

California High-Speed Train Project



TECHNICAL MEMORANDUM

Phase 1 Service Plan TM 4.2

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Revision	Date	Description
0	20 Nov 08	Initial Release

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TABLE OF CONTENTS

1. INTRODUCTION	3
2. ANALYTIC METHODOLOGY	3
3. ASSUMPTIONS AND GENERAL PRINCIPLES	4
4. PHASE 1 SERVICE PLAN	6
STOPPING PATTERNS AND SERVICE FREQUENCIES	6
TRAIN SCHEDULE DEVELOPMENT	9
ESTIMATED PASSENGER LOADS AND LOAD FACTORS	11
5. FLEET REQUIREMENTS	17
EQUIPMENT CYCLES	17
REVENUE TRAINSETS.....	17
6. TRAIN STORAGE REQUIREMENTS	18
APPENDICES – PHASE 1 SERVICE PLAN CHARACTERISTICS	20
[A] BASE, WITH 7.0% RECOVERY TIME ALLOWANCE	20
A1. <i>Hypothetical Timetable</i>	22
A2. <i>Stringline Diagrams</i>	27
A3. <i>Equipment Cycles</i>	32
[B] – VARIATION, WITH 1.0-3.5% RECOVERY TIME ALLOWANCE	39
B1. <i>Hypothetical Timetable</i>	44
B2. <i>Stringline Diagrams</i>	49

FIGURES

FIGURE 1 – ESTIMATED PASSENGER LOADS IN 2030 – EVENING PEAK HOUR SOUTHBOUND	12
FIGURE 2 – ESTIMATED PASSENGER LOADS IN 2030 – EVENING PEAK SHOULDER HOUR SOUTHBOUND	13
FIGURE 3 – ESTIMATED PASSENGER LOADS IN 2030 – EVENING PEAK HOUR NORTHBOUND.....	14
FIGURE 4 – ESTIMATED PASSENGER LOADS IN 2030 – EVENING PEAK SHOULDER HOUR NORTHBOUND.....	15
FIGURE 5 – ESTIMATED PASSENGER LOADS IN 2030 – AVERAGE OFF-PEAK.....	16

TABLES

TABLE 1 – INTERMEDIATE STATION DWELL TIMES	5
TABLE 2 – TERMINAL STATION MINIMUM LAYOVER TIMES	5
TABLE 3 – TRAIN STOPPING PATTERNS	6
TABLE 4 – MINIMUM TRIP TIMES BETWEEN SELECTED STATIONS	7
TABLE 5 – PEAK AND OFF-PEAK SERVICE FREQUENCIES	8
TABLE 6 – REVENUE TRAINS BY TIME PERIOD AND TRAIN TYPE	10
TABLE 7 – DAILY AND ANNUAL TRAIN-MILES	10
TABLE 8 – ESTIMATED DAILY STATION-TO-STATION RIDERSHIP IN 2030 (PHASE 1)	11
TABLE 9 – RIDERSHIP PEAKING FACTORS	11
TABLE 10 – 200M TRAIN SECTIONS NEEDED TO “FILL OUT” 400M TRAINS	17
TABLE 11 – OVERNIGHT TRAIN STORAGE REQUIREMENTS	18
TABLE 12 – MID-DAY TRAIN STORAGE REQUIREMENTS.....	19

PHASE 1 SERVICE PLAN

1. INTRODUCTION

A concept level service plan and hypothetical timetable for the Phase 1 California High Speed Train (HST) project has been developed, which provides a description of the proposed type and quantity of service that is more detailed than had been available previously. The Phase 1 service plan is intended to serve several purposes:

- Confirm the level of service assumptions (travel times and service frequencies between station pairs) used to develop the estimates of system ridership and revenue
- Validate the operational feasibility of the desired level of service at a conceptual level
- Identify operable patterns of train service, particularly the general requirements for non-stop or limited-stop trains to pass slower trains that need to make a greater number of stops along the route (i.e., the locations and frequencies of occurrence of these “overtakes” at various times of day)
- Provide a basis for estimating the number of required train sets and overall rolling stock fleet requirements
- Provide a basis for estimating platform track and storage track capacity needed to support operations at the end terminal stations

2. ANALYTIC METHODOLOGY

A PB-developed spreadsheet-based “static” model for formulating and analyzing concept level operating plans for railroad systems was adapted for the HST network. This model utilizes train performance calculations taken from prior detailed “dynamic” simulation modeling results to identify the running time characteristics of the various types of service and train stopping patterns that are expected to operate on the HST system. The model generates stringline (time-distance) diagrams and tabular outputs describing the timing and scheduled operating performance of every train. It provides a level of detail sufficient to confidently perform “pattern analysis” of the various express, limited stop and all-stop local services that are envisioned, with the objective of identifying a reasonable service pattern that achieves the desired level of service at each station while minimizing both conflicts between trains and the required number of overtakes.

The spreadsheet model provides the ability for trains to be “linked” with subsequent trains and assigned to specific train sets. The resulting train set equipment cycles form the basis for estimating the size of the required rolling stock fleet.

The model also includes a module that compares the forecast level of system ridership with the quantity of service delivered, allocating riders to specific trains and calculating estimated load factors (projected number of riders per train divided by train seating capacity), using station specific boarding and alighting passenger (detail) estimates and peaking factors derived from the ridership forecasts.

This plan, while contributing to confident approximations at the conceptual level, does not yet represent a detailed operating plan for the system, even though the train timetables and stringline (time-distance) diagrams give the impression of a high level of precision. This conceptual plan

analysis is based on optimal ideal operations with trains running exactly on schedule. It does not analyze any randomization, delays or perturbations to the normal schedule and does not address the time required to recover from track blockages or the impacts of delay conditions on the network. A full detailed operating plan supported by dynamic computer simulation modeling of train movements throughout the system will be developed in a subsequent task later in the project, at which time an actual proposed timetable can be confidently prepared and approved.

3. ASSUMPTIONS AND GENERAL PRINCIPLES

The following assumptions and general principals guided the development of the Phase 1 service plan:

1. The HST system assumed to operate independently of any other passenger or freight rail services
2. Train sets are assumed to comprise units of 200 meters (m) in length, either singly (200 m train with 500 passengers) or operating as pairs (400 m train with 1,000 passengers)
3. Train running times were obtained from simulated train performance calculations, with an additional time factor added to these times. This added time, sometimes referred to as “schedule pad” or “recovery time” accounts for operator performance, external conditions and minor delays, which result in minimal day-to-day fluctuations in train performance – the additional time factor assumed in this analysis is common in passenger train scheduling, permits trains to recover from time lost due to minor causes, and provides an allowance for the system to maintain a high degree of overall on-time performance when operations are normal. Two different scenarios were analyzed concerning recovery time. The initial base case analysis assumed a recovery time factor of seven percent on top of the minimum train run time. This is consistent with current industry practice in the U.S. and is considered a conservative estimate, since the HST system is expected to operate at a higher level of precision than is “typical.” A second service plan variation was developed assuming a recovery time factor of three and one-half percent for most trains. In this second case, certain “premium” services, such as express trains during peak periods were assumed to operate with a recovery time allowance of as little as one percent.
4. The schedule features “clockface” service patterns and regular intervals between trains (headways), which can be easily remembered and is markedly customer friendly
5. The schedule features service patterns that repeat every hour, as opposed to patterns that differ somewhat from hour-to-hour providing for more simplified operations – this makes the service more regular and predictable and reduces the number of different types of overtakes required
6. The minimum spacing between trains following each other past a given point is set at three minutes, based on the assumed practical capacity design attributes of the signal and train control system
7. Express trains are given the highest priority in terms of their schedule paths; limited stop trains and those that travel a longer distance along the network have the next highest priority, and all-stop local trains generally have the lowest priority and, therefore, the highest incidence of overtakes
8. Train overtakes were arranged to utilize station (siding) tracks for express trains to pass local trains making a service stop, while maintaining consistency and reliability in the service stopping patterns.

9. The level of service between Los Angeles and Anaheim is maintained at four trains per hour per direction in the business travel peaks, and three trains per hour per direction at other times of day
10. The service levels and patterns developed as the basis for the ridership and revenue forecasts were taken as a guideline in the development of the Phase 1 service plan; adjustments were made where necessary to improve the operational efficiency and performance of the system; in all cases the level of service provided at each station remains at or better than the level assumed in the ridership forecasts.

The analysis assumed the following station dwell times and minimum terminal layover (turnaround) times. The latter is defined to be the minimum time allowed between the scheduled arrival of a train set at a terminal and the scheduled departure of the same train set in the opposite direction of service.

TABLE 1 – INTERMEDIATE STATION DWELL TIMES

Code	Station	Scheduled Dwell Time (mins)
SFO	Millbrae	1.5
RWC	Redwood City	1.5
SJC	San Jose	2.0
GLY	Gilroy	1.5
FNO	Fresno	1.5
BFD	Bakersfield	1.5
PMD	Palmdale	1.5
SYL	Sylmar	1.5
BUR	Burbank	1.5
LAU	L.A. Union Sta.	2.0
NSF	Norwalk	1.5

TABLE 2 – TERMINAL STATION MINIMUM LAYOVER TIMES

Code	Station	Minimum Scheduled Layover Time (mins)
SFT	S.F.-Transbay	30
LAU	L.A. Union Sta.	40
ANA	Anaheim	40
MCD	Merced	40

4. PHASE 1 SERVICE PLAN

STOPPING PATTERNS AND SERVICE FREQUENCIES

Table 3 depicts the various train types and stopping patterns that were used to formulate the Phase 1 service plan, along with the average total estimated travel time from the origin station to the final destination station. The “Express” train type makes only one intermediate stop between San Francisco and Los Angeles – at San Jose – and therefore provides the fastest run time between these points and with an assumption of one percent recovery time during the peak period, is estimated to run between San Francisco and Los Angeles in two hours-forty minutes. At the other end of the spectrum are “All Stop” trains that serve every station along the line and therefore take significantly longer to make a run between San Francisco and the Los Angeles basin.

TABLE 3 – TRAIN STOPPING PATTERNS

STOPPING PATTERNS

Southbound

Train Type/Pattern	SFT	SFO	RWC	SJC	GLY	MCD	FNO	BFD	PMD	SYL	BUR	LAU	NSF	ANA	End-to-End Run Time (mins)
1 Bay Area Limited	X		X	X	X							X	X	X	205
2 Express	X			X								X	X	X	194
4 All-Stop	X	X	X	X	X		X	X	X	X	X	X	X	X	241
7 Central Valley Limited	X	X	X	X	X		X	X				X	X	X	225
9 San Fernando Valley Limited	X	X		X			X	X		X		X			198
10 Central Valley Limited	X	X	X	X	X		X		X		X	X	X	X	228
13 San Fernando Valley Limited	X		X	X					X	X	X	X	X	X	216
14 SF-Merced	X	X	X	X	X	X									94
15 LA-Merced						X	X	X	X	X	X	X	X	X	161
16 Central Valley Limited	X	X	X	X	X		X	X				X			200
17 San Fernando Valley Limited	X		X	X	X				X	X	X	X			196
18 Central Valley Limited	X	X	X	X	X		X		X		X	X			203
19 San Fernando Valley Limited	X		X	X	X				X	X		X			191
20 Central Valley Limited	X	X	X	X			X	X		X		X			200
21 San Fernando Valley Limited	X			X	X			X	X	X	X	X			199

Northbound

Train Type/Pattern	ANA	NSF	LAU	BUR	SYL	PMD	BFD	FNO	MCD	GLY	SJC	RWC	SFO	SFT	End-to-End Run Time (mins)
1 Bay Area Limited	X	X	X							X	X	X		X	205
2 Express	X	X	X								X			X	194
4 All-Stop	X	X	X	X	X	X	X	X		X	X	X	X	X	240
7 Central Valley Limited	X	X	X				X	X		X	X	X	X	X	223
9 San Fernando Valley Limited			X		X		X	X			X		X	X	197
10 Central Valley Limited	X	X	X	X		X		X		X	X		X	X	221
13 San Fernando Valley Limited	X	X	X	X	X	X					X	X		X	216
14 SF-Merced									X	X	X	X	X	X	94
15 LA-Merced	X	X	X	X	X	X	X	X	X						163
16 Central Valley Limited			X				X	X		X	X	X	X	X	197
17 San Fernando Valley Limited			X	X	X	X				X	X	X		X	196
18 Central Valley Limited			X	X		X		X		X	X	X	X	X	196
19 San Fernando Valley Limited			X		X	X				X	X	X		X	191
20 Central Valley Limited			X		X		X	X			X	X	X	X	198
21 San Fernando Valley Limited			X	X	X	X	X			X	X	X		X	203

In between these two service types are various categories of “Limited Stop” trains that make selected intermediate station stops but skip other stations. Several different limited stop patterns have been defined. They are grouped and named according to the part of the network within which they provide the greatest degree of service to individual intermediate stations. For instance, the “Bay Area Limiteds” make several stops within the Bay Area between San Francisco and Gilroy and then operate non-stop to Los Angeles. The “Central Valley Limiteds” stop at Fresno and/or Bakersfield but skip selected other intermediate stations, and the “San Fernando Valley Limiteds” make most or all of the stops between Los Angeles and Palmdale but skip many of the stations in the Bay Area and Central Valley. These “Limiteds” make up the majority of trains operating on the network and offer a compromise of a relatively fast run time along with connectivity among various groups of intermediate stations along the line.

The on-board travel time between stations varies, depending on the number of intermediate station stops (which is different for each train type) and the time of day (some trains have additional time built into their peak schedules to allow them to be “overtaken” by express or limited-stop trains while en route). The minimum or “fastest” trip times between selected city pair stations is presented in Table 4, based on the mix of train types and stopping patterns included in the Phase 1 service plan.

TABLE 4 – MINIMUM TRIP TIMES BETWEEN SELECTED STATIONS

(Based on Phase 1 Service Plan Train Stopping Patterns)

With Schedule Pad Allowance of 1.0%

		<u>Times in Hours:Minutes</u>				
		SFT	SJC	FNO	LAU	ANA
SFT	San Francisco-Transbay	--	0:27	1:29	2:40	3:04
SJC	San Jose	0:27	--	0:50	2:11	2:35
FNO	Fresno	1:29	0:50	--	1:31	1:55
LAU	Los Angeles Union Station	2:40	2:11	1:31	--	0:22
ANA	Anaheim	3:04	2:35	1:55	0:22	--

With Schedule Pad Allowance of 3.5%

		<u>Times in Hours:Minutes</u>				
		SFT	SJC	FNO	LAU	ANA
SFT	San Francisco-Transbay	--	0:28	1:31	2:44	3:08
SJC	San Jose	0:28	--	0:51	2:14	2:38
FNO	Fresno	1:31	0:51	--	1:33	1:57
LAU	Los Angeles Union Station	2:44	2:14	1:33	--	0:22
ANA	Anaheim	3:08	2:38	1:57	0:22	--

Note: The HST system is expected to operate at a high level of precision, with schedule pad allowances lower than for other intercity passenger rail corridors in the U.S. The development of system timetables will be based on tradeoffs that will need to be made among trip time, service reliability, alignment engineering, capital cost and operations and maintenance cost considerations.

**Explanation:* Table 4 (above) displays estimated timetable travel times between the city pairs presented in the matrix. For example, when reading the first row of the first table (with schedule pad allowance of 1%), the numbers shown represent the trip time between: San Francisco and San Jose (27 minutes); San Francisco and Fresno (1 hour, 29 minutes); San Francisco and Los Angeles (2 hours, 40 minutes); and San Francisco and Anaheim (3 hours and 4 minutes).

Table 5 compares the service levels and stopping patterns originally assumed as the basis for high speed rail ridership and revenue estimates, and the proposed Phase 1 service plan. The original set of stopping patterns proved to be operationally infeasible, resulting in excessive numbers of overtakes and delays to trains being overtaken. Alternative patterns were examined that deliver

approximately the same level of service at each station, in terms of service frequency and the mix of express, limited stop and all-stop local service. Though the mix of stopping patterns has been modified, the number of trains per hour at each terminal and intermediate station is the same as or higher than what was assumed for the ridership demand forecasting purposes. The proposed mix of services offers regular clockface patterns, with each service type leaving at the same time each hour, with relatively limited exceptions. Slightly more service is assumed during the three hour peak periods in the morning and late afternoon.

TABLE 5 – PEAK AND OFF-PEAK SERVICE FREQUENCIES

ORIGINAL SERVICE PLAN ASSUMPTIONS FOR RIDERSHIP FORECASTING

PEAK HOUR STATION STOPS-SOUTHBOUND

Pattern No. → 2 1 9 10 7 13 14 15

	Super	Exp	Ltd A	Ltd B	NLAX	VX	SF-M	LA-M	
Trains per hour →	1	0.5	2	2	0.5	0.5	1.5	1.5	9.5
	TOTAL								
SFT S.F.-Transbay	1	0.5	2	2	0.5	0.5	1.5		8
SFO Millbrae			2		0.5		1.5		4
RWC Redwood City		0.5		2	0.5	0.5	1.5		5
SJC San Jose	1	0.5	2	2	0.5	0.5	1.5		8
GLY Gilroy		0.5		2	0.5		1.5		4.5
MCD Merced							1.5	1.5	3
FNO Fresno				2	0.5			1.5	4
BFD Bakersfield			2		0.5			1.5	4
PMD Palmdale				2		0.5		1.5	4
SYL Sylmar			2			0.5		1.5	4
BUR Burbank				2		0.5		1.5	4
LAU L.A. Union Sta.	1	0.5	2	2	0.5	0.5		1.5	8
NSF Norwalk		0.5			0.5	0.5		1.5	3
ANA Anaheim		0.5			0.5	0.5		1.5	3

PEAK HOUR STATION STOPS-NORTHBOUND

Pattern No. → 2 1 9 10 7 13 14 15

	Super	Exp	Ltd A	Ltd B	NLAX	VX	SF-M	LA-M	
Trains per hour →	1	0.5	2	2	0.5	0.5	1.5	1.5	9.5
	TOTAL								
ANA Anaheim		0.5			0.5	0.5		1.5	3
NSF Norwalk		0.5			0.5	0.5		1.5	3
LAU L.A. Union Sta.	1	0.5	2	2	0.5	0.5		1.5	8
BUR Burbank				2		0.5		1.5	4
SYL Sylmar			2			0.5		1.5	4
PMD Palmdale				2		0.5		1.5	4
BFD Bakersfield			2		0.5			1.5	4
FNO Fresno			2		0.5			1.5	4
MCD Merced							1.5	1.5	3
GLY Gilroy		0.5		2	0.5			1.5	4.5
SJC San Jose	1	0.5	2	2	0.5	0.5		1.5	8
RWC Redwood City		0.5		2	0.5	0.5		1.5	5
SFO Millbrae			2		0.5			1.5	4
SFT S.F.-Transbay	1	0.5	2	2	0.5	0.5		1.5	8

OFF-PEAK HOUR STATION STOPS

Pattern No. → 2 1 9 10 7 13 14 15 4

	Super	Exp	Ltd A	Ltd B	NLAX	VX	SF-M	LA-M	Local	
Trains per hour →	0	0.5	2	2	0.5	0	0.8	0.8	0.5	7.1
	TOTAL									
SFT S.F.-Transbay	0	0.5	2	2	0.5	0	0.8	0.8	0.5	6.3
SFO Millbrae			2		0.5		0.8	0.5		3.8
RWC Redwood City		0.5		2	0.5	0	0.8	0.5		4.3
SJC San Jose	0	0.5	2	2	0.5	0	0.8	0.5		6.3
GLY Gilroy		0.5		2	0.5		0.8	0.5		4.3
MCD Merced							0.8	0.8		1.6
FNO Fresno			2		0.5			0.8	0.5	3.8
BFD Bakersfield			2		0.5			0.8	0.5	3.8
PMD Palmdale				2		0		0.8	0.5	3.3
SYL Sylmar			2			0		0.8	0.5	3.3
BUR Burbank				2		0		0.8	0.5	3.3
LAU L.A. Union Sta.	0	0.5	2	2	0.5	0		0.8	0.5	6.3
NSF Norwalk		0.5			0.5	0		0.8	0.5	2.3
ANA Anaheim		0.5			0.5	0		0.8	0.5	2.3

PROPOSED PHASE 1 SERVICE PLAN Version 10

PEAK HOUR STATION STOPS-SOUTHBOUND

Pattern No. → 2 1 14 15 18 19 20 21 4

	Super	Exp	SF-M	LA-M	CV2	SFV2	CV3	SFV3	Local	
Trains per hour →	1	1	1	1	1	1	1	1	1	9
	TOTAL									
SFT S.F.-Transbay	1	1	1		1	1	1	1	1	8
SFO Millbrae			1		1		1		1	4
RWC Redwood City		1	1		1	1	1		1	6
SJC San Jose	1	1	1		1	1	1	1	1	8
GLY Gilroy		1	1		1	1		1	1	6
MCD Merced			1	1						2
FNO Fresno				1	1			1	1	4
BFD Bakersfield				1			1	1	1	4
PMD Palmdale				1	1	1		1	1	5
SYL Sylmar				1	1	1	1	1	1	5
BUR Burbank					1	1		1	1	4
LAU L.A. Union Sta.	1	1		1	1	1	1	1	1	8
NSF Norwalk	1	1		1					1	4
ANA Anaheim	1	1		1					1	4

PEAK HOUR STATION STOPS-NORTHBOUND

Pattern No. → 2 1 14 15 18 19 20 21 4

	Super	Exp	SF-M	LA-M	CV2	SFV2	CV3	SFV3	Local	
Trains per hour →	1	1	1	1	1	1	1	1	1	9
	TOTAL									
ANA Anaheim	1	1		1					1	4
NSF Norwalk	1	1		1					1	4
LAU L.A. Union Sta.	1	1		1	1	1	1	1	1	8
BUR Burbank		0.5		1	1			1	1	4
SYL Sylmar				1	1	1	1	1	1	5
PMD Palmdale				1	1	1		1	1	5
BFD Bakersfield				1			1	1	1	4
FNO Fresno				1	1		1		1	4
MCD Merced			1	1						2
GLY Gilroy		1	1		1	1		1	1	6
SJC San Jose	1	1	1		1	1	1	1	1	8
RWC Redwood City		1	1		1	1	1	1	1	6
SFO Millbrae			1		1		1		1	4
SFT S.F.-Transbay	1	1	1		1	1	1	1	1	8

OFF-PEAK HOUR STATION STOPS

Pattern No. → 2 1 14 15 16 17 4

	Super	Exp	SF-M	LA-M	CV2	SFV2	Local	
Trains per hour →	0	1.1	1	1	1.7	1.7	1.1	7.6
	TOTAL							
SFT Anaheim		1.1		1			1.1	3.2
SFO Norwalk		1.1		1			1.1	3.2
RWC L.A. Union Sta.	0	1.1		1	1.7	1.7	1.1	6.6
SJC Burbank				1		1.7	1.1	3.8
GLY Sylmar				1		1.7	1.1	3.8
FNO Palmdale				1		1.7	1.1	3.8
BFD Bakersfield				1	1.7		1.1	3.8
PMD Fresno				1	1.7		1.1	3.8
MCD Merced			1	1				2
SYL Gilroy		1.1	1		1.7	2	1.1	6.9
BUR San Jose	0	1.1	1		1.7	1.7	1.1	6.6
LAU Redwood City		1.1	1		1.7	1.7	1.1	6.6
NSF Millbrae			1		1.7		1.1	3.8
ANA S.F.-Transbay	0	1.1	1		1.7	1.7	1.1	6.6

The Phase 1 service plan as outlined in this document and its attachments provides a level of service at each station that is generally equivalent to the level of service assumed in the development of the estimates of system ridership and revenue (for Phase 1). A similar methodology is being applied to the service and operations analysis of the HST project to include the extensions of the system to Sacramento and San Diego; the results of the analysis of the system extensions to Sacramento and San Diego will be reported in a separate Technical Memorandum at a later date.

Table 5 indicates a slight increase in the number of peak station stops at Redwood City, Gilroy, Palmdale and Sylmar on the San Fernando Valley and Central Valley Limited services (Patterns 18-21), with a slightly longer running time for these services than indicated in the original service plan for the limited stop services (Patterns 9 and 10). As the HST project studies continue to progress it would be prudent to consider a more detailed ridership estimation to assess the relative merits of these run time and service frequency tradeoffs.

TRAIN SCHEDULE DEVELOPMENT

The process of developing a feasible train schedule for the various combinations of stopping patterns, train origins and destinations and service frequencies entailed overlaying the various patterns in a graphical template known as a “stringline” – which is a diagram with clock time on the horizontal axis and location along the rail system on the vertical axis. Each train movement is represented by a line that traces its path along the network in both time and distance. The stringline for a non-stop train has a steeper slope than that of a multiple-stop train. Stringlines in the same direction of flow are not permitted to intersect one another except at locations where there are additional tracks (at passenger stations) available for faster trains to bypass slower or stopped trains. These locations are assumed to be limited to the areas surrounding the stations on the main portion of the HST line between Gilroy and Palmdale – where non-stop trains are permitted to bypass or “overtake” trains operating in the same direction and stopping at the station. It is also worthy to note that with these service levels and consistent stopping patterns, the conceptual analysis revealed that trains are able to run in sequence (without overtakes) north of Gilroy and south of Palmdale. This attribute is subject to further study and validation, and will be examined in detail when the full dispatch computer simulation is performed

Stringline diagrams were constructed in the spreadsheet model by starting with the highest priority trains (express trains running on clockface schedules), and then adding the other stopping patterns and frequencies in a priority order, adjusting the starting times of each subsequent group of trains to minimize the number of required overtakes and to make sure that all overtakes, when required, occur at the appropriate intermediate station locations. Additional station dwell time was added to the schedules of trains being overtaken, as necessary, to ensure that the minimum three minute separation between trains is maintained.

Hypothetical timetables are presented in the appendices. A timetable for the base service plan is presented in Appendix A1. This same schedule is represented in stringline format in Appendix A2, which shows the patterns of train movements during the morning peak, mid-day period, afternoon peak and late evening period. Appendix B presents the same information for the service plan variation based on three and one half percent and one percent recovery time allowances. A hypothetical timetable for this service plan variation is presented in Appendix B1, with this schedule represented in stringline format in Appendix B2.

Table 6 shows the number of scheduled trains, for each stopping pattern/service type, within the morning peak, mid-day, afternoon peak and late evening periods. The daily schedule provides a total of 260 revenue trains.

TABLE 6 – REVENUE TRAINS BY TIME PERIOD AND TRAIN TYPE

Pattern	Train Type	End Points	Daily Trains (both directions)				Total Daily
			Morning Peak 3 Hrs	Mid-Day 7 Hrs	Afternoon Peak 3 Hrs	Late Evening 3+ Hrs	
1	Bay Area Limited	SFT-ANA	6	14	6	8	34
2	Express	SFT-ANA	6	—	6	—	12
4	All-Stop Local	SFT-ANA	6	14	6	8	34
10	Central Valley Limited	SFT-ANA	2	—	2	—	4
14	San Francisco-Merced All-Stop	SFT-MCD	6	14*	6	6	32
15	Anaheim-Merced All-Stop	MCD-ANA	6	14*	6	6	32
16	Central Valley Limited	SFT-LAU	—	28	—	6	34
17	San Fernando Valley Limited	SFT-LAU	—	28	—	6	34
18	Central Valley Limited	SFT-LAU	4	—	4	—	8
19	San Fernando Valley Limited	SFT-LAU	6	—	6	—	12
20	Central Valley Limited	SFT-LAU	6	—	6	—	12
21	San Fernando Valley Limited	SFT-LAU	6	—	6	—	12
Total			54	112	54	40	260

*Assumes one mid-day interval of 2 hours instead of normal 1 hour headway, during period of lowest ridership demand.

Annual operating costs for HST service, in large measure, are estimated based on the number of train-miles of assumed service operated. Table 7 presents the annual train-miles associated with the Phase 1 service plan. This estimate is based on full daily service for 250 weekdays per year, plus 115 weekend days and holidays with a reduced level of service.

TABLE 7 – DAILY AND ANNUAL TRAIN-MILES

	Daily Train-Miles	Daily Train-Miles (200m equivalent)	Days/ Year	Annual Train-Miles (200m equivalent)
Weekday	106,211	140,405	250	35,101,000
Weekend & Holiday	83,760	83,760	115	9,632,000
Total	--	--	365	*44,734,000

* Average annual train miles per 200 meter trainset is estimated at approximately 426,000, assuming a Phase 1 fleet requirement of 105 trainsets including spares (assumed spare ratio of 10%).

ESTIMATED PASSENGER LOADS AND LOAD FACTORS

In order to estimate train consists and fleet requirements, and verify that the capacity of the Phase 1 service plan approximately matches demand, the estimated daily Phase 1 ridership in 2030 of 159,000 trips was factored to develop an approximation of demand by hour for the peak, peak shoulder and off-peak periods. Ridership projections for daily boardings at each station, and annual region-to-region trips factored down to average daily travel, were used to derive a station-to-station daily trip table, which is presented in Table 8 below. The assumed peaking factors are presented in Table 9.

TABLE 8 – ESTIMATED DAILY STATION-TO-STATION RIDERSHIP IN 2030 (PHASE 1)

Alighting Station...	Boarding Station...														Total
	San Francisco (Transbay)	Millbrae	Redwood City	San Jose	Gilroy	Merced	Fresno	Bakersfield	Palmdale	Sylmar	Burbank	Los Angeles Union Station	Norwalk	Anaheim	
SFT San Francisco (Transbay)	0	262	1,247	3,154	856	1,707	1,654	1,653	3,421	2,586	614	2,256	1,836	11,643	32,890
SFO Millbrae	262	0	352	891	242	68	66	66	137	104	25	91	74	467	2,845
RWC Redwood City	1,247	352	0	40	11	184	178	178	369	279	66	243	198	1,254	4,599
SJC San Jose	3,154	891	40	0	50	396	384	383	794	600	142	523	426	2,702	10,485
GLY Gilroy	856	242	11	50	0	306	297	296	615	465	110	405	330	2,092	6,074
MCD Merced	1,707	68	184	396	306	0	405	671	556	420	100	367	298	1,892	7,370
FNO Fresno	1,654	66	178	384	297	405	0	955	365	276	65	241	196	1,242	6,324
BFD Bakersfield	1,653	66	178	383	296	671	955	0	514	389	92	339	276	1,750	7,562
PMD Palmdale	3,421	137	369	794	615	556	365	514	0	135	360	6,473	826	2,499	17,063
SYL Sylmar	2,586	104	279	600	465	420	276	389	135	0	91	1,632	208	630	7,814
BUR Burbank	614	25	66	142	110	100	65	92	360	91	0	1,686	215	651	4,217
LAU Los Angeles Union Station	2,256	91	243	523	405	367	241	339	6,473	1,632	1,686	0	730	2,211	17,197
NSF Norwalk	1,836	74	198	426	330	298	196	276	826	208	215	730	0	0	5,613
ANA Anaheim	11,643	467	1,254	2,702	2,092	1,892	1,242	1,750	2,499	630	651	2,211	0	0	29,034
Total	32,890	2,845	4,599	10,485	6,074	7,370	6,324	7,562	17,063	7,814	4,217	17,197	5,613	29,034	159,087

TABLE 9 – RIDERSHIP PEAKING FACTORS

Origin-Destination Market	Peak Hour	Peak Shoulder Hour	6 peak hours	10 off-peak hours	Directional Peaking Factors	
					PM Peak South-bound	PM Peak North-bound
Inter-regional	12%	10%	54%	46%	1.0	1.0
Within MTC territory	17%	11%	67%	33%	1.2	0.8
Within SCAG territory	15%	10%	61%	39%	0.9	1.1

For the peak hour, average peak shoulder hour and average off-peak hour, station-to-station ridership was allocated among the available trains operating during those hours. Where choices among both express and local trains exist, a higher percentage of trips is allocated to the faster express services. Within each hour, overall demand is constrained by trainset seating capacity. Where the initial allocation of trips resulted in some trains being over capacity, a portion of the affected station-to-station loads were re-assigned to trains with available seating capacity operating within the same hour.

The graphs on the following pages show the estimated passenger loadings on the various train types for each station-to-station segment. In all cases, passenger loads can be kept within the 1,000 seat capacity of a 400 m trainset. The express services require 400 m trainsets all day long. The all-stop local trains, selected limited stop trains, and the Anaheim-Merced local trains all have passenger loads between 500 and 1,000 passengers, necessitating 400 m trainsets. All off-peak trains other than the hourly expresses have passenger loads under 500 and can be accommodated on 200 m trainsets.

FIGURE 1 – ESTIMATED PASSENGER LOADS IN 2030 – EVENING PEAK HOUR SOUTHBOUND

**Passenger Loadings - Peak Hour (Individual Trains)
PM Peak Southbound**

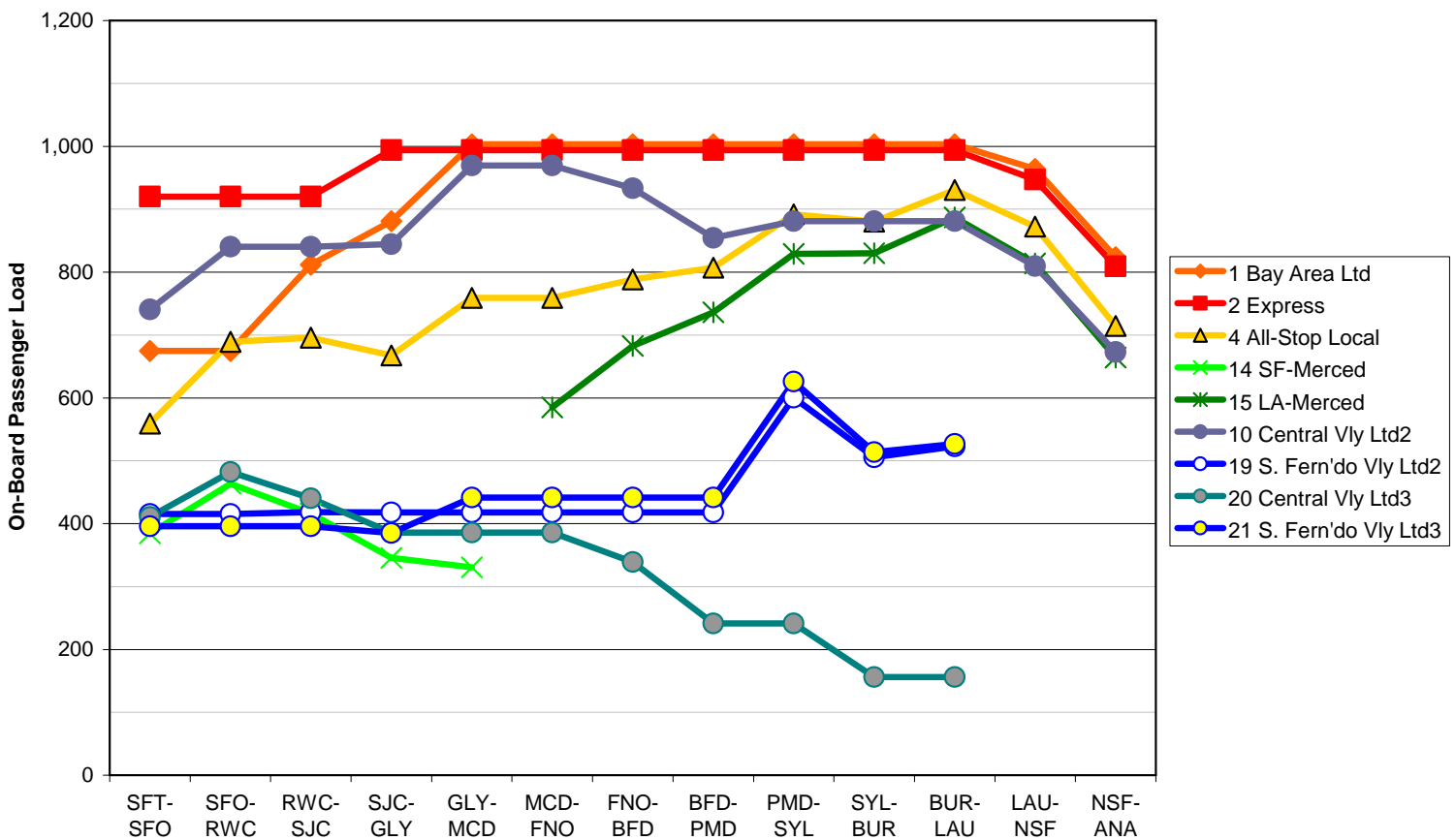


FIGURE 2 – ESTIMATED PASSENGER LOADS IN 2030 – EVENING PEAK SHOULDER HOUR SOUTHBOUND

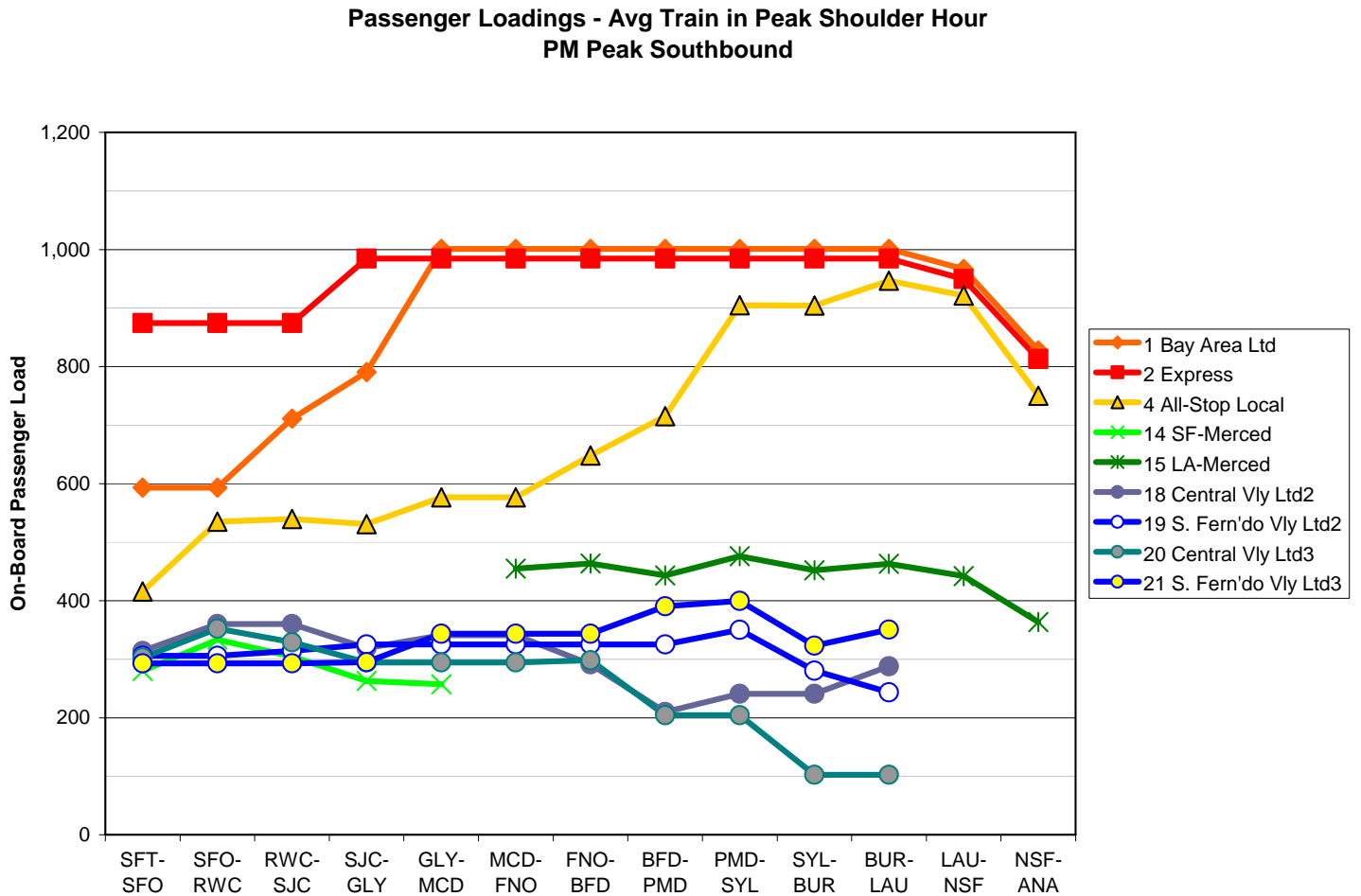


FIGURE 3 – ESTIMATED PASSENGER LOADS IN 2030 – EVENING PEAK HOUR NORTHBOUND

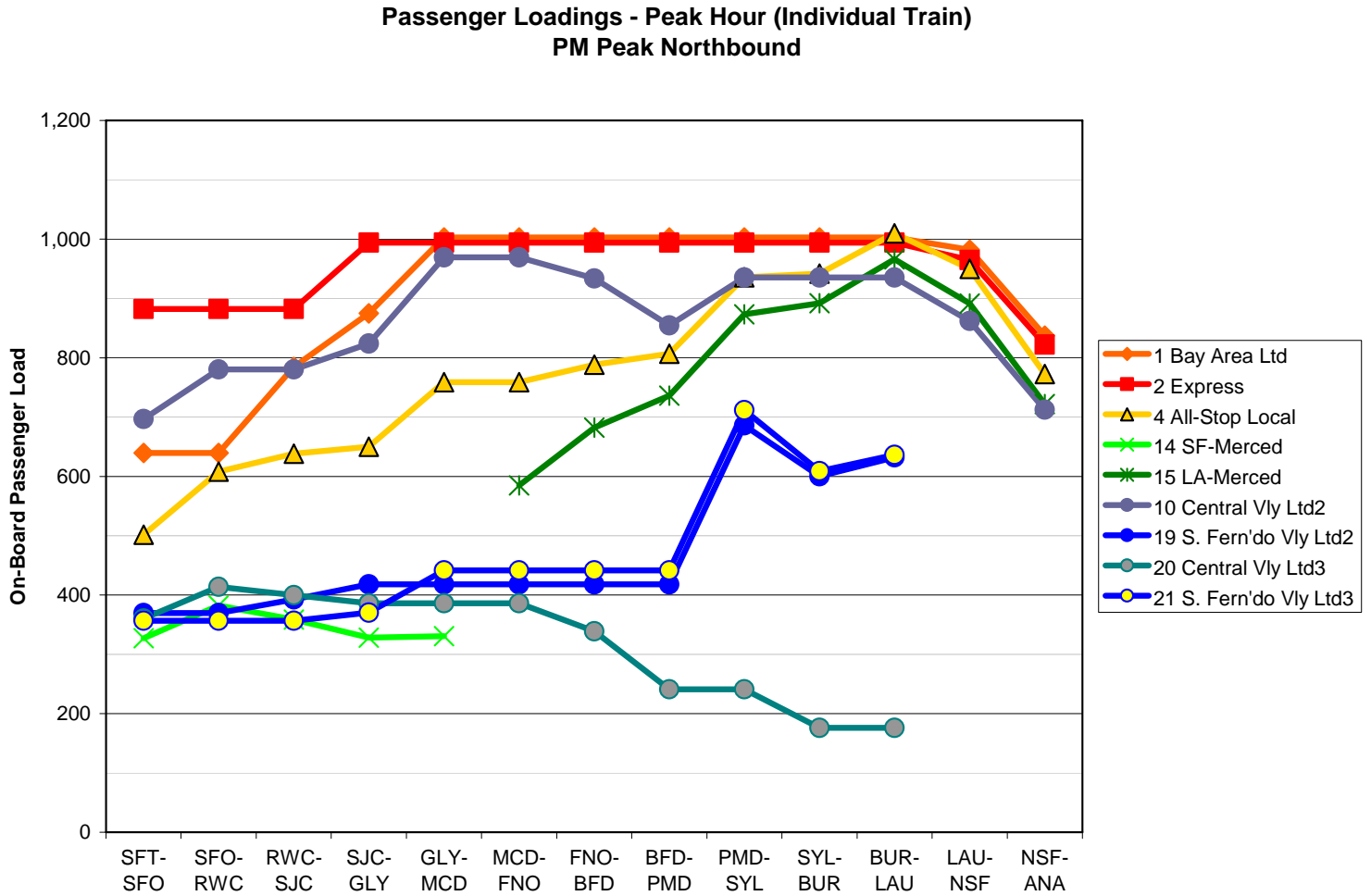


FIGURE 4 – ESTIMATED PASSENGER LOADS IN 2030 – EVENING PEAK SHOULDER HOUR NORTHBOUND

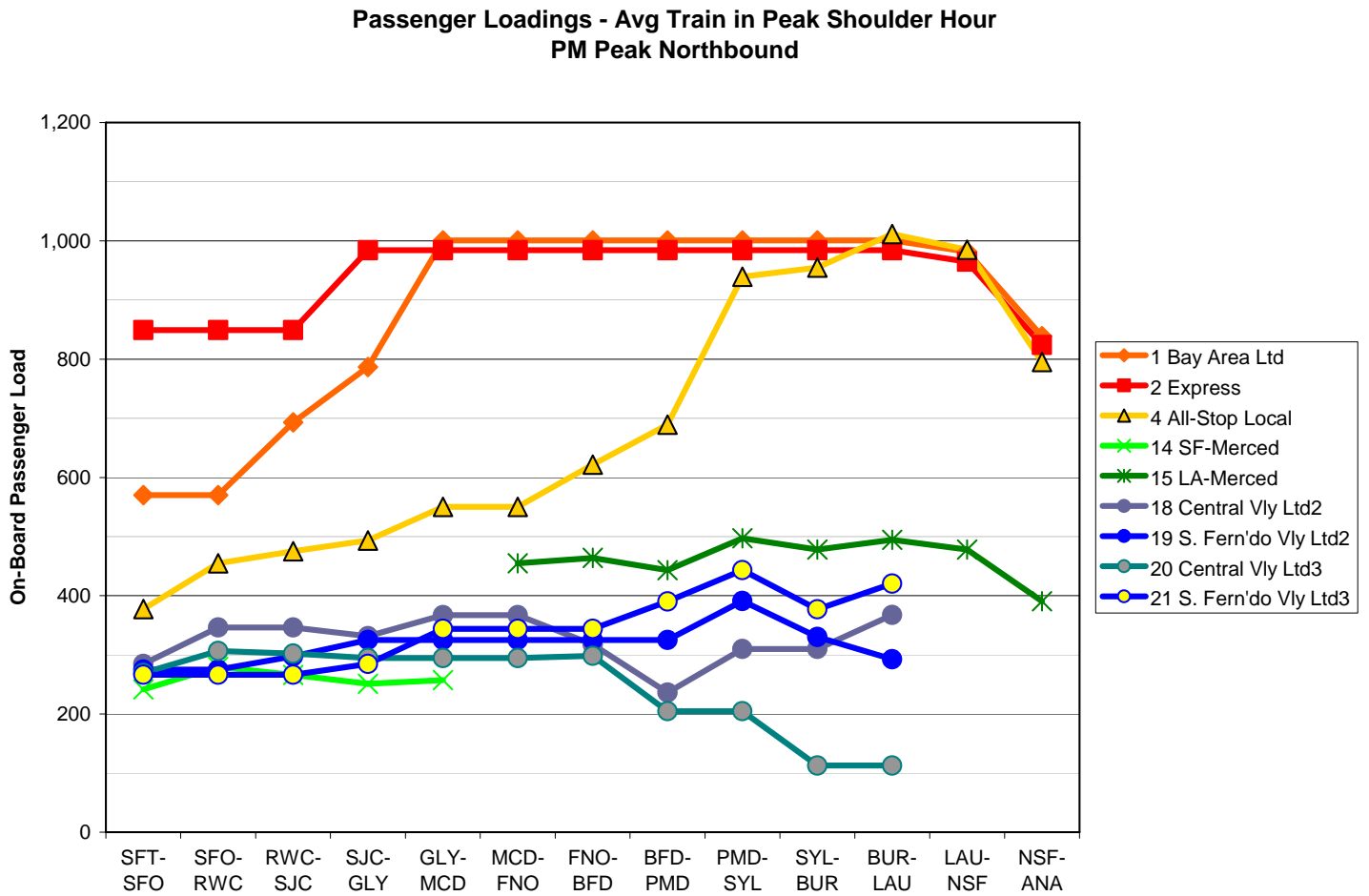
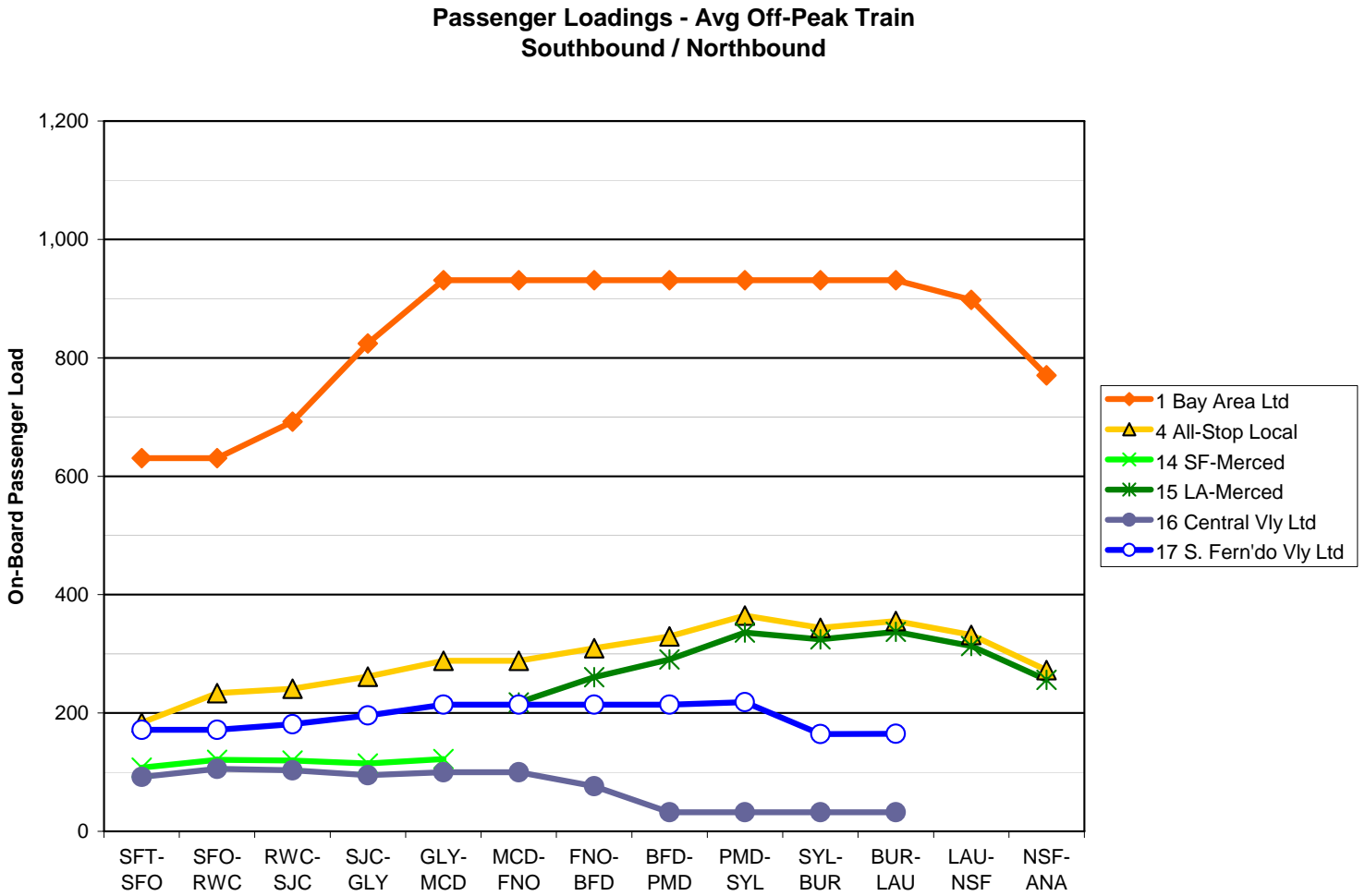


FIGURE 5 – ESTIMATED PASSENGER LOADS IN 2030 – AVERAGE OFF-PEAK



5. FLEET REQUIREMENTS

EQUIPMENT CYCLES

The concept level train schedule presented in Appendix A, which shows 260 daily revenue trains, was analyzed to estimate the number of trainsets based upon the number of 200 m and 400 m trainsets required to meet forecasted 2030 demand. Trains arriving at a terminal station are assumed to lay over at the platform for a certain period of time, for passenger alighting train servicing/inspection and passenger boarding, then depart in the opposite direction as the next available departing revenue train. This analysis generally adhered to the minimum terminal layover times presented in Table 2. In certain cases, shorter layover times were assumed in order to keep the number of trainsets to a reasonable minimum and to avoid inordinately long layovers, which would occupy terminal station or yard tracks for extended periods of time. Except during the late evening time period, train sets are generally available at the SFT and ANA terminals to provide “protection” for short connections from potentially delayed trains. These additional equipment sets would be culled from the 400 m local and limited trains operating during the morning peak period that continue during the mid-day period as 200 m trains. The train turns at the endpoint terminals are balanced during the mid-day and late evening off-peak hours. During the peaks, additional directional service is offered, so a relatively small number of trains are designated for mid-day yard storage in lieu of making a revenue turn.

Most trainsets are able to make 3-4 trips between the Bay area and Los Angeles basin over the course of a service day. Selected trains (one per hour each way) operate to and from Merced. At Merced, these trains then turn for the next available train operating towards the alternate terminal (i.e., a San Francisco-Merced train will lay over at Merced and turn for a Merced-Anaheim train).

REVENUE TRAINSETS

A “baseline” total of sixty five (65), 200 m trainsets were estimated to operate the 260 daily train schedule in revenue service. An additional twenty-nine (29), 200m sets are required to “fill out” the 400m trainsets that serve the peak periods (and all-day express services), as shown in Table 10.

TABLE 10 – 200M TRAIN SECTIONS NEEDED TO “FILL OUT” 400M TRAINS

Bay Area Limited	9
Express	6
All-Stop Local	6
Anaheim-LA-Merced	2
Central Valley Limited	2
San Fernando Valley Limited	4
Total	29

6. TRAIN STORAGE REQUIREMENTS

The number of trainsets estimated to be stored at each terminal location during both the overnight period and the mid-day off-peak period was calculated for the Phase 1 service plan based on the Phase 1 equipment cycles. The sixty five (65) revenue trainset consists required for Phase 1, includes thirty-six (36) 200m trainsets and twenty-nine (29) 400m trainsets, were distributed among the four terminals for overnight storage as follows:

TABLE 11 – OVERNIGHT TRAIN STORAGE REQUIREMENTS

(Revenue Trainsets)

Location	200 m Sets	400 m Sets	Total Trainsets	200 m Equivalents	400 m Yard Tracks*
San Francisco	14	[13] 4 BayArea Ltd 3 Express 2 SF Vly Ltd 1 CenVly Ltd 3 All-Stop	27	40	20
Los Angeles	13	[2] 2 SF Vly Ltd	15	17	9
Anaheim	4	[13] 5 BayArea Ltd 3 Express 1 CenVly Ltd 3 All-Stop 1 LA-Merced	17	30	15
Merced	5	[1] 1 LA-Merced	6	7	4
Total	36	29	65	94	48

* Additional tracks will be required at most locations for train maneuvering and to support required maintenance functions. Allowances for extensions to Sacramento and San Diego to satisfy full system needs are not included and will be added later at the conclusion of the Sacramento and San Diego extensions Study which will follow this analysis and report.

The overnight train storage requirements influence the sizes of the required storage yards capacities significantly. Train storage yards can be configured in several different ways, depending upon the size and shape of the available property for yard storage. Yards could be configured as a series of double-ended 400m tracks capable of storing either one 400m train or two 200m trains. Or, yards could comprise a combination of 400m and 200m long tracks. The storage yards are assumed to be located in reasonable proximity to the terminal stations, to minimize the extent of non-revenue or “deadhead” train movements, although the yards do not need to be immediately adjacent to the stations. Detailed operations analysis of the terminal stations, storage yards and connecting trackage have not yet been performed but are planned to be undertaken at a future stage of project development. Utilization of tracks in terminal stations to supplement overnight storage capacity will be examined during this analysis.

All sixty five trainset consists are forecasted to be in active revenue during both the morning and afternoon peak periods. The mid-day off-peak train schedule (between approximately 11:00 AM and 3:00 PM) can be operated with fifty-eight revenue trainsets. The remaining seven trainsets (all 400m long) will be stored in the terminal and yards, along with an additional thirteen (13) 200m sets culled from trains that need to be 400m long to meet peak demand but which can be reduced to 200m long during the mid-day period to reduce the quantity of off-peak empty seat-mileage. The number of required mid-day storage tracks, by location, is presented in the following table.

TABLE 12 – MID-DAY TRAIN STORAGE REQUIREMENTS

(Revenue Trainsets)

Location	200 m Extra Sets	400 m Sets	Total Trainsets	200 m Equivalents	400 m Yard Tracks
San Francisco	[6] 2 SF Vly Ltd 1 CenVly Ltd 3 All-Stop	[3] 3 Express	9	12	6
Los Angeles	2 SF Vly Ltd		2	2	1
Anaheim	[4] 3 All-Stop 1 LA-Merced	[4] 3 Express 1 CenVly Ltd	8	12	6
Merced	1 LA-Merced	--	1	1	1
Total	13	7	20	27	14

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APPENDICES – PHASE 1 SERVICE PLAN CHARACTERISTICS

[A] BASE, WITH 7.0% RECOVERY TIME ALLOWANCE

To develop the base Phase 1 conceptual service plan and hypothetical train schedules, trains were applied to the schedule in the following sequence:

1. San Francisco-Los Angeles-Anaheim Bay Area Limited service (Pattern #1) - (SFT-RWC-SJC-GLY-LAU-NSF-ANA)
 - Clockface departures on the hour southbound from SFT, with first departure at 5:00 AM and last departure at 9:00 PM
 - Clockface hourly departures northbound, from ANA at :35 and departing LAU at :00, with first departure at 4:35 AM and last departure at 8:35 PM
2. San Francisco-Los Angeles Express service (Pattern #2) - (SFT-SJC-LAU)
 - Service provided only during the 3-hour morning and afternoon business travel peaks, one train per hour in each direction in each peak period
 - Clockface departures on the half hour southbound from SFT and northbound from LAU, with morning departures at approximately 5:30 AM, 6:30 AM and 7:30 AM and afternoon departures from Los Angeles at approximately 3:30 PM, 4:30 PM and 5:30 PM, and from Anaheim at :05 past the hour.
 - These trains are assumed to operate to Anaheim in Phase 1, in order to spread the peak period demand between the Bay Area and Anaheim among a greater number of trains.
3. San Fernando Valley Ltd. (Patterns #19 and #21 peak, #17 off-peak) – Limited stop service between San Francisco and L.A., stopping at San Fernando Valley stations and generally bypassing Central Valley stops
 - 30-minute headways in both directions of travel all day long
 - Off-peak, southbound departures from SFT at :03 and :33; northbound departures from LAU at :10 and :40
 - Service operates without being overtaken
 - Service tapers after 7:00 pm
4. Central Valley Ltd. (Patterns #18 and #20 peak, #16 off-peak) – Limited stop service between San Francisco and L.A. stopping at Fresno and Bakersfield and making limited stops within the San Fernando Valley
 - 30-minute headways in both directions of travel all day long
 - Off-peak, southbound departures from SFT at :08 and :38; northbound departures from LAU at :03 and :33
 - During off-peak hours, service operates without being overtaken
 - During peak hours, one of the two trains in each hour is overtaken in each direction (southbound at Fresno, northbound at Gilroy)
 - Peak train in each peak period operates to/from Anaheim (ANA) to provide additional required seating capacity at the height of the peak at Anaheim.

- Service tapers after 7:00 pm
5. All-stop service, to ensure direct train service connectivity among all possible station pairs (Pattern #4)
 - Hourly service with clockface departure times, San Francisco to Anaheim all day long (Pattern #4, SFT-SFO-RWC-SJC-GLY-FNO-BFD-PMD-SYL-BUR-LAU-NSF-ANA)
 - Southbound trains depart SFT at :14
 - Northbound trains depart Anaheim (ANA) at :52, except during AM and PM business travel peaks, when these trains depart ANA at :46
 - During off-peak hours, the All-Stop trains are overtaken once per trip by limited stop trains, southbound at Bakersfield and northbound at Palmdale
 - During business travel peaks, southbound trains are overtaken twice, by the Super Express service, at Gilroy and by a limited stop train at Fresno; northbound All-Stop trains are overtaken once, at Bakersfield.
 6. Anaheim-Los Angeles-Merced local service (Pattern #15)
 - Hourly service with clockface departure times, San Francisco to Merced making all intermediate stops (MCD-FNO-BFD-PMD-SYL-BUR-LAU-NSF-ANA)
 - Off-peak trains depart Merced southbound at :02 and depart Anaheim northbound at :20.
 - Peak period trains have slightly different departure times on account of different overtake patterns: southbound from Merced at :19 and northbound from Anaheim at :19.
 - Provides for equipment rotations to/from storage and maintenance facility at Merced
 - These trains could be extended in the system expansions to Sacramento and San Diego
 - During off-peak times, these trains are overtaken by two closely-spaced express trains – northbound at Palmdale and southbound at Bakersfield (extra 6 minutes of dwell time)
 - During business travel peaks, southbound trains have the same double overtake at Bakersfield, and northbound trains are overtaken twice – at Palmdale and Fresno.
 7. San Francisco-Merced local service (Pattern #14)
 - Hourly service with clockface departure times, San Francisco to Merced making all intermediate stops (SFT-SFO-RWC-SJC-GLY-MCD)
 - Southbound trains depart SFT at :47; northbound trains depart Merced at :37
 - Provides for equipment rotations to/from storage and maintenance facility at Merced
 - These trains could be extended in the system expansions to Sacramento and San Diego
 - The relatively short distance of operation for this train on the San Francisco-Los Angeles network makes it easier to “slot in” around other trains without triggering an overtake – hence its position at the end of the priority sequence.

A hypothetical daily timetable for this service plan is presented in Appendix A1. This same schedule is presented in stringline (time-distance) diagram format in Appendix A2. Equipment cycles and the patterns of movement of each trainset throughout the day are documented in Appendix A3.

A1. Hypothetical Timetable

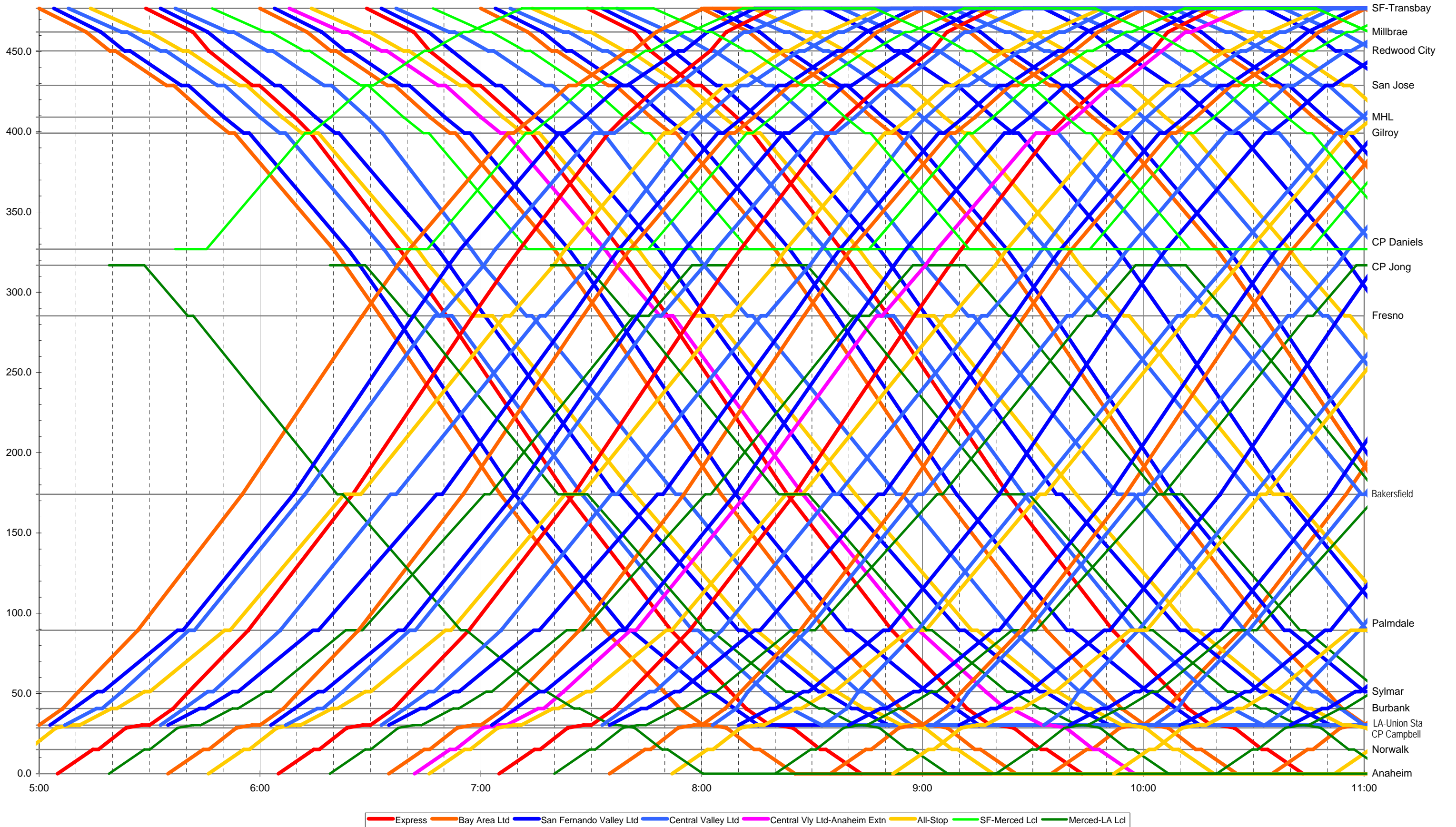
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A2. Stringline Diagrams

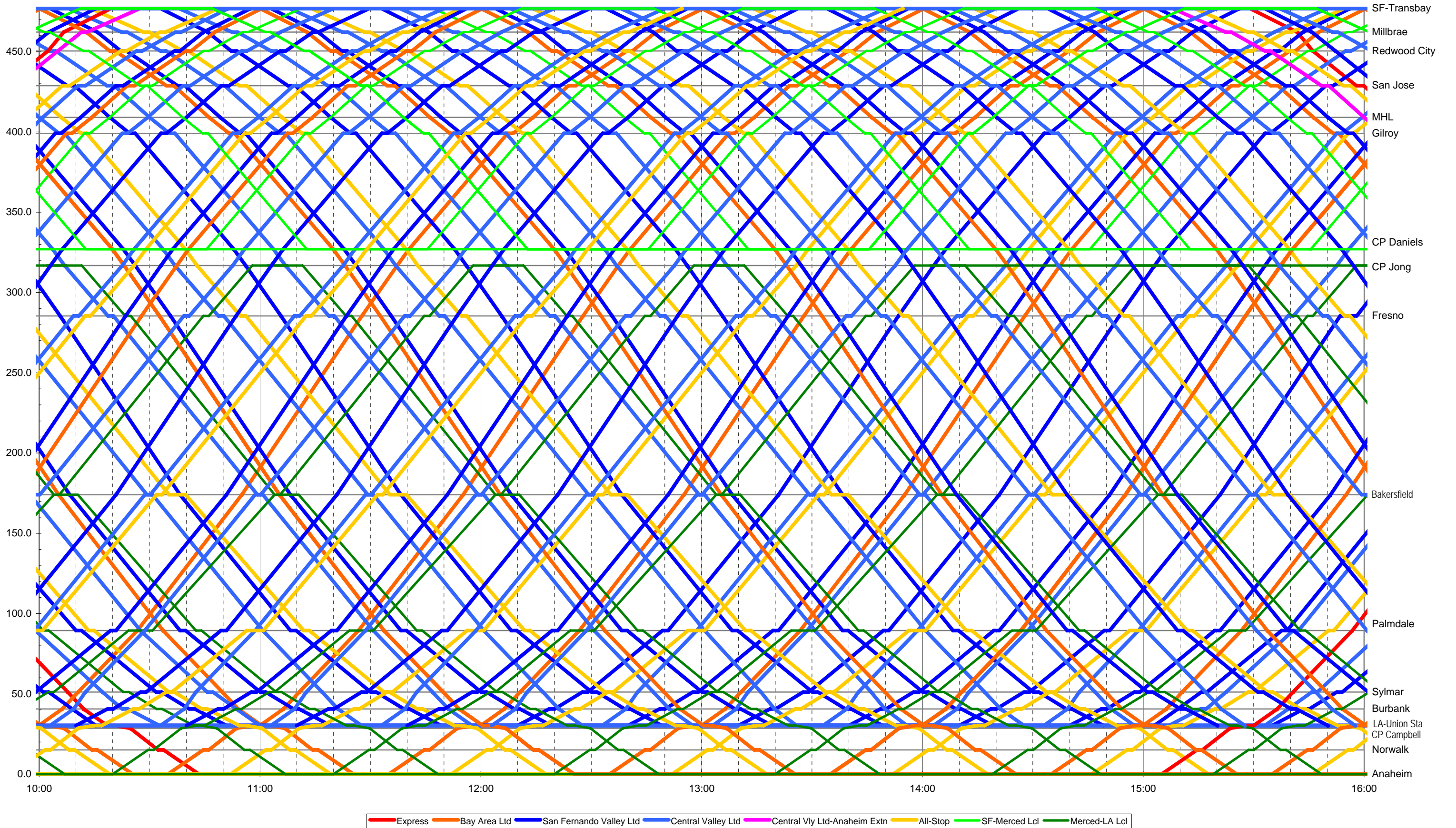
- Morning Peak Period
- Mid-Day Period
- Afternoon Peak Period
- Evening and Late Night Period

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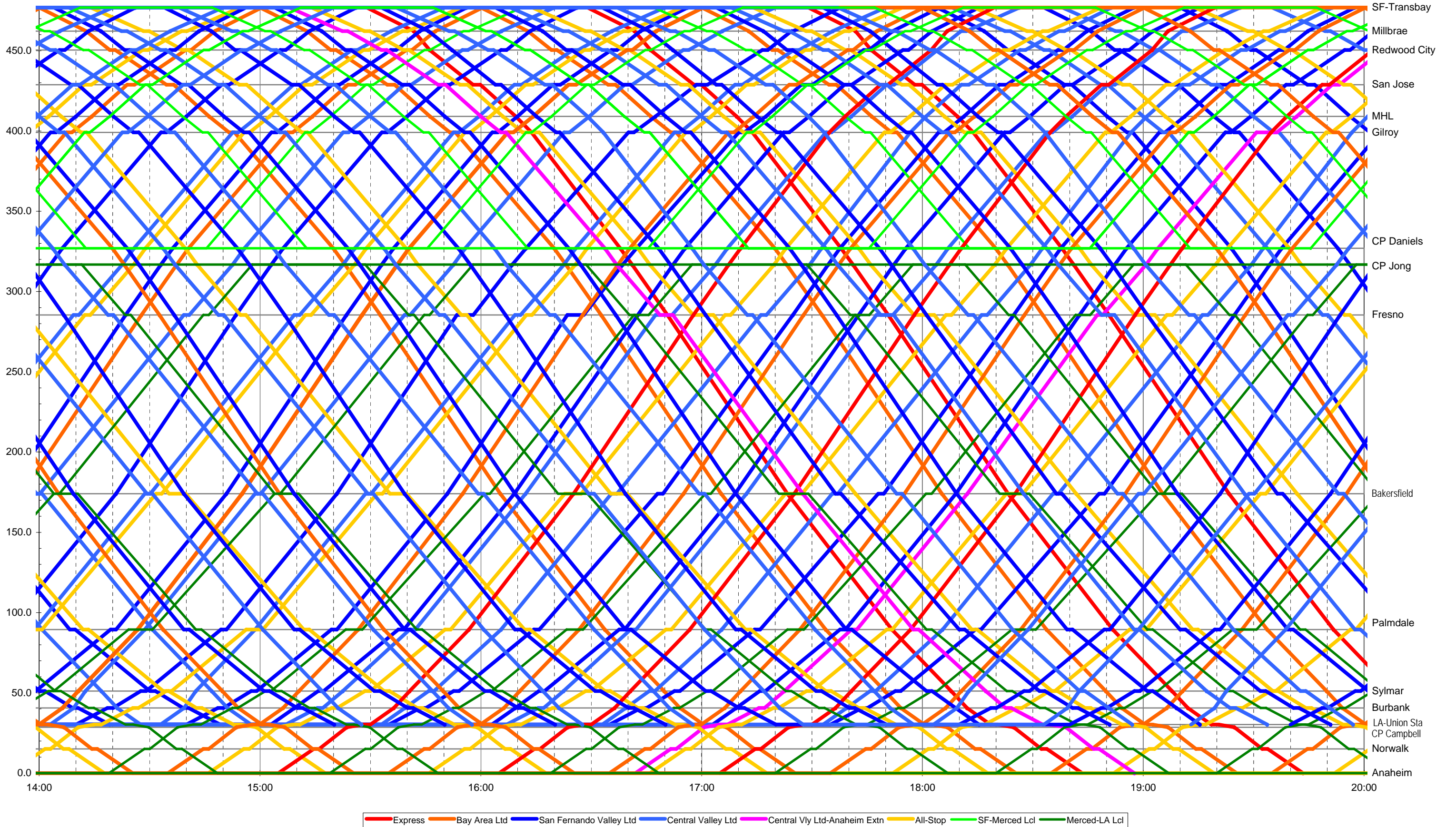
Appendix A2 - HST PHASE 1 SERVICE PLAN - BASE (Version 10) - MORNING PEAK



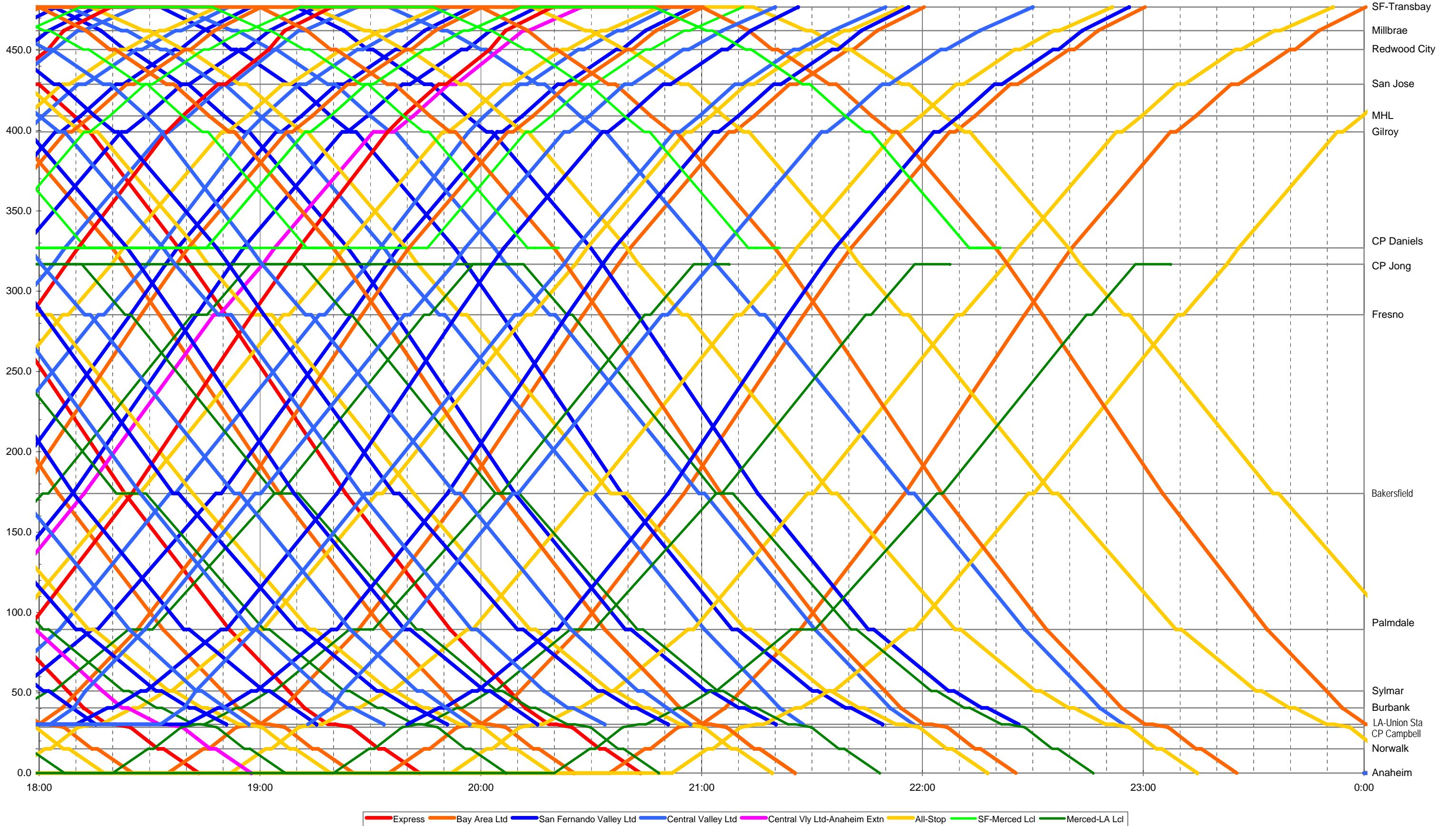
Appendix A2 - HST PHASE 1 SERVICE PLAN - BASE (Version 10) - MID-DAY



Appendix A2 - HST PHASE 1 SERVICE PLAN - BASE (Version 10) - AFTERNOON PEAK



Appendix A2 - HST PHASE 1 SERVICE PLAN - BASE (Version 10) - LATE EVENING



A3. Equipment Cycles

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**CALIFORNIA HIGH SPEED RAIL
APPENDIX A3 -- EQUIPMENT CYCLES -- PHASE 1 BASE SERVICE PLAN (Version 10)**

ID	OverkScheme	Dir	Set	Set2	Consist	Train No.	Pattern	Train Type	Orig	OrigTime	Dest	DestTime	RunTime	MinLay	Avail	Layover	Excess	DestArr	DestDep	T	TrnMi	200m SetMi	Wkend	Yd
205	Reg	NB	M6			N171340	17	S.Fernando Vly. Ltd	LAU	13:40	SFT	16:56	3:16	30	17:26	0:37	7	16:56	17:33		446.6	446.6	446.6	
109	Peak O/T	SB	M6			S211733	21	S.Fernando Vly. Ltd	SFT	17:33	LAU	20:51	3:18	40	21:31	--	--	20:51	--		446.6	446.6	446.6	

*Additional 200m trainsets available for these equipment turns ←

Totals 2,037 106211 140405 83760

	<u>Weekday</u>	<u>Weekend</u>
Days/yr	250	115
Ann miles	35101	9632
Ann miles	44,734	

[B] – VARIATION, WITH 1.0-3.5% RECOVERY TIME ALLOWANCE

Appendix B presents the characteristics of a variation of the California High-Speed Train (HST) Phase 1 Service Plan, which assumes a lower and more aggressive allowance for schedule pad or recovery time, consistent with the intent of the HST system to operate at a very high level of precision. In this variation of the service plan, the express services operating between San Francisco and Los Angeles with one intermediate stop at San Jose would have a scheduled run time of 2 hours and 40 minutes, with a recovery time allowance of one percent. All other trains in this variation of the plan would have a recovery time allowance of three and one half percent.

In this version of the service plan, the train stopping patterns, hours of service, and service frequencies were kept essentially the same as that of the base service plan described in Appendix A. Certain changes were made to the assumptions and general principles to allow for the marginally faster travel times estimated for the “express” trains:

- Recovery time incorporated in the end-to-end train running times was reduced from 7 percent to 1 percent for “express” trains and to 3.5 percent for all other train types
- The minimum headway between trains following each other past a given point was kept at 3 minutes except for sections north of San Jose and near each terminal location, which includes San Francisco-Transbay, Los Angeles Union Station, Anaheim, and Merced stations, because it was assumed that the rate in which trains would arrive and depart these locations could support a minimum headway of no less than 2 minutes.
- In addition to the standard 1 to 3.5 percent recovery time applied to all trains, additional recovery was added to certain trains to adjust the running time so as to avoid the overtakes and to maintain the minimum spacing between trains. This is described in more detail in the *New Service Sequence* section of this memorandum.
- To further reduce the estimated travel time, station dwell times at intermediate stops were reduced from two minutes to 90 seconds at San Jose and Los Angeles Union Station, and from 90 seconds to 75 seconds at all other intermediate stops.
- While the original baseline timetable presented clock face scheduling, the reduction of the amount of recovery time in this iteration resulted in departure times that do not allow for maintaining the clock face structure as long as the stopping patterns of each service type are kept the same as in the baseline timetable.

This variation of the Phase 1 service plan for the initial operating segment between Anaheim, Los Angeles and San Francisco was composed of the following train types and service patterns:

1. San Francisco-Los Angeles-Anaheim “Express” service (Pattern #1)
 - Clockface departure on the hour southbound from San Francisco between 5:00 AM and 9:00 PM
 - Clockface hourly departures northbound from Anaheim at 35 minutes past the hour, and departures from Los Angeles at the “top of the hour”.
 - During the peak period, northbound departures at Los Angeles were changed to 59 minutes past the hour to create time slots for local and limited-stop trains in order to minimize the overtakes.

2. San Francisco-Los Angeles-Anaheim “Express” service (Pattern #2)
 - Southbound trains depart San Francisco at 5:30 AM, 6:30 AM, 7:30 AM, 3:30 PM, 4:30 PM, and 5:30 PM.
 - Northbound trains depart Anaheim at 5:05 AM, 6:05 AM, 7:05 AM, 3:05 PM, 4:05 PM, and 6:05 PM so that the trains can depart Los Angeles at the “bottom” (:30) of the hour.
3. San Fernando Valley Off-peak Limited – Limited stop service between San Francisco and Los Angeles stopping at stations in the San Fernando Valley and the Santa Clara/Silicon Valley area, while generally bypassing Central Valley stations (Pattern #17)
 - 30-minute headways in both direction for travel between 8:00 AM and 3:00 PM, and again between 6:00 PM and 9:00 PM.
 - Southbound departure from San Francisco at :03 and :33 of the hour; northbound departure from Los Angeles at :10 and :40 of the hour.
 - No overtakes occur en route
 - Two northbound trips, departing Los Angeles at 8:10 AM and 9:10 AM, provide service to the Milbrae station.
 - Northbound trains departing Los Angeles at :40 of the hour reduce speed between Palmdale and Bakersfield to increase travel time by 2 minutes in order to minimize the dwell time of local trains overtaken at Bakersfield.
 - Reduced service to 60-minute headways after 7:00 PM
4. San Fernando Valley Peak Limited – Peak-only Limited stop service between San Francisco and Los Angeles stopping at stations in the San Fernando Valley and the Santa Clara/Silicon Valley area, while generally bypassing Central Valley stations (Patterns #19 and 21).
 - Two trains per hour per direction with combined 28 to 32 minute headways during the peak period.
 - Southbound departures from San Francisco at :03 of the hour (Pattern #19) and :33 of the hour (Pattern #21); Northbound departures from Los Angeles at :03 of the hour (Pattern #19) and :35 of the hour (Pattern #21)
 - No overtakes occur en route
5. Central Valley Off-peak Limited – Limited stop service between San Francisco and Los Angeles stopping at all stations north of Bakersfield while skipping all San Fernando Valley stations (Pattern #16).
 - 30-minute headways in both directions for travel between 8:00 AM and 3:00 PM, and again between 6:00 PM and 9:00 PM.
 - Southbound departure from San Francisco at :08 and :38 of the hour; northbound departure from Los Angeles at :03 and :33 of the hours
 - No overtakes occur en route

- Southbound trains departing San Francisco at :08 of the hour reduce speed between Bakersfield and Los Angeles to increase travel time by 5 to 10 minutes in order to avoid an overtake.
 - Reduced service to 60-minute headways after 7:00 PM
6. Central Valley Peak Limited – Limited stop service between San Francisco and Los Angeles stopping at all stations in the Central Valley and the north while making limited stops in the San Fernando Valley (Patterns #10, 18, and 20)
- Two trains per hour per direction with 28 to 32 minute headways during peak period
 - Southbound departure from San Francisco at :08 of the hour (Pattern #10/18) and :39 of the hour (Pattern #20); Northbound departure from Los Angeles at :06 of the hour (Pattern #10) or :07 of the hour (Pattern #19) and :33 of the hour (Pattern #21)
 - Two roundtrips in each direction are extended to Anaheim
 - Southbound trains departing San Francisco at :08 of the hour are overtaken by Express trains (Pattern #2) at Fresno
 - Northbound trains departing Los Angeles at :06 or :07 of the hour are overtaken by Express trains (Pattern #2) at Fresno
 - Some southbound trains reduce speed between Bakersfield and Los Angeles in order to avoid an overtake.
7. Local service, making all stops between San Francisco and Anaheim (Pattern #4)
- All day, hourly service with semi-clockface schedule.
 - Southbound departure from San Francisco at :14 of the hour during peak period, :15 of the hour during off-peak period; northbound departure from Anaheim at :46 of the hour during peak period, :40 of the hour during off-peak period (departure at Los Angeles at :10 and :06 of the hour, respectively)
 - During the peak period, southbound trains are overtaken twice by Express trains (Pattern #2) at Gilroy and by San Fernando Valley Limited trains at Fresno; while northbound trains are overtaken once by Express trains (Pattern #2) at Bakersfield
 - During off-peak period, both southbound and northbound trains are overtaken once by San Fernando Valley Limited trains at Bakersfield
 - All trains during mid-day period are overtaken once by San Fernando Valley Limited trains at Bakersfield
8. Merced-Los Angeles Local (Pattern #14)
- All day, hourly service with semi-clockface schedule
 - Southbound departure from Merced at :05 of the hour throughout the day; northbound departure from Anaheim at :17 of the hour during peak period, :12 of the hour during off-peak period (departure at Los Angeles at :41 and :36 of the hour, respectively)

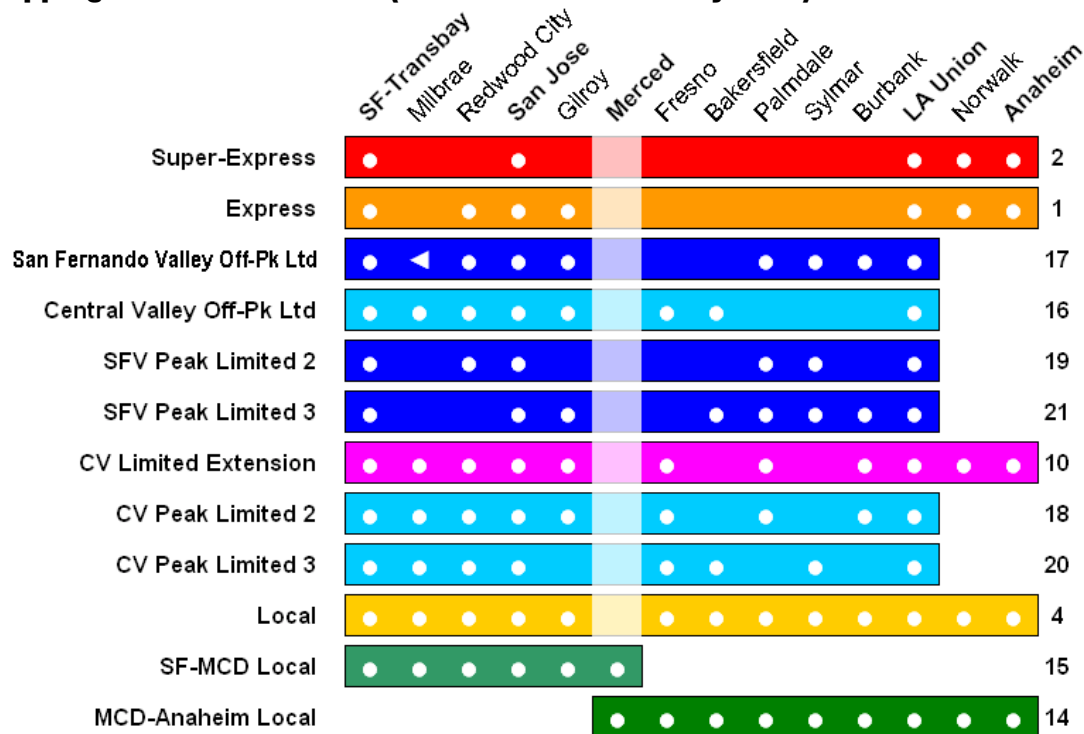
- During peak period, southbound trains have overtakes by Express (Pattern #1) and San Fernando Valley Limited trains at Fresno and Express trains (Pattern #2) at Bakersfield while northbound trains are overtaken once by Express trains (Pattern #1) at Bakersfield
- During off-peak periods, all trains have overtakes: (by San Fernando Valley Limited and Express trains (Pattern #1); northbound at Bakersfield and southbound at Fresno)
- Southbound trains arrive at Los Angeles Union Station before the following Central Valley Limited trains

9. San Francisco-Merced local service (Pattern #15)

- All-day, hourly service with semi-clockface schedule
- Southbound departure from San Francisco at :47 of the hour throughout the day; northbound departure from Merced at :34 of the hour during peak period and :37 of the hour during off-peak period
- No overtakes occur en route

Stations served by each stopping pattern are illustrated in the chart provided below:

Stopping Pattern in Revised (with reduced recovery time) Phase 1 Service Plan



Note: Trains make a stop at station with white circle; ◀: Special stop (northbound only).

This schedule variation provides a total of 260 revenue trips, the same number of trips assumed in the base plan. Since both service plans follow the same planning principles, the breakdown of the levels of service in each time period of the day is identical between them. This is illustrated in the revised timetable and time-distance chart presented in the Appendices B1 and B2.

As a result of reducing the recovery and station dwell times, it is estimated that Express trains (Pattern #2) can complete the travel between San Francisco and Los Angeles within 2 hours and 40 minutes. This reduction in the recovery and dwell times also improves the travel time of most of the projected 260 revenue trips in this service plan.

A hypothetical daily timetable for this service plan is presented in Appendix B1. This same schedule is presented in stringline (time-distance) diagram format in Appendix B2. Equipment cycles and the number of required trainsets will be the same in this scenario as in the base plan documented in Appendix A3, so a separate analysis of equipment cycles is not shown for the service plan variation.

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B1. Hypothetical Timetable

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CALIFORNIA HIGH-SPEED RAIL
PHASE 1 TIMETABLE

VARIATION SERVICE PLAN

Turns from →

APPENDIX B1

Direction →	Reg	Reg	Mid 1	Reg	Reg	Mid 2	Reg	Reg	Reg	Reg	Mid 1	Reg	Reg	Mid 2	Reg	Reg	Reg	Reg	Mid 1	Reg	Reg	Mid 2	Reg	Reg	Mid 1	Reg	Reg	Mid 2	Reg	Reg	Mid 1	Reg	Reg	Mid 2											
Trainset	62	43	63	42	64	M6	45	61	65	66	47	46	68	44	49	45	69	50	52	51	71	48	54	49	72	73	74	55	75	53	57	54	2	3	6	M1	7	56							
Train No. →	S010900	S170903	S160908	S040915	S170933	S160938	S150947	S141105	S011000	S171003	S161008	S041015	S171033	S161038	S151047	S141205	S011100	S171103	S161108	S041115	S171133	S161138	S151147	S141305	S011200	S171203	S161208	S041215	S171233	S161238	S151247	S141405	S011300	S171303	S161308	S041315	S171333	S161338							
Pattern →	1	17	16	4	17	16	15	14	1	17	16	4	17	16	15	14	1	17	16	4	17	16	15	14	1	17	16	4	17	16	15	14	1	17	16	4	17	16							
Service Type →	Bay Area Limited	S.Fern'do Valley Limited	Central Valley Limited	All-Stop Local	S.Fern'do Valley Limited	Central Valley Limited	S.F. - Merced Local	L.A. - Merced Local	Bay Area Limited	S.Fern'do Valley Limited	Central Valley Limited	All-Stop Local	S.Fern'do Valley Limited	Central Valley Limited	S.F. - Merced Local	L.A. - Merced Local	Bay Area Limited	S.Fern'do Valley Limited	Central Valley Limited	All-Stop Local	S.Fern'do Valley Limited	Central Valley Limited	S.F. - Merced Local	L.A. - Merced Local	Bay Area Limited	S.Fern'do Valley Limited	Central Valley Limited	All-Stop Local	S.Fern'do Valley Limited	Central Valley Limited	S.F. - Merced Local	L.A. - Merced Local	Bay Area Limited	S.Fern'do Valley Limited	Central Valley Limited	All-Stop Local	S.Fern'do Valley Limited	Central Valley Limited							
Mile	0.0	14.7	26.4	48.0	77.7	187.5	191.5	302.8	387.4	425.7	436.3	446.6	461.8	476.9																															
Station	S.F.-Transbay	Millbrae	Redwood City	San Jose	Gilroy	Merced	Fresno	Bakersfield	Palmdale	Sylmar	Burbank	L.A. Union Sta.	Norwalk	Anaheim																															
Dep	9:00	9:03	9:08	9:15	9:33	9:38	9:47	10:00	10:03	10:08	10:15	10:33	10:38	10:47	11:00	11:03	11:08	11:15	11:33	11:38	11:47	12:00	12:03	12:08	12:15	12:33	12:38	12:47	13:00	13:03	13:08	13:15	13:33	13:38											
Arr												11:05	11:25	12:05	12:42	13:12	14:14	15:14	16:14	16:22	16:35	16:46	17:00	17:10	17:21	17:29																			
Available →	12:57	12:51	13:05	13:50	13:21	13:29	11:57	14:26	13:57	13:51	14:05	14:50	14:21	14:29	12:57	15:26	14:57	14:51	15:05	15:50	15:21	15:29	13:57	16:26	15:57	15:51	16:05	16:50	16:21	16:29	14:57	17:26	16:57	16:51	17:05	17:50	17:21	17:29							

Turns from →

Direction →	Reg	Reg	Reg	Shoulder	Reg	Reg	Mid 2	Reg	Reg	Reg	Reg	Reg	Reg	Mid 2	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg									
Trainset	53	NB 2	NB M1	NB 3	NB 6	NB 1	NB 7	NB 5	NB 56	NB 10	NB M2	NB 4	NB 14	NB 9	NB 15	NB 13	NB 1	NB 18	NB M5	NB 19	NB 22	NB 17	NB 23	NB 21	NB 9	NB M3	NB 8	NB 26	NB 41	NB 25	NB M4	NB 16	NB 17	NB 43	NB 27	NB 63	NB 64	NB 62									
Train No. →	N151037	N160903	N040842	N170910	N160933	N140912	N170940	N010935	N151137	N161003	N040942	N171010	N161033	N141012	N171040	N011035	N151237	N161103	N041042	N171110	N161133	N141112	N171140	N011135	N151337	N161203	N041142	N171210	N161233	N141212	N171240	N011235	N151437	N161303	N041242	N171310	N161333	N141312									
Pattern →	15	16	4	17	16	14	17	1	15	16	4	17	16	14	17	1	15	16	4	17	16	14	17	1	15	16	4	17	16	14	17	1	15	16	4	17	16	14									
Service Type →	S.F. - Merced Local	Central Valley Limited	All-Stop Local	S.Fern'do Valley Limited	Central Valley Limited	L.A. - Merced Local	S.Fern'do Valley Limited	Bay Area Limited	S.F. - Merced Local	Central Valley Limited	All-Stop Local	S.Fern'do Valley Limited	Central Valley Limited	L.A. - Merced Local	S.Fern'do Valley Limited	Bay Area Limited	S.F. - Merced Local	Central Valley Limited	All-Stop Local	S.Fern'do Valley Limited	Central Valley Limited	L.A. - Merced Local	S.Fern'do Valley Limited	Bay Area Limited	S.F. - Merced Local	Central Valley Limited	All-Stop Local	S.Fern'do Valley Limited	Central Valley Limited	L.A. - Merced Local	S.Fern'do Valley Limited	Bay Area Limited	S.F. - Merced Local	Central Valley Limited	All-Stop Local	S.Fern'do Valley Limited	Central Valley Limited	L.A. - Merced Local									
Mile	0.0	15.0	30.3	40.6	51.1	89.4	174.1	285.4	354.4	399.2	428.8	450.5	462.2	476.9																																	
Station	ANA Anaheim	NSF Norwalk	LAU L.A. Union Sta.	BUR Burbank	SYL Sylmar	PMD Palmdale	BFD Bakersfield	FNO Fresno	MCD Merced	GLY Gilroy	SJC San Jose	RWC Redwood City	SFO Millbrae	SFT S.F.-Transbay																																	
Dep				8:42			9:12			9:35			9:42			10:12			10:35			10:42			11:12			11:35			11:42			12:12			12:35			12:42			13:12				
Arr				9:03	9:06	9:10	9:33	9:36	9:40	10:00	10:03	10:06	10:10	10:33	10:36	10:40	11:00	11:03	11:06	11:10	11:33	11:36	11:40	12:00	12:03	12:06	12:10	12:33	12:36	12:40	13:00	13:03	13:06	13:10	13:33	13:36											
Dep	11:12	11:28	11:43	11:53	12:07	12:12	12:17	12:20	12:28	12:34	12:56	12:45	13:04	12:17	13:17	13:20	13:28	13:34	13:56	13:45	14:04	14:17	14:20	14:28	14:34	14:56	14:45	15:04	15:17	15:20	15:28	15:34	15:56	15:45	16:04												
Arr	12:37	12:42	13:05	12:52	13:12	12:38	13:20	13:23	13:37	13:42	14:05	13:48	14:12	13:38	14:20	14:23	14:37	14:42	15:05	14:48	15:12	14:38	15:20	15:23	15:37	15:42	16:05	15:48	16:12	15:38	16:20	16:23	16:37	16:42	17:05	16:48	17:12	16:38									

CALIFORNIA HIGH-SPEED RAIL
PHASE 1 TIMETABLE

VARIATION SERVICE PLAN

Turns from →

APPENDIX B1

Reg	Mid 1	Reg	Reg	Mid 2	Reg	Night O/T	Reg	Reg	Night	Mid 1	Reg	Reg	Night	Reg	Reg	Night				
Turns from →																				
Direction →	SB	SB	SB	SB	SB	SB	SB	SB	SB	SB	SB	SB	SB	SB	SB	SB				
Trainset	42	68	44	61	62	50	66	11	52	46	71	73	74	51	3	20	55			
Train No. →	S171803	S161808	S041815	S171833	S161838	S151847	S142005	S011900	S171910	S041914	S161935	S151947	S012000	S042014	S152047	S012100	S042114			
Pattern →	17	16	4	17	16	15	14	1	17	4	16	15	1	4	15	1	4			
Service Type →	S.Fern'do Valley Limited	Central Valley Limited	All-Stop Local	S.Fern'do Valley Limited	Central Valley Limited	S.F. - Merced Local	L.A. - Merced Local	Bay Area Limited	S.Fern'do Valley Limited	All-Stop Local	Central Valley Limited	S.F. - Merced Local	Bay Area Limited	All-Stop Local	S.F. - Merced Local	Bay Area Limited	All-Stop Local			
Mile	Station																			
0.0 SFT	S.F.-Transbay	Dep	18:03	18:08	18:15	18:33	18:38	18:47			19:00	19:10	19:14	19:35	19:47	20:00	20:14	20:47	21:00	21:14
14.7 SFO	Millbrae	Dep		18:23	18:30		18:53	19:02			---		19:29	19:50	20:02	---	20:29	21:02	---	21:29
26.4 RWC	Redwood City	Dep	18:23	18:33	18:40	18:53	19:03	19:12			19:20	19:30	19:39	20:00	20:12	20:20	20:39	21:12	21:20	21:39
48.0 SJC	San Jose	Dep	18:38	18:48	18:55	19:08	19:18	19:27			19:34	19:45	19:54	20:15	20:27	20:34	20:54	21:27	21:34	21:54
77.7 GLY	Gilroy	Arr																		
		Dep	18:53	19:04	19:11	19:23	19:34	19:43			19:50	20:00	20:10	20:31	20:43	20:50	21:10	21:43	21:50	22:10
187.5 MCD	Merced	Arr																		
		Dep						20:17						21:17			22:17			
191.5 FNO	Fresno	Arr																		
		Dep		19:45	19:52		20:15			20:25			20:30				21:51			22:51
302.8 BFD	Bakersfield	Arr																		
		Dep		20:24	20:30		20:54			21:08			21:13				22:30			23:30
387.4 PMD	Palmdale	Arr																		
		Dep	20:33		21:09	21:03				21:45		21:40	22:03				23:03			0:03
425.7 SYL	Sylmar	Dep	20:54		21:30	21:24				22:06		22:01	22:24				23:24			0:24
436.3 BUR	Burbank	Arr																		
		Dep	21:03		21:38	21:33				22:14		22:10	22:32				23:32			0:32
446.6 LAU	L.A. Union Sta.	Arr	21:11	21:25	21:46	21:41	21:49			22:23	21:53	22:18	22:40	22:52		22:53	23:40		23:53	0:40
		Dep			21:48					22:25	21:55		22:42			22:55	23:42		23:55	0:42
461.8 NSF	Norwalk	Arr			22:00					22:37	22:07		22:55			23:07	23:55		0:07	0:55
476.9 ANA	Anaheim	Arr			22:10					22:46	22:17		23:04			23:17	0:04		0:17	1:04
Available →			21:51	22:05	22:50	22:21	22:29	20:57	23:26	22:57	22:58	23:44	23:32	21:57	23:57	0:44	22:57	0:57	1:44	

Turns from →

APPENDIX B1

Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Reg	Night	Reg	Reg	Night	Night O/T	Reg	Night				
Turns from →																				
Direction →	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB				
Trainset	4	14	M1	15	10	1	2	57	19	M2	18	23	67	5	M3	70	13			
Train No. →	N161803	N171810	N041746	N161833	N141812	N171840	N152034	N011835	N161913	N041855	N141912	N171940	N011935	N041955	N142020	N012035	N042055			
Pattern →	16	17	4	16	14	17	15	1	16	4	14	17	1	4	14	1	4			
Service Type →	Central Valley Limited	S.Fern'do Valley Limited	All-Stop Local	Central Valley Limited	L.A. - Merced Local	S.Fern'do Valley Limited	S.F. - Merced Local	Bay Area Limited	Central Valley Limited	All-Stop Local	L.A. - Merced Local	S.Fern'do Valley Limited	Bay Area Limited	All-Stop Local	L.A. - Merced Local	Bay Area Limited	All-Stop Local			
Mile	Station																			
0.0 ANA	Anaheim	Dep		17:46		18:12				18:35		18:55	19:12		19:35	19:55	20:20	20:35	20:55	
15.0 NSF	Norwalk	Dep		17:56		18:22				18:45		19:05	19:22		19:45	20:05	20:30	20:45	21:05	
30.3 LAU	L.A. Union Sta.	Arr		18:08		18:34				18:56		19:17	19:34		19:56	20:17	20:42	20:56	21:17	
		Dep	18:03	18:10	18:10	18:33	18:36	18:40		19:00	19:13	19:19	19:36	19:40	20:00	20:19	20:44	21:00	21:19	
40.6 BUR	Burbank	Dep		18:19	18:18		18:45	18:49				19:29	19:45	19:49		20:29	20:53		21:29	
51.1 SYL	Sylmar	Dep		18:28	18:19		18:54	18:58				19:37	19:54	19:58		20:37	21:02		21:37	
89.4 PMD	Palmdale	Arr																		
		Dep		18:48	18:28		19:14	19:18				19:58	20:14	20:18		20:58	21:27		21:58	
174.1 BFD	Bakersfield	Arr																		
		Dep	18:58		19:24	19:28	19:55					20:08	20:29	20:55		21:29	21:58		22:29	
285.4 FNO	Fresno	Arr																		
		Dep	19:37		20:03	20:07	20:34					20:47	21:08	21:34		22:08	22:37		23:08	
354.4 MCD	Merced	Arr																		
		Dep					20:58			20:34				21:58			22:57			
399.2 GLY	Gilroy	Arr																		
		Dep	20:18	20:31	20:44	20:48		20:59	21:09	21:04	21:28	21:50		21:59	22:04	22:50		23:04	23:50	
428.8 SJC	San Jose	Dep	20:34	20:47	21:00	21:04		21:15	21:25	21:20	21:44	22:05		22:15	22:20	23:05		23:20	0:05	
450.5 RWC	Redwood City	Arr	20:48	21:00	21:14	21:18		21:28	21:40	21:34	21:58	22:19		22:28	22:34	23:19		23:34	0:19	
462.2 SFO	Millbrae	Arr			21:24			21:50				22:29				23:29			0:29	
476.9 SFT	S.F.-Transbay	Arr	21:12	21:20	21:39	21:42		21:48	22:04	21:53	22:22	22:44		22:48	22:53	23:44		23:53	0:44	
Available →			21:42	21:50	22:09	22:12	21:38	22:18	22:34	22:23	22:52	23:14	22:38	23:18	23:23	0:14	23:37	0:23	1:14	

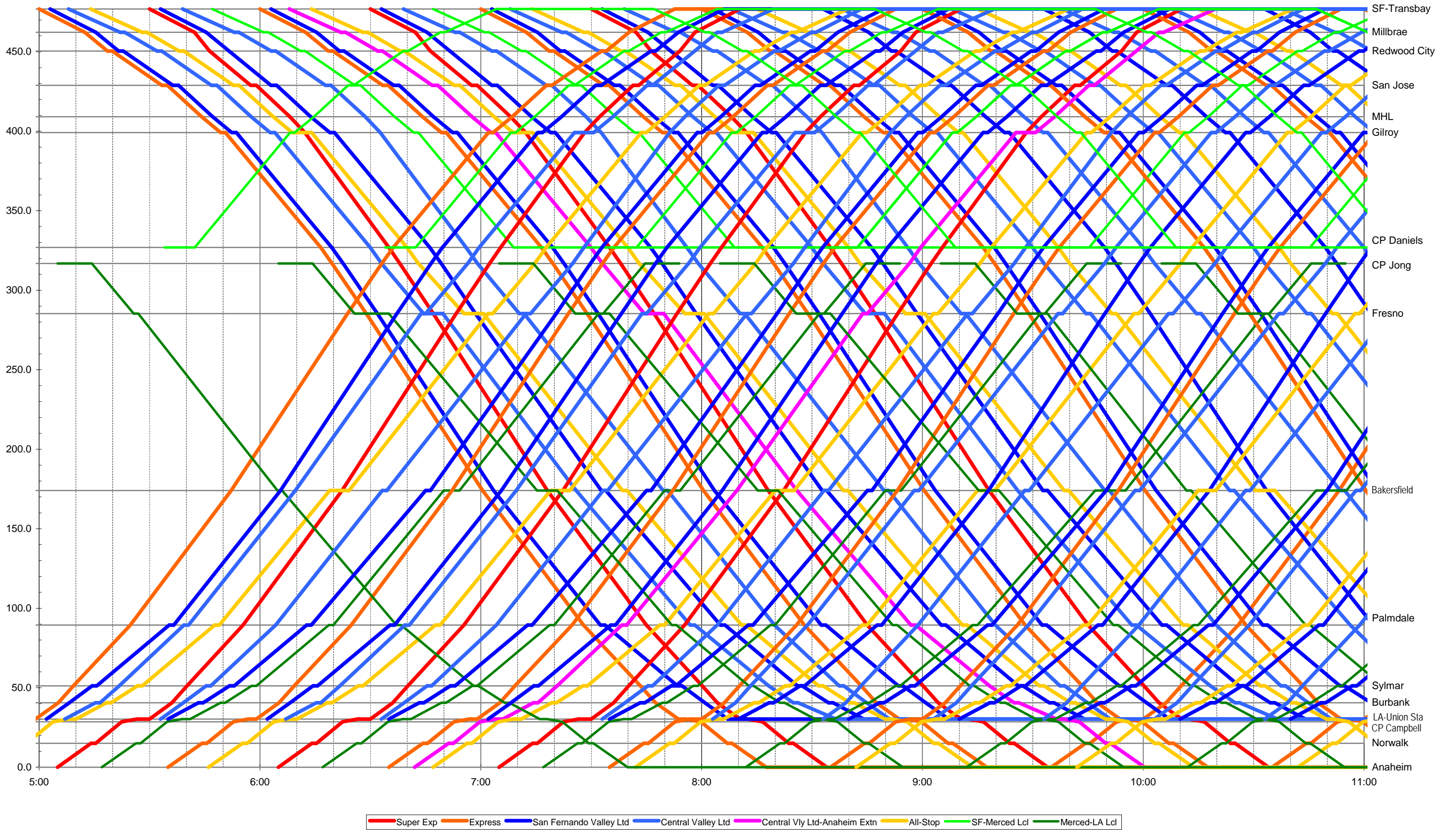
Turns from →

B2. Stringline Diagrams

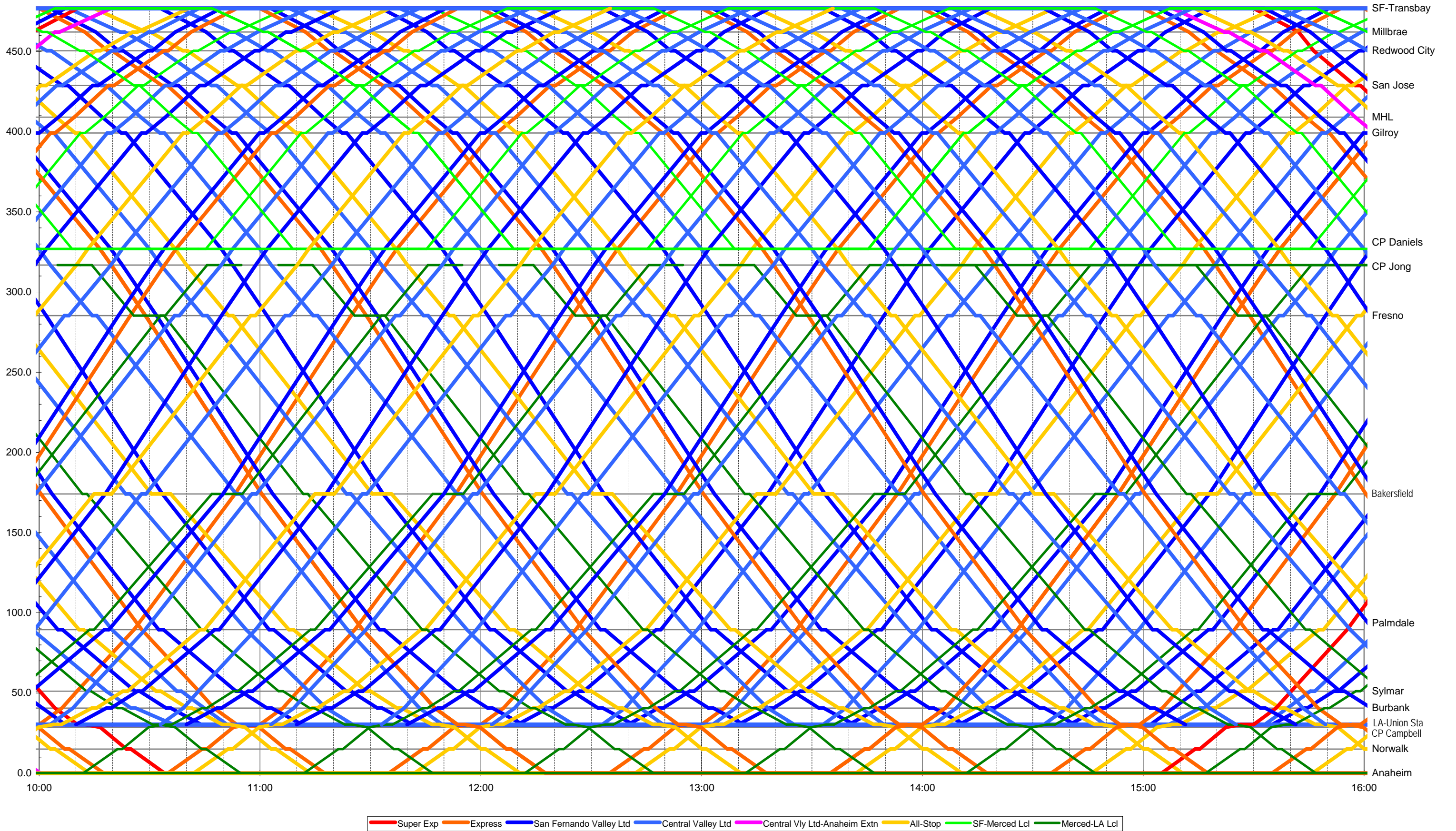
- Morning Peak Period
- Mid-Day Period
- Afternoon Peak Period
- Evening and Late Night Period

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Appendix B2 - HSR PHASE 1 SERVICE PLAN - VARIATION (Version 10B) - MORNING PEAK

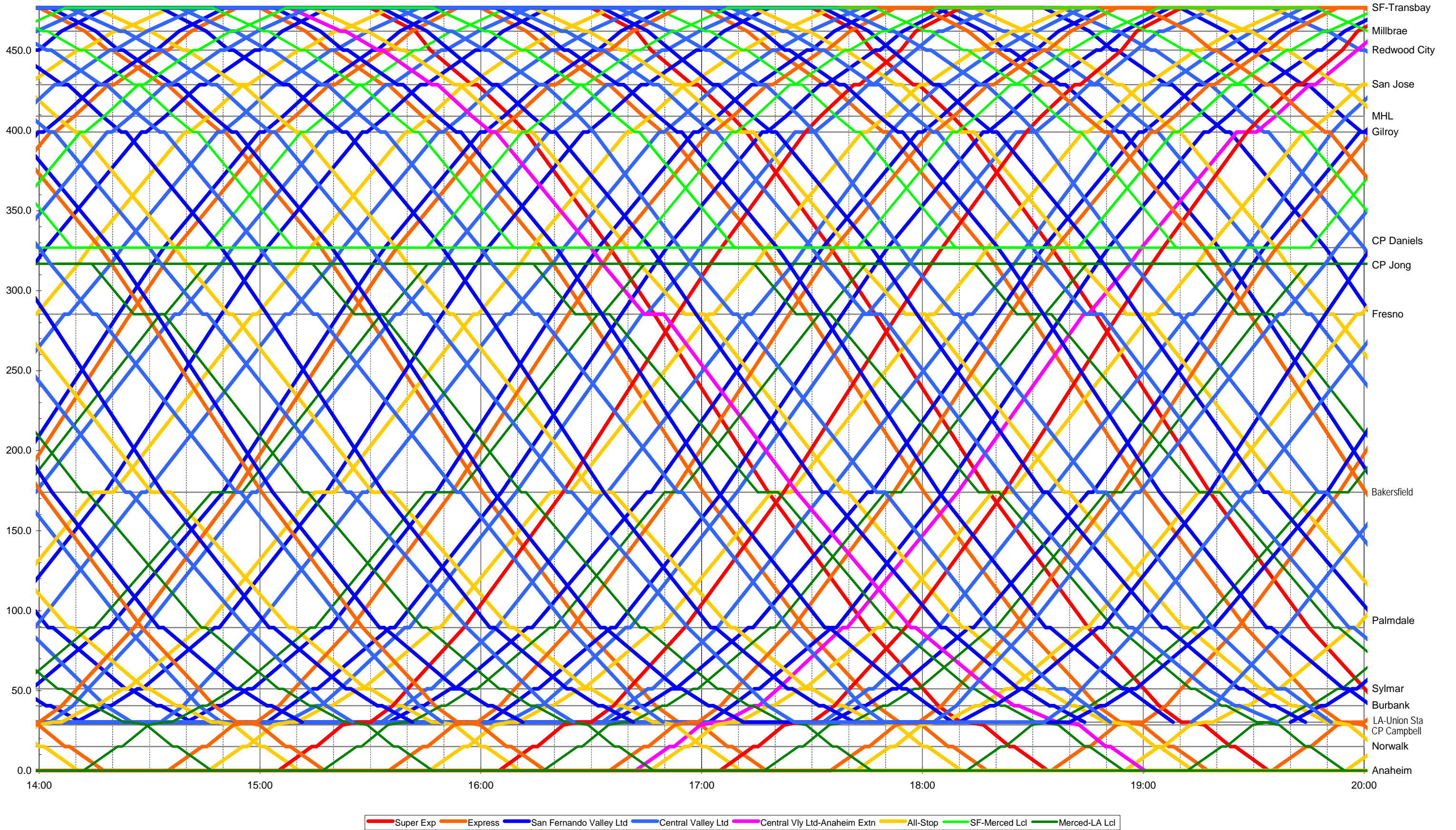


Appendix B2 - HSR PHASE 1 SERVICE PLAN - VARIATION (Version 10B) - MID-DAY



Legend: Super Exp (red), Express (orange), San Fernando Valley Ltd (dark blue), Central Valley Ltd (light blue), Central Vly Ltd-Anaheim Extn (magenta), All-Stop (yellow), SF-Merced Lcl (green), Merced-LA Lcl (dark green)

Appendix B2 - HSR PHASE 1 SERVICE PLAN - VARIATION (Version 10B) - AFTERNOON PEAK



Appendix B2 - HSR PHASE 1 SERVICE PLAN - VARIATION (Version 10B) - LATE EVENING

