during peak demand, i.e., commute hours and special events. This may require removing seats to increase the number of trains with 64 bike spaces.
- Caltrain staff delivers an annual rolling plan to the JPB articulating what it would take to meet bike demand now, in 1 year, in 5 years, and in 10 years.

Short term (6 to 12 months)

- Provide real-time information on bike spaces available on trains.
- Ensure non-peak trains have a minimum of 32 bike spaces.

Medium Term (1 to 5 years)

- Reconfigure cars to maximize bike space and increase bike capacity during peak demand to 15%.
- Hire a full-time bicycle planner/coordinator (who actually commutes by bike and train).

Long term (>5 years)

- Provide unrestricted bike access on electrified trains.

8 Conclusions

Bikes on board is a service success that built Caltrain's ridership, enhanced its reputation, and has been studied and admired by transit systems all over the nation. Bikes on board is the central and essential element of Caltrain's bicycle service and must be addressed fully in any planning process. Far from being a "special interest" service for Caltrain, bicycle bring-along by Caltrain passengers serves the system's and region's goals more perfectly than almost any other trip type and should be supported and enhanced by Caltrain with energy and focus.

Caltrain's Bicycle Master Plan misses the point, because it does not include anything about increasing bike capacity on board. To achieve Caltrain's stated goal to make Caltrain a convenient and user-friendly transit service for bicyclists, an increase in bicycle carriage on board trains must be included in the Bicycle Master Plan.

9 References

- [1] TAG 1/24/07 Meeting Summary, attached to the agenda for the March 13, 2007 meeting of the Caltrain Bicycle Master Plan Technical Advisory Group, contact Celia Chung.
- [2] Metropolitan Transportation Commission's Resolution 3434, Transit-Oriented Development Policy, July, 2006.
- [3] 2007 Caltrain Online Bicycle Survey: Selected Preliminary Results, reported in the agenda for the July 11, 2007 meeting of the Caltrain Bicycle Master Plan Technical Advisory Group, contact Celia Chung. Caltrain conducted the Online Bicycle Survey from May 21 to June 1, 2007. The number of respondents was 1571 including 1180 bike+Caltrain users, 169 former users, and 222 potential users.
- [4] San Francisco Municipal Transportation Agency, 2007 Citywide Bicycle Counts Report, November 2007.
- [5] Source: San Francisco Municipal Transportation Agency
- [6] Source: San Francisco Bicycle Coalition
- [7] Source: Silicon Valley Bicycle Coalition
- [8] Caltrain Electrification Program Environmental Assessment/Draft Environmental Impact Report, April 2004, Section 3.15.8.
- [9] Key Findings, February 2005 Caltrain Annual Passenger Counts
- [10] Key Findings, February 2006 Caltrain Annual Passenger Counts
- [11] Key Findings, October 2004 Caltrain Passenger Counts
- [12] Key Findings, February 2007 Caltrain Annual Passenger Counts
- [13] Key Findings, February 2008 Caltrain Annual Passenger Counts
- [14] Key Findings, February 2003 Caltrain Annual Passenger Counts
- [15] 2007 Onboard Bike Count Summary Report, prepared by Corey, Canapary & Galanis Research for Caltrain.
- [16] Project 2025, Peninsula Corridor Joint Powers Board, November 30, 2006
- [17] Caltrain 2004 2023 Strategic Plan
- [18] Caltrain Short Range Transit Plan, Fiscal Years 2008 to 2017, adopted February 7, 2008
- [19] The Bikes-On-Cars Subcommittee's Recommendations for Bicycle-related Specifications for Rolling Stock Procurement, October 2007; attachment to agenda dated February 5, 2008 for Caltrain Bicycle Master Plan - Technical Advisory Committee, contact Celia Chung.
- [20] Peninsula Joint Powers Board Comprehensive Annual Financial Report, Fiscal Year Ended June 30, 2008, p. 49.
- [21] Osborn, Lynn, (2003), "TDM Cost Effectiveness, How VMT Reduction Translates to Congestion Mitigation and Improved Air Quality", ACT International Conference, TDM Cost Effectiveness White Paper, p.7.
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- [23] Tol, Richard, S. J., (2005) "The Marginal Costs of Carbon Dioxide Emissions: An Assessment of the Uncertainties", Energy Policy 33(16):2064–2074.
- [24] Caltrain 2007 Progress Report, p. 5.
- [25] Email dated May 22, 2008 from Martha Martinez, JPB Secretary, who wrote "There is no dwell time study report."
- [26] JPB Meeting agenda packets, February 2008 through August 2008, Caltrain Performance Reports.

10 Appendices

Appendix A: Most Favorable Financial Outcome of Adding a New Bike Car

Appendix B: Most Probable Financial Outcome of Adding a New Bike Car

Appendix C: Least Favorable Financial Outcome of Adding a New Bike Car

Appendix D: Adjustable Parameters in the Financial Model

Appendix A: Most Favorable Financial Outcome of Adding a New Bike Car

Current Schedule, Ridership, and Train Sets

5	Number of trips per day per train set	1	20	train sets	2	98	runs/weekday
	35 Average number of bikes per trip	3	3,382	bikes/weekday			
	410 Average number of non-bikers per trip	4	40,149	non-bikers/weekday			
	46 Average number of bikes spaces per trip						
	605 Average number of seats per trip						
	108% Utilization of bike spaces averaged over the entire day						
	68% Utilization of seats averaged over the entire day						
5	\$ 3.20 Average Caltrain fare						

Adding a New Car

6	32	Number of passenger seats lost to bike space
	64	Number of passenger seats if no bike space

Ticket Revenue

\$ 501.76	Daily ticket revenue due to bikers at 100% capacity
\$ 1,003.52	Daily ticket revenue due to non-bikers at 100% capacity

Loss Due to Bikers from a New Bike Car

0.00	Dwell time delay in min/run due to bike (7	0	annual dwell time delay in hours due to bikers
\$ 29.28	Value of each minute	8	\$ 1,757	operating cost per hour
\$ -	Loss per run due to dwell time			
\$ -	Total loss of dwell time per day			

Loss Due to Non-Bikers from a New Non-bike Car

Shuttle costs

28	Number of daily shuttle passengers	9	8.8%	non-bikers use free shuttles
10	\$ 6.60	Operating cost per passenger		
\$ 182.14	Total shuttle costs per day			

Transit costs (assume bus)

66	Number of daily bus passengers	11	20.9%	non-bikers use buses	
12	\$ 6.41	Operating cost per passenger	13	120	passengers/bus/day
14	\$ 1.13	Average bus fare		0.55	number of buses needed
\$ 345.86	Total bus operating costs per day	15	\$ 500,000	cost of new bus	
\$ 62.35	Daily depreciation of bus cost	16	\$ 12	bus lifetime in years	4,380 days
\$ 408.21	Total bus costs per day (operating + depreciation)				

Parking spaces

20	Number of parking spaces needed	17	31%	non-bikers use parking spaces	
\$ 55.58	Parking revenue loss per day	18	290	square feet per parking space	
\$ 3.67	Parking maintenance costs per day	19	\$ 5.75	monthly rent per square foot	
			\$ 1,668	rent per month	30 days
20	\$ 2.00	Parking revenue per day	21	\$ 110	parking space maintenance cost per month
\$ 1,128.51	Total daily loss due to parking spaces (operating + land revenue loss)				

Adjustment Due to Expected Demand

\$ -	Loss due to bikers if 100% capacity
\$ -	Realistic loss due to expected demand 100% due to dwell time
\$ 1,718.86	Loss due to non-bikers if 100% capacity
\$ 1,164.90	Realistic loss due to expected demand 11% due to free shuttles 24% due to buses 66% due to parking spaces
\$ 501.76	Ticket revenue from bikers at 100% capacity
\$ 541.19	Realistic ticket revenue from bikers due to expected demand
\$ 1,003.52	Ticket revenue from non-bikers at 100% capacity
\$ 680.10	Realistic ticket revenue from non-bikers due to expected demand
\$ 541.19	Realistic net gain (loss) due to bikers
\$ (484.80)	Realistic net gain (loss) due to non-bikers

Benefit of Adding a New Bike Car

\$ 1,025.99	Daily gain (loss) of adding a new bike car compared with a non-bike car
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Appendix B: Most Probable Financial Outcome of Adding a New Bike Car

Current Schedule, Ridership, and Train Sets

5	Number of trips per day per train set	1	20	train sets	2	98	runs/week day
	29	Average number of bikes per trip	3	2882	bikes/weekday		
	381	Average number of non-bikers per trip	4	37,380	non-bikers/weekday		
	46	Average number of bikes spaces per trip					
	605	Average number of seats per trip					
	92%	Utilization of bike spaces averaged over the entire day					
	63%	Utilization of seats averaged over the entire day					
5	\$ 3.35	Average Caltrain fare					

Adding a New Car

6	32	Number of passenger seats lost to bike space
	64	Number of passenger seats if no bike space

Ticket Revenue

\$ 525.28	Daily ticket revenue due to bikers at 100% capacity
\$ 1,050.56	Daily ticket revenue due to non-bikers at 100% capacity

Loss Due to Bikers from a New Bike Car

0.00	Dwell time delay in min/run due to bike (7	0	annual dwell time delay in hours due to bikers
\$ 31.04	Value of each minute	8	\$ 1,862	operating cost per hour
\$ -	Loss per run due to dwell time			
\$ -	Total loss of dwell time per day			

Loss Due to Non-Bikers from a New Non-bike Car

Shuttle costs

25	Number of daily shuttle passengers	9	8.0%	non-bikers use free shuttles
10	\$ 6.00	Operating cost per passenger		
\$ 150.53	Total shuttle costs per day			

Transit costs (assume bus)

60	Number of daily bus passengers	11	19.0%	non-bikers use buses	
12	\$ 5.80	Operating cost per passenger	13	244	passengers/bus/day
14	\$ 0.84	Average bus fare		0.24	number of buses needed
\$ 295.54	Total bus operating costs per day	15	\$ 500,000	cost of new bus	
\$ 27.85	Daily depreciation of bus cost	16	\$ 12	bus lifetime in years	4,380 days
\$ 323.38	Total bus costs per day (operating + depreciation)				

Parking spaces

18	Number of parking spaces needed	17	28%	non-bikers use parking spaces	
\$ 19.44	Parking revenue loss per day	18	243	square feet per parking space	
\$ 2.87	Parking maintenance costs per day	19	\$ 2.40	monthly rent per square foot	
			\$ 583	rent per month	30 days
20	\$ 2.00	Parking revenue per day	21	\$ 86	parking space maintenance cost per month
\$ 363.90	Total daily loss due to parking spaces (operating + land revenue loss)				

Adjustment Due to Expected Demand

\$ -	Loss due to bikers if 100% capacity
\$ -	Realistic loss due to expected demand 100% due to dwell time
\$ 837.81	Loss due to non-bikers if 100% capacity
\$ 528.64	Realistic loss due to expected demand 18% due to free shuttles 39% due to buses 43% due to parking spaces
\$ 525.28	Ticket revenue from bikers at 100% capacity
\$ 482.77	Realistic ticket revenue from bikers due to expected demand
\$ 1,050.56	Ticket revenue from non-bikers at 100% capacity
\$ 662.88	Realistic ticket revenue from non-bikers due to expected demand
\$ 482.77	Realistic net gain (loss) due to bikers
\$ 134.24	Realistic net gain (loss) due to non-bikers

Benefit of Adding a New Bike Car

\$ 348.53	Daily gain (loss) of adding a new bike car compared with a non-bike car
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Appendix C: Least Favorable Financial Outcome of Adding a New Bike Car

Current Schedule, Ridership, and Train Sets

5	Number of trips per day per train set	1	20	train sets	2	98	runs/week day
	24	Average number of bikes per trip	3	2,382	bikes/weekday		
	353	Average number of non-bikers per trip	4	34,611	non-bikers/weekday		
	46	Average number of bikes spaces per trip					
	605	Average number of seats per trip					
	76%	Utilization of bike spaces averaged over the entire day					
	58%	Utilization of seats averaged over the entire day					
5	\$ 3.35	Average Caltrain fare					

Adding a New Car

6	32	Number of passenger seats lost to bike space
	64	Number of passenger seats if no bike space

Ticket Revenue

\$ 525.28	Daily ticket revenue due to bikers at 100% capacity
\$ 1,050.56	Daily ticket revenue due to non-bikers at 100% capacity

Loss Due to Bikers from a New Bike Car

0.42	Dwell time delay in min/run due to bike (7	250	annual dwell time delay in hours due to bikers
\$ 31.04	Value of each minute	8	\$ 1,862	operating cost per hour
\$ 13.02	Loss per run due to dwell time			
\$ 63.78	Total loss of dwell time per day			

Loss Due to Non-Bikers from a New Non-bike Car

Shuttle costs

23	Number of daily shuttle passengers	9	7.2%	non-bikers use free shuttles
10	\$ 2.91	Operating cost per passenger		
\$ 65.81	Total shuttle costs per day			

Transit costs (assume bus)

54	Number of daily bus passengers	11	17.1%	non-bikers use buses	
12	\$ 2.22	Operating cost per passenger	13	554	passengers/bus/day
14	\$ 0.60	Average bus fare		0.10	number of buses needed
\$ 86.87	Total bus operating costs per day	15	\$ 350,000	cost of new bus	
\$ 7.73	Daily depreciation of bus cost	16	\$ 12	bus lifetime in years	4,380 days
\$ 94.61	Total bus costs per day (operating + depreciation)				

Parking spaces

16	Number of parking spaces needed	17	25%	non-bikers use parking spaces	
\$ 4.50	Parking revenue loss per day	18	180	square feet per parking space	
\$ 1.67	Parking maintenance costs per day	19	\$ 0.75	monthly rent per square foot	
			\$ 135	rent per month	30 days
20	\$ 2.00	Parking revenue per day	21	\$ 50	parking space maintenance cost per month
\$ 67.20	Total daily loss due to parking spaces (operating + land revenue loss)				

Adjustment Due to Expected Demand

\$ 63.78	Loss due to bikers if 100% capacity
\$ 48.45	Realistic loss due to expected demand 100% due to dwell time
\$ 227.62	Loss due to non-bikers if 100% capacity
\$ 132.99	Realistic loss due to expected demand 29% due to free shuttles 42% due to buses 30% due to parking spaces
\$ 525.28	Ticket revenue from bikers at 100% capacity
\$ 398.99	Realistic ticket revenue from bikers due to expected demand
\$ 1,050.56	Ticket revenue from non-bikers at 100% capacity
\$ 613.78	Realistic ticket revenue from non-bikers due to expected demand
\$ 350.54	Realistic net gain (loss) due to bikers
\$ 480.79	Realistic net gain (loss) due to non-bikers

Benefit of Adding a New Bike Car

\$ (130.25)	Daily gain (loss) of adding a new bike car compared with a non-bike car
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Appendix D: Adjustable Parameters for the Financial Model

#	Parameter	Most favorable	Most probable	Least favorable	Reference for most favorable	Reference for most probable	Reference for least favorable
3	Caltrain bike boardings per weekday	3382	2882	2382	42% increase over Feb 2008; Caltrain October 2004 Annual Passenger Count showed 42% increase in cyclists over February 2004 Annual Passenger Count	Average of least and most favorable	Caltrain Feb 2008 Annual Passenger Counts
4	Caltrain passengers per weekday	40,149	37,380	34,611	Caltrain reports 16% higher ridership in summer months; Caltrain Feb 2008 Annual Passenger Counts	Average of least and most favorable	Total count minus bicycle boardings; Caltrain Feb 2008 Annual Passenger Counts
5	Average Caltrain fare	\$3.20	\$3.35	\$3.35	FY06 average ticket price - Caltrain Short Range Transit Plan, table 3-1, p. 20.	JPB Monthly Meeting Minutes, Report of the Executive Director	JPB Monthly Meeting Minutes, Report of the Executive Director
7	Annual dwell time delay in hours due to bikers	0	0	250	Caltrain 2007 Progress Report shows 95% on-time performance 2003-2007, even though bike boardings increased 45%	Addition of a new bike car will not increase dwell time, it will reduce it by making another car for bicyclists to board.	Caltrain Bike Master Plan Key Findings state 250 hrs dwell time per year due to bikes
8	Caltrain operating cost per hour	\$1,757	\$1,862	\$1,974	Caltrain Short Range Transit Plan, Table 3.1, operating cost per revenue hour in FY06	Assume 6% annual increase in operating expense based on JPB FY09 adopted budget	Assume 6% annual increase in operating expense based on JPB FY09 adopted budget
9	Non-bikers use free shuttles	8.8%	8.0%	7.2%	Assume 10% variation in metric	Caltrain Bike Master Plan Key Findings, based on 2007 Passenger Count	Assume 10% variation in metric
10	Shuttle cost per passenger	\$6.60	\$6.00	\$2.91	Assume 10% variation in CMEQ benchmark	C/CAG benchmark for shuttle operating cost per passenger, City/County Association of Governments of San Mateo County, Congestion Management & Environmental Quality Committee, packet attached to the agenda for 7/28/08, p. 16.	Caltrain Short Range Transit Plan, Chapter 4, p.28, FY2008 shuttle ridership = 1344874; Adopted FY08 annual operating cost = \$2,834,540 (pd by Caltrain) +\$1,085,509 (pd by others), Caltrain Short Range Transit Plan, Chapter 4, p 28, and Caltrain FY2009 Budget
11	Non-bikers use buses	20.9%	19.0%	17.1%	Assume 10% variation in metric	Caltrain Bike Master Plan Key Findings, based on 2007 Passenger Count	Assume 10% variation in metric
12	Bus operating cost per passenger	\$6.41	\$5.80	\$2.22	VTA operating cost per boarding in FY07, VTA Short Range Transit Plan, Figure 2-11	Samtrans annual operating expense = \$86,371,188 and annual passengers = 14,892,745; http://www.samtrans.com/pdf/Facts_and_Figures/ST_Facts_Figures_2008_web.pdf	Muni FY2008 Q3 average bus operating cost per passenger; San Francisco Municipal Transportation Authority, Q3FY08 Service Standards Appendix (Jan-Mar 2008), p. 23
13	Passengers/bus/day	120	244	554	Samtrans has 341 buses: http://www.samtrans.org/facts_fleet.html , and carries 14,900,000 passengers per year: http://www.samtrans.org/facts_ridership.html	VTA has 471 active buses, VTA Short Range Transit Plan, section 1.8.1, p. 26, and carries 41,990,098 passengers in FY07, VTA Short Range Transit Plan, Figure 2-13.	Muni has 1005 service vehicles; SFMTA San Francisco Transportation Fact Sheet, May 2008, and 203,373,547 annual passengers excluding cable cars; SFMTA Short Range Transit Plan, p.4-13.
14	Average bus fare	\$1.13	\$0.84	\$0.60	FY07 fare revenue = \$16,262,073 and annual riders = 14,351,402; San Mateo County Transit District Short Range Transit Plan FY08-FY17, p. 34.	VTA average fare per boarding for the entire system in FY07, VTA Short Range Transit Plan, Figure 2-13	Muni average fare per passenger excluding cable cars; San Francisco Municipal Transportation Authority, Q3FY08 Service Standards Appendix (Jan-Mar 2008), p. 21
15	Cost of new bus	\$500,000	\$500,000	\$350,000	Hybrid bus: http://www.sfmta.com/cms/mfleet/hybrids.htm	Hybrid bus: http://www.sfmta.com/cms/mfleet/hybrids.htm	Diesel bus: http://www.sfmta.com/cms/mfleet/hybrids.htm

The financial model uses Caltrain weekday ridership counts, though weekend ridership is lower. Segregating weekday and weekend ridership would likely favor the bike car over the non-bike car. Fewer weekend passengers result in lower Caltrain ticket revenue from both bikers and non-bikers. However, non-bikers also result in lower parking and bus revenue, but comparable service vehicle depreciation and parking lot costs.